A COMPREHENSIVE ASSESSMENT OF ALABAMA'S FUEL TAX ADJUSTMENT MECHANISMS AND ITS IMPACT ON TAXPAYERS' FINANCIAL CAPACITY

by

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ABSTRACT

This thesis presents a comprehensive evaluation of fuel tax adjustment mechanisms intended to address Alabama's transportation demands without exceeding taxpayers' financial capacity. The study focuses on assessing the effectiveness of current and proposed methodologies for adjusting fuel tax rates, ensuring sustainable and equitable funding for transportation infrastructure.

The research addresses the growing funding gap in transportation infrastructure, driven by rising construction costs and evolving fuel consumption patterns. To promote a sustainable funding approach, this thesis developed the Alabama Department of Transportation Construction Cost Index (ALDOT_CCI), a robust tool designed to reflect average construction cost growth. This index serves as a critical resource for budgeting and financial planning within ALDOT. The study then employed a risk-based forecasting methodology, using Monte Carlo simulations to project future trends in construction costs, fuel tax revenues, and taxpayers' financial capacity over a 20-year period. This approach provides a probabilistic perspective on these key variables, highlighting their potential variability and implications for long-term sustainability.

A comparative analysis of the predicted values of the ALDOT_CCI, Gasoline Revenue Index (GRI), and Gasoline Tax Rate Index (GTRI) with the Taxpayer Financial Capacity Index (TFCI) was performed to assess the potential impacts of tax rate adjustments on ALDOT's financial capacity and taxpayers. The analysis underscores the importance of aligning tax rate adjustments with ALDOT's financial needs and taxpayers' ability to absorb these changes.

The study proposes two innovative methodologies for adjusting fuel tax rates: a fixed annual percentage adjustment based on the ALDOT_CCI, and a modified adjustment cap and frequency based on the National Highway Construction Cost Index (NHCCI). These methodologies aim to provide a balanced and equitable framework for future transportation funding policies, ensuring that tax rate adjustments are responsive to economic conditions and taxpayer capacity.

The findings reveal a growing disparity between rapidly increasing fuel taxes and slower growth in taxpayer financial capacity, particularly since the implementation of the Rebuild Alabama Act. The study highlights the need for periodic tax rate reviews and adjustments, improved data collection and analysis, stakeholder engagement, and the development of risk mitigation strategies. It further highlights the importance of exploring alternative funding mechanisms and assessing the impact of technological advances on fuel tax revenues and infrastructure needs.

The study concludes with several recommendations for improving Alabama's transportation funding mechanisms. These include periodic tax rate reviews, improved data analysis for decision making, and stakeholder engagement to foster public support. The research also calls for exploring alternative funding mechanisms, such as public-private partnerships and electric vehicle fees, to diversify revenue streams as fuel consumption patterns evolve. By implementing the proposed strategies, Alabama can meet future challenges and opportunities while maintaining a strong and resilient transportation infrastructure that supports economic growth and public well-being.

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War Eagle!

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LIST OF ABBREVIATIONS

ACCA	Association of County Commissions of Alabama
ACEA	Association of County Engineers of Alabama
ALDOT	Alabama Department of Transportation
ASCE	American Society of Civil Engineers
BLS	Bureau of Labor Statistics
CCI	Construction Cost Index
CPG	Cost Per Gallon
CPI	Consumer Price Index
DRI	Diesel Revenue Index
FHWA	Federal Highway Administration
GRI	Gasoline Revenue Index
ITEP	Institute of Economic and Tax Policy
MAPE	Mean Absolute Percentage Error
MCCI	Multilevel Construction Cost Index
NCSL	National Conference of State Legislatures
NHCCI	National Highway Construction Cost Index
PPPs	Public-Private Partnerships
ROUT	Robust Regression and Outlier Removal
STAs	State Transportation Agencies
TFCI	Taxpayer Financial Capacity Index
TRAM	Tax Rate Adjustment Methodology
VMT	Vehicles Miles Traveled

CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND AND MOTIVATION

Like other states in the United States, Alabama faces an increasing gap between the resources required to address road construction and maintenance needs and actual funding availability, including funding derived from gasoline and diesel taxes, also known as "fuel tax" (ASCE Report Card, 2022; IRC Brochure AL, 2022; Fisher II, M. P., 2018). The revenue created from these taxes contributes a considerable portion of Alabama's transportation funding (Transport Topics, 2023). Alabama relies heavily on fuel taxes to fund its road construction and maintenance projects (Puentes, R., & Prince, R., 2005).

In an ideal fuel taxation system, fuel tax rates would be constantly adjusted to match changes in transportation infrastructure needs without exceeding the financial capacity of taxpayers. However, besides the fact that Alabama's financial transportation infrastructure needs tend to exceed the financial capacity of taxpayers (as demonstrated in this thesis), there are several other factors that should be considered to determine ideal fuel tax rates. Examples of those influential factors include changes in the number of registered vehicles (which could be seen as a function of population), the implementation of fuel efficiency technologies by vehicle manufacturers, the increase in the number of electric vehicles (EV), and other factors that could affect fuel consumption trends (Miller, G., 2024; U.S. DOT, 2021; ICCC, 2022; ASCE, 2022; O'Connell, L., & Yusuf, J. E., 2013; Fisher II, M. P., 2018; Dumortier, J., Zhang, F., & Marron, J., 2016; Tax Policy Center, 2024; Auxier, Richard C., Iselin, John., 2017; Boddupalli, Aravind, & Erin Huffer., 2020; Zaretsky, Renu., 2019; Auxier, Richard C., 2014; U.S. Department of Transportation, 2021).

All those influencing factors create a level of complexity that makes it virtually impossible to establish rates that satisfy all stakeholders. Facing this impossibility, fuel taxation systems tend to be simplified by focusing on the needs of the most critical stakeholders. This thesis evaluates the current fuel tax rate adjustment methodology (TRAM) implemented in Alabama, and proposed alternative approaches, form the perspective of two important stakeholders: the Alabama Department of Transportation (ALDOT) and Alabama's taxpayers.

According to the U. S. Department of Transportation – Federal Highway Administration, Alabama kept its gasoline and diesel tax rates unchanged between 1993 and until the enactment of the Rebuild Alabama Act in 2019 (FHWA, 2024). That legislative act was intended to reduce Alabama's transportation funding gap through a two-phased process. The first phase, and the most aggressive one, consisted of a series of fixed tax rate increases between 2019 and 2021. By October 2021, both gasoline and diesel tax rates were increased by 10 cents per gallon, bringing them to 28 and 29 cents per gallon, respectively (Rebuild Alabama Act, 2019; Transport Topics, 2023). In the second phase, the Rebuild Alabama Act went beyond this 10-cent adjustment by indexing the fuel tax rate to the National Highway Construction Cost Index (NHCCI), ordering biannual (every two years) tax rate adjustments starting in October 2023, and according to observed NHCCI fluctuations (Rebuild Alabama Act, 2019). The act also provides a maximum biannual gasoline and diesel tax rate increase of one-cent per gallon during the second phase to limit the potential impact of significant NHCCI increases on taxpayers' financial capacity. Thus, phase two provides for significantly smaller increases, on a biannual basis, and over an indefinite period of time.

This study could not determine the reason that motivated Alabama to maintain a constant fuel tax rate for almost 30 years (between 1993 and 2021). It could be potentially explained by the observed annual increase in the sale of gasoline and diesel taxable gallons (U.S. Energy Information Administration EIA, 2024; ALDOR Annual Report, 2023), making tax rate adjustments unnecessary.

It should be noted that total taxes collected from fuel sales do not depend on fuel prices per gallon but on the number of taxable gallons sold across the state. Fuel tax rates are set as a fixed number of cents per gallon sold (FHWA, 2024). Thus, fuel prices could significantly increase or decrease without impacting total fuel tax revenue if fuel demand levels remain constant. On the other hand, an increase in fuel consumption could be sufficient to cope with the increasing transportation infrastructure demand without the need for a tax rate adjustment. However, this thesis demonstrates that observed annual increases in fuel consumption are not high enough to disregard the need for fuel tax rate adjustments. This could be the trigger for the new fuel taxation system implemented through the Rebuild Alabama Act.

Some neighboring states such as Georgia and Florida reacted earlier to this situation, in 2016 and 1997, respectively (Justia Law, 2022; FDOT, 2024), by indexing their fuel tax rates to the Consumer Price Index (CPI) published and maintained by the Bureau of Labor Statistics (BLS), states can ensure that tax revenues keep pace with inflation. This approach has been proposed by the Congressional Budget Office (CBO) as a way to increase federal excise tax rates on gasoline and diesel fuel (CBO, 2021). However, this thesis argues that the CPI is not an appropriate index to guide fuel tax rate adjustments when the TRAM is intended to react to changes transportation infrastructure needs. The CPI, which measures changes in the price level of a market basket of consumer goods and services, is a reliable indicator of inflation (BLS, 2024a), but transportation construction market could be affected by different inflationary trends.

The BLS provides detailed information on how the CPI is calculated and used, including specific categories such as household energy and motor fuel (Bureau of Labor Statistics, 2024b; Bureau of Labor Statistics, 2024c). By using the CPI, states can adjust their fuel tax rates to reflect general economic conditions (Congressional Budget Office, 2010), and it is a feasible TRAM indexing option when it is intended to be guided by changes in the financial capacity of taxpayers rather than on actual infrastructure needs. This thesis includes an assessment of the suitability of the CPI as the index to dictate periodical fuel tax rate adjustments in Alabama. However, the research methodology and proposed TRAM alternatives are based on infrastructure needs, using the CPI to determine how that infrastructure-needs focus would impact the financial capacity of taxpayers. The overall research methodology that framed this study presented in this thesis is divided into three parts aimed at answering three primary questions, as follows:

- **Part I** – How has the current Alabama's TRAM performed since its implementation?

  This is a deterministic, six-year performance assessment of the recently implemented TRAM. The assessment includes three years before and three years after the enactment of the Rebuild Alabama Act, and it is focused on quantifying the impact of its implementation on the financial capacity of both ALDOT and Alabama's taxpayers.

- **Part II** – How is the current Alabama's TRAM expected to perform over the next 20 years?

  This part of the study relays on risk-based (or probabilistic) 20-year forecasts of relevant transportation construction indices, fuel consumption and revenue trends, and several taxpayers' financial capacity indices (TFCIs) specifically developed for this study. Monte Carlos simulation was used to perform the risk-based forecasts as well as to conduct a stochastic comparative analysis among forecasted outcomes to predict potential future financial impacts of the current TRAM on ALDOT and Alabama's taxpayers.

- **Part III** – Is there an alternative TRAM that could offer a better long-term performance?

  Finally, the third part of this thesis proposes two alternative TRAMs intended to maintain the financial capacity of ALDOT. That means those TRAMs would not reduce ALDOT's financial gap but would prevent it from continuing to grow. While the financial impact on taxpayers is not considered on the tax rates adjustments from the two proposed TRAMs, this impact is quantified, so that policymakers can take them into consideration or plan for countermeasures if those TRAMs are considered for implementation.

In summary, Part I of this study allowed to conclude that the aggressive fuel tax rate adjustments provided by the Rebuild Alabama Act during its first phase successfully reduced the ALDOT's funding gap. However, the performance of that new TRAM was impacted by the unforeseen occurrence of the COVID-19 pandemic shortly after the enactment of the Rebuild Alabama Act.

The second part of the research methodology showed that the inflation measured by the NHCCI, which is aimed at representing the transportation construction market at the national level, tends to be higher than the actual inflation observed by ALDOT in the fluctuation of its construction costs. Nonetheless, it does not mean that the NHCCI-based TRAM is yielding tax rate increments that surpass actual inflation. As per the Rebuild Alabama Act, gas and diesel tax rate adjustments are limited to one-cent every two years, which is not sufficient to cope with the increase in transportation construction costs, facilitating again the continuous grow of the funding gap. This situation is erasing the financial benefits experienced by Alabama's transportation infrastructure during the first phase of the new TRAM.

The two alternative TRAMs proposed in Part III of this thesis are intended to align with ALDOT's inflation. The first alternative TRAM proposes annual adjustments based on a construction cost index specifically developed for this study. This alternative does not include a rate adjustment cap. This index was used in Parts I and II of the study to represent ALDOT's construction inflation.

Finally, the second alternative TRAM modifies the rate adjustment cap in the current NHCCI-based TRAM to allow for greater adjustments that align with the projected inflation. Likewise, the rate adjustment cap is set as a fixed percentage value rather than a fixed number of cents. That would make the TRAM more sustainable as it would now consider the time value of value. One-cent today is not the same as one-cent in 20 years.

The projected financial impact on different types of taxpayers due to forecasted tax rate adjustments from the two proposed alternatives was quantified and was found to be reasonably inconsequential. However, this thesis does not make conclusive statements regarding the significance of those impacts. That judgement is to be made by policymakers based on the results of this study.

1.2 ALABAMA TRANSPORTATION INFRASTRUCTURE NEEDS AND FUNDING GAP

Alabama's transportation infrastructure functions as the backbone of the state's economic vitality, linking communities, facilitating commerce, and ensuring the smooth flow of goods and services (ASCE Report Card, 2022). However, a concerning gap has emerged between the growing demands on the transportation system and the available resources. One key factor contributing to this disparity is the static nature of fuel taxes in Alabama, which have remained unchanged since 1993.

Over the past three decades, the state has undergone significant demographic and economic changes, leading to a proportional increase in transportation demands. The infrastructure that once adequately served the population now struggles to meet the burgeoning requirements of modern society. Despite the pressing need expressed by ALDOT for an additional $502 million annually to meet the state's transportation needs (ACEA, 2011 "A Silent Crisis"), current revenues from taxes on gasoline and diesel remain inadequate.

As Alabama's transportation infrastructure needs and funding challenges are navigated, it is becoming clear that changes implemented through the Rebuild Alabama Act were highly needed. The subsequent sections of this chapter explore the historical context of gasoline and diesel taxes and the structure of transportation funding in Alabama. They also briefly discuss the details of TRAM introduced by the Rebuild Alabama Act.

This study does not attempt to quantify the magnitude of Alabama's transportation infrastructure funding gap, which would be a challenging endeavor due to the complexity of ALDOT's operations and the wide range of transportation assets and programs managed by this agency. Those types of assessments usually involve higher uncertainty levels and rely on several assumptions. This thesis rather relies on a thorough assessment of Alabama's transportation infrastructure needs conducted by the American Society of Civil Engineers (ASCE) and published in its Infrastructure Report Card (ASCE, 2022). Although that ASCE report comprises various reports and assessments published across 2021 and 2022, many of their findings seem to be associated with data collected during 2019. Therefore, this study assumes that ASCE Infrastructure Report Card for Alabama represents the transportation infrastructure funding needs experienced by ALDOT during 2019. That is also the year in which the Rebuild Alabama Act was enacted. It is important to note that the information presented in the ASCE report may be interpreted with some bias, potentially influenced by the organization's objectives or advocacy efforts. The ASCE Infrastructure Report Card is cited in this study as the only available source that attempts to assess the transportation infrastructure founding gap in Alabama in 2019.

Assuming that this 2019 assessment of transportation infrastructure needs is reliable, the study takes this as a point of reference to determine if Alabama's new TRAM and the proposed alternative approaches are increasing, decreasing, or maintaining the 2019 funding gap. This year is also used as a reference to measure the impact that different TRAMPs would have on the financial capacity of different types of taxpayers. This is also a convenient point of reference since it is based on pre-COVI-19 conditions, allowing to assess the resiliency of the recently implemented TRAM.

If should be noted that the COVID-19 pandemic hit the world shortly after the enactment of the Rebuild Alabama Act, with worldwide social and economic consequences, including a significant impact on the transportation construction industry. Figure 1-1 shows a considerable post-COVID increase in the annual average growth rate (AAG) of six different construction cost/price indices after the pandemic, including two composite and four materials indices. The

NHCCI and Colorado Department of Transportation (CDOT) Construction Cost Index (CCI) (CDOT, 2024) are considered composite indices. That means that they mathematically combine historical pricing data from various types of construction activities and materials to produce a single index intended to reflect general price fluctuations in the highway construction market at the national and state level, respectively. The NHCCI indicates that construction prices are growing ten times faster after the pandemic (see Figure 1-1.a), while CDOT-CCI's AAG shows a 400% increase during the same period, going from 4.1% to 18.1% (see Figure 1-1.b).

The other four indices in Figure 1-1 are aimed at tracking price changes for specific construction materials. Those are the ALDOT Performance Grade (PG) Price Index (Figure 1-1.c) (ALDOT, 2024) and three Producer Price Indices (PPIs) published by the Bureau of Labor Statistics (BLS) for concrete products (Figure 1-1.d), iron and steel (Figure 1-1.e), and aggregate materials (Figure 1-1.f) (BLS, 2024). All those four indices show higher post-COVID AAGs, ranging from 9.9% to 26.1%. Even the aggregate materials index, which has the lowest post-COVID AAG among the four indices, shows a 250% AAG increase after January 2021 (from 3.9% to 9.9%). It is very unlikely for policymakers to have foreseen these market conditions when the new TRAM was implemented in 2019.

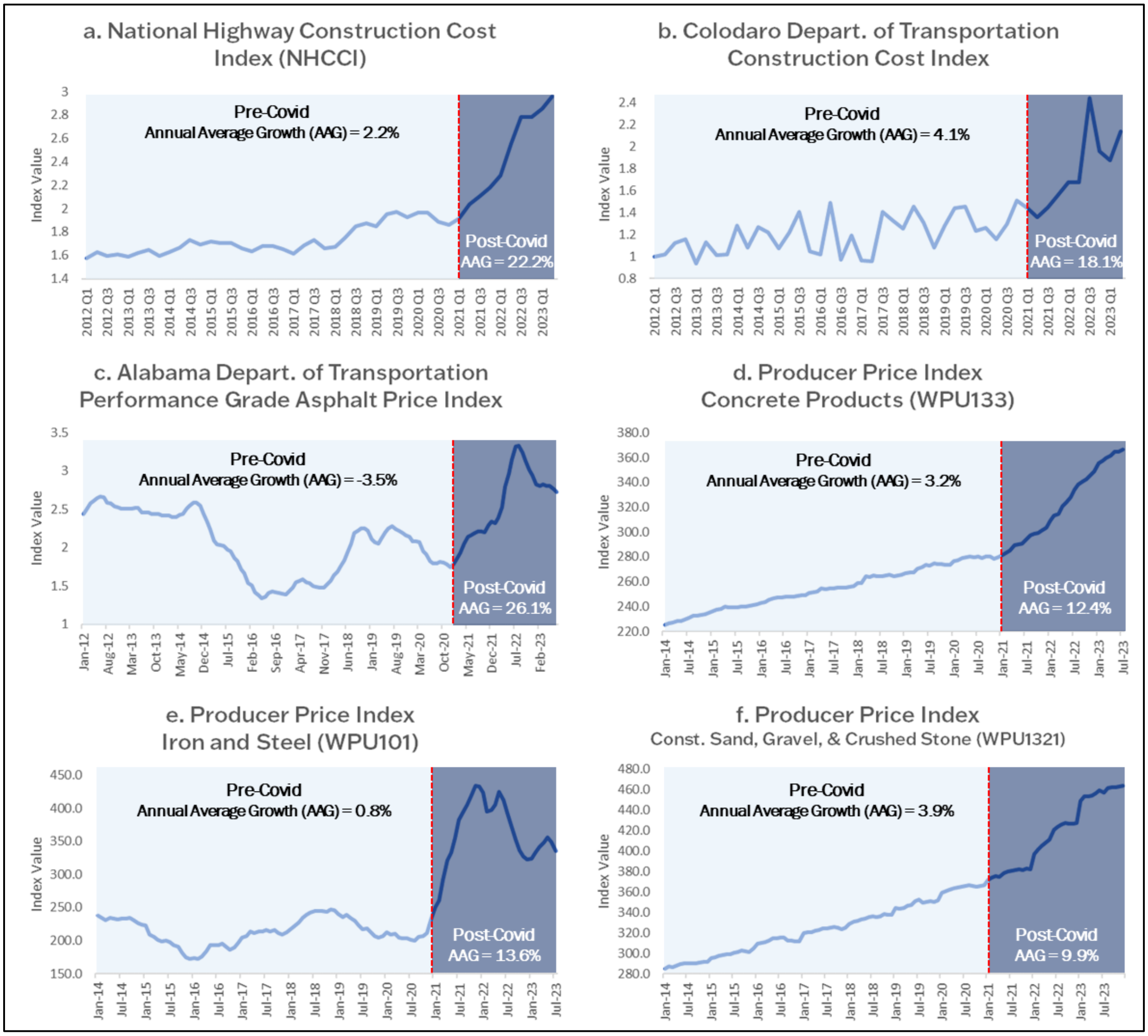


Figure 1-1. Pre- and Post-COVID Construction Market Growth

1.3 ALABAMA TRANSPORTATION FUNDING STRUCTURE

To comprehend the complexity of Alabama's transportation funding system, it is essential to understand the underlying structure that supports the development and maintenance of the state's expansive network. This section delves into the mechanisms and frameworks that constitute the financial backbone of Alabama's transportation infrastructure.

Alabama's transportation funding draws from a diverse array of sources, each playing a unique role in sustaining the extensive network of roads, bridges, and transit systems (ALDOT, 2023; Office of the Governor of Alabama, 2024). These sources include but are not limited to, fuel taxes, which have historically been a primary source of revenue for Alabama's transportation sector. However, the prolonged freeze on tax adjustments has hindered the sector's ability to keep pace with evolving demands. Vehicle registration fees also contribute substantially to the funding pool, and analyzing the trends and distribution of these fees provides insights into their effectiveness in addressing specific infrastructure needs. Additionally, Alabama receives federal allocations for transportation projects, and understanding the dynamics of these funds, including any conditions or limitations, is crucial for a comprehensive assessment of the state's infrastructure financing.

While these funding sources form the basis of Alabama's transportation finance, challenges persist within the existing structure. These challenges include insufficient revenue streams, as the current revenue sources, particularly fuel taxes, fall short of meeting the escalating demands for infrastructure development and maintenance. Additionally, navigating through budgetary constraints further complicates the allocation of funds, impacting the prioritization of crucial projects.

As the funding structure is examined, it becomes clear that a reassessment is essential to ensure the sustainability and resiliency of Alabama's transportation infrastructure. The subsequent chapters of this thesis will explore possible adjustments to fuel taxes and other financing mechanisms, offering ideas on how the state can overcome the challenges posed by the existing financing structure.

1.4 GASOLINE AND DIESEL TAXES IN ALABAMA

The taxation of gasoline and diesel fuels has long been a critical component of Alabama's revenue generation for transportation infrastructure. This section delves into the historical trajectory of gasoline and diesel taxes, with a particular emphasis on the provisions outlined in the latest legislative milestone, the Rebuild Alabama Act.

1.4.1 Historical Perspective

In Alabama, the evolution of gasoline and diesel taxes reveals a thoughtful aspect of how the state manages transportation infrastructure funding. From their early days, these taxes played a crucial role as a key financial pillar, supporting the development and maintenance of the state's roads and bridges (Alabama Transportation Institute, 2019). However, a point of genuine concern arises; tax rates have remained unchanged since 1993 and with the implementation of the Rebuild Alabama Act in 2019, a maximum increase of one-cent per gallon every two years is proposed. It should be considered that this regulation was implemented before the COVID-19 pandemic, so its performance should be evaluated again. This static approach over more than 30 years caused a growing funding gap that makes it increasingly difficult for the State to adequately invest in its infrastructure needs. Other states have been proactively adjusting their gasoline and diesel taxes to better accommodate inflation and rising project costs. But Alabama's tax rates have remained unchanged for years.

1.4.2 The Rebuild Alabama Act: Key Provisions

The most recent significant legislative intervention associated with this issue came in the form of the Rebuild Alabama Act. This act, enacted in 2019, outlined a comprehensive framework for funding transportation projects, emphasizing the need for sustainable revenue sources. Key provisions of the Rebuild Alabama Act related to gasoline and diesel taxes include:

- **Incremental Fuel Tax Increase:** Effective October 1, 2019, there was a modest 6 cents per gallon increase in the state gas and diesel tax. This incremental approach continued with an additional of two-cents per gallon on October 1, 2020, and another two-cents per gallon on October 1, 2021. The Alabama State Government estimates that when the full 10 cents per gallon gas tax increase went into effect, translates into an average monthly cost of $4.58 for the typical driver (Rebuild Alabama Act, 2019). As mentioned earlier in this chapter, this was the first and the most aggressive phase in the implementation of the new TRAM.
- **Distribution of Revenues:** The additional funds generated by these adjustments to the gasoline and diesel tax will be distributed with a community-centered approach. A majority, precisely 66.67%, will go to the State of Alabama, ensuring a broader impact on projects at the state level. Counties will receive a significant 25%, with the goal of addressing more localized needs and challenges. Finally, municipalities will receive 8.33%, contributing to the improvement of infrastructure at the community level. This distribution reflects a thoughtful strategy to ensure that the benefits of these tax increases reach various levels of the state, promoting a comprehensive improvement of the transportation infrastructure system.
- **Indexing:** After the 10-cent increase in the gasoline and diesel tax rate, the second TRAM phase consisted in indexing those rates to the NHCCI, which is maintained and published by the Federal Highway Administration. This means that starting in June 1, 2023, Alabama's gasoline and diesel tax rates are adjusted based on the annual percentage change in the NHCCI. This adjustment is made every two years, but it cannot exceed one-cent for each adjustment period.

In addition, tariffs are established for electric vehicles (EVs), with a portion of the funds allocated to an infrastructure program for charging stations. Restrictions are also imposed on the use of this new revenue, with annual audits to ensure accountability.

As the study navigated the historical landscape of gasoline and diesel taxes in Alabama, the need for a critical reevaluation became apparent. Subsequent chapters will delve into potential adjustments to these tax generation systems, considering both historical contexts and the evolving demands on the state's transportation infrastructure.

1.5 RESEARCH OBJETIVES

The main objective of this research was to evaluate the performance of the recently implemented gasoline and diesel tax collection system in Alabama and propose alternatives to optimize this performance to secure the funds necessary to maintain and expand Alabama's transportation network.

To accomplish this general objective, the research methodology was divided into three parts, with each part aimed at answering specific research questions, as follows:

Part I: Assess the performance of the Gasoline and Diesel Tax Rate Adjustment Methodology (TRAM) proposed by the Rebuild Alabama Act from its implementation in 2019 to the present. This evaluation is crucial for understanding the impact of the COVID-19 pandemic on the methodology's execution, given that the Act was implemented shortly before the pandemic began. Performance is assessed through the following research questions:

- How has the current TRAM impacted ALDOT’s financial capacity to expand and maintain Alabama’s Transportation Infrastructure? This was evaluated through the following tasks:

- Create a Construction Cost Index (ALDOT_CCI) using actual construction prices paid by ALDOT between October 2017 to September 2023 (Fiscal Year 2018 – Fiscal Year 2023), representing ideal revenue changes to match actual changes in the construction market perceived by ALDOT.
- Create Gasoline and Diesel Tax Revenue indices between October 21017 and September 2023.
- Compare ALDOT_CCI against Gasoline and Diesel Tax Revenue Indices.

➢ How the current TRAM has financially impacted taxpayers since its implementation? This was assessed through the following tasks:

- Create an annual Alabama Taxpayer Financial Capacity Index (TFCI) for each of the 22 occupations categories considered by the Bureau of Labor Statistics (BLS), as well as an overall TFCI for all Alabama workers ("All Occupations" Category in BLS system), covering FY 2018 to FY 2023.
- Create a Gasoline and Diesel Tax Rate Index to represent changes to those tax rates between FY 2018 and FY 2023.
- Compare Alabama TFCIs against Gasoline and Diesel Tax Rate Indices to determine if Tax Rate increases are exceeding, matching, or falling behind the financial capacity of taxpayers.

Part II: Assess the potential future performance of the current Gasoline and Diesel TRAM over the next 20 years (FY 2024 to FY 2043). Similar to objective 1, performance under this objective will be assessed through the following research questions:

- How will the current TRAM affect ALDOT's financial capacity to expand and maintain Alabama Transportation Infrastructure if it continues to be applied over the next 20 years? This was evaluated through the following tasks:
  - Use Monte Carlo Simulation to create a 20-years Risk-Based forecasts for:
    - ALDOT_CCI.
    - Gasoline and Diesel Annual Tax Revenue Indices. This task also requires 20-year forecasts for NHCCI and Annual Gasoline and Diesel Consumption.
  - Conduct a probabilistic comparison of Gasoline and Diesel tax Revenue Indices forecasts against ALDOT_CCI forecast.
- How will the current TRAM financially impact taxpayers if it continues to be applied over the next 20-year?
  - Use Monte Carlo Simulation to create 20-years Risk-Based forecasts for:
    - Each of the 23 TFCIs.
    - Gasoline and Diesel tax rate indices.
  - Conduct a probabilistic comparison of each forecasted TFCIs against the forecasted Gasoline and Diesel tax rates.

Part III: Based on the findings from Parts I and II, propose two alternative TRAMs to replace or enhance the current one. Recognizing that it is unrealistic to implement an alternative to fully address all infrastructure needs, the proposed alternatives are intended to maintain 2019 ALDOT's financial capacity.

- Alternative TRAM 1: A fixed annual percentage tax adjustment rate intended to match the forecasted ALDOT_CCI annual growth rate. This option is presented along with anticipated average wage increases required by each BLS occupation to compensate for the projected gasoline rate increase.

- Alternative TRAM 2: A modified adjustment cap and adjustment frequency for current NHCCI-based TRAM. This option is also presented with corresponding taxpayers annual wage increases.

1.6 ORGANIZATION OF THE THESIS

This thesis has been organized into Six Chapters, structured as follows:

- ***Chapter 1: Introduction and Background.*** This chapter provides an overview of the research topic, outlining the significance of the study within the context of current transportation infrastructure challenges. It introduces key concepts and sets the foundation for the subsequent chapters.
- ***Chapter 2: Literature Review***. This chapter discus existing research and relevant theories related to fuel taxation and transportation funding. The literature is synthesized to identify gaps in knowledge that this study aims to address.
- ***Chapter 3: Methodology.*** This chapter outlines and explains all the tasks that comprise the research methodology, as well as their corresponding research questions. It explains the research design and methods used to collect and analyze data and details the approach taken to evaluate the current fuel tax system and its adequacy in meeting infrastructure needs.
- ***Chapter 4: Results and Analysis.*** This chapter discusses the findings from the implementation of the research methodology presented in Chapter 3. This chapter

includes statistical results and insights drawn from the findings, highlighting trends and implications for fuel taxation.

- ***Chapter 5: Propose Alternative TRAMs***. This chapter proposes two alternative Tax Rate Adjustment Methodologies (TRAMs) based on the research findings. It discusses the potential performance of those alternatives in addressing funding shortfalls and adapting to changing transportation demands.
- ***Chapter 6: Conclusions and Recommendations.*** The final chapter summarizes the key findings of the study and offers recommendations for policymakers and stakeholders, as well as recommendations for future research. It evaluates the proposed options and discusses their potential impact on future transportation funding strategies.

CHAPTER TWO:
LITERATURE REVIEW

2.1 INTRODUCTION

This chapter provides a comprehensive review of the literature related to fuel tax adjustment mechanisms, focusing on their application to address transportation demands without exceeding taxpayers' financial capacity. The review covers the national funding gap, gasoline taxes in the United States, and alternative financing strategies.

2.2 FUNDING GAP AT NATIONAL LEVEL

ASCE (ASCE, 2022) has consistently highlighted the growing gap between infrastructure needs and available funding in the United States. The 2021 Report on America's Infrastructure underscores the urgent need to increase investment in transportation infrastructure to maintain and improve the nation's roads, bridges, and transit systems (ASCE, 2022). Focusing on Alabama, the ASCE Report on Alabama's Infrastructure provides a detailed assessment of the state's infrastructure across several categories. Over the lasts years, these reports have underscored the urgent need to increase investment in Alabama's transportation infrastructure to maintain and improve the state's roads, bridges, and transit systems.

The 2022 ASCE Report Card on Alabama's Infrastructure highlights the critical state of the State's transportation infrastructure and emphasizes the urgent need for increased investment. The report assigns an overall C grade to Alabama's infrastructure, indicating middling conditions that require significant attention. Specifically, the report notes that of Alabama's nearly 16,000 bridges, 41.5% are in good condition, 54.7% are in fair condition, and 3.8% are in poor condition. This marks an improvement from 2015, when 8.6% of bridges were rated as poor, largely due to financial support from the 2019 Rebuild Alabama Act, which increased the state's fuel tax by 10 cents per gallon (ASCE, 2022).

Additionally, Alabama's 102,200 miles of public roads face increasing congestion, which is projected to impact 17% of roads by 2035 (ASCE, 2022). The Rebuild Alabama Act and the Alabama Transportation Rehabilitation Improvement Program (ATRIP) have funded more than 140 road improvement projects since 2020, but the state still faces a 10-year annual funding shortfall of $113 million for bridges alone (ASCE, 2022; ALDOT, 2022). The Infrastructure Investment and Jobs Act (IIJA) is expected to provide Alabama with an average of $1.046 billion annually through 2026, which will help address these infrastructure challenges. The report recommends continued prioritization of transportation funding, improved project planning and management, increased infrastructure resilience and sustainability, and establishing a dam safety program to ensure the safety and functionality of Alabama's infrastructure systems.

To address these persistent challenges, the ASCE report offers several key recommendations. First, it highlights the need to increase the replacement of structurally deficient bridges, many of which are locally owned and operated. This is crucial to ensuring the safety and reliability of the state's transportation network. Second, the report calls for the development of state funding strategies that recognize the importance of functional drinking water, stormwater, and sewer infrastructure, which are essential to supporting Alabama's economic development.

In addition, the report recommends establishing a dam safety program to inspect the condition of the state's dams. This program should include a grant or revolving loan program to rehabilitate and repair dams in need, address potential safety risks, and ensure the integrity of these structures. The report also suggests prioritizing project planning and management techniques such as asset management, design-build project execution, and life-cycle costing. These techniques can help implement projects more intelligently and use funds more efficiently across all infrastructure sectors.

Another key recommendation is to leverage federal funding from initiatives like the Infrastructure Investment and Jobs Act. This influx of funds can help address the state’s infrastructure needs and support long-term improvements. Finally, the report highlights the importance of promoting public-private partnerships (PPPs) to attract outside investment and expertise, fostering innovation and efficiency in infrastructure development.

These recommendations aim to address critical issues facing Alabama’s infrastructure, ensuring the state’s transportation, water, and energy systems are safe, reliable, and capable of supporting future growth.

2.3 GASOLINE TAXATION IN THE U.S

The U.S. gasoline tax system is complex, but it plays a critical role in the financing the nation's transportation infrastructure. Historically, the gas tax has served as a primary source of revenue for both federal and state transportation systems, with its origins tracing back to 1919 at the state level, and the 1930s when the first federal gas tax was introduced at just one-cent per gallon. Over time, this tax became a cornerstone of transportation funding, helping to build and maintain highways, bridges, and other critical infrastructure (Alabama Transportation Institute, 2019).

However, the structure of gasoline taxation presents several challenges. The federal gas tax has remained constant at 18.4 cents per gallon since 1993, not accounting for inflation or increasing infrastructure costs (Auxier, R., & Iselin, J. 2017). This has led to a gradual erosion of the purchasing power of fuel tax revenues over the last few decades. Furthermore, the rise of fuel-efficient vehicles and the transition toward electric vehicles have worsened the issue, as they reduce fuel consumption and, consequently, the tax revenue collected.

Each state adds its own gasoline tax on top of the federal rate, leading to significant variation across the country. States with higher taxes, such as California, often generate more revenue for infrastructure projects, while states with lower taxes struggle to keep up with growing transportation needs. Some states have attempted to address these challenges through innovative solutions, such as vehicle miles traveled (VMT) taxes, to ensure a sustainable revenue stream for future infrastructure demands while taxing their taxpayers based on their level of use of the public transportation infrastructure (Alabama Transportation Institute, 2019).

2.3.1 Historical evolution

The historical evolution of gasoline taxes in the United States began in the early 20th century, with significant milestones marking its development. The first state gasoline tax was introduced in Oregon in 1919, followed by other states in the following decade (Abramson, 2017; Frohlich, 2021). This early adoption laid the groundwork for a widespread implementation of gas taxes across the country, highlighting its significance in financing infrastructure.

The federal gasoline tax was first enacted with the Revenue Act of 1932, originally set at $0.01 per gallon. This tax was initially intended as a temporary measure to help reduce the budget deficit during the Great Depression, but it became permanent as the need for infrastructure funding grew. Over time, the federal tax has seen several adjustments, particularly to support the expanding highway system, and it has remained unchanged at 18.4 cents per gallon since 1993 (Tax Foundation, 2014; Guttman Energy, 2018).

Gas taxes play a critical role in funding transportation infrastructure, with state and federal revenues primarily allocated to the construction and maintenance of roads. However, some states have diverted these funds for other uses, which has led to discussions about the effectiveness of gas taxes in meeting transportation needs (Kiplinger, 2014; Guttman Energy, 2018)

2.3.2 Federal vs. State Fuel Taxation

Gasoline taxes in the United States are managed at both federal and state levels, creating a complex interplay that significantly influences infrastructure funding. The federal government imposes a per-gallon excise tax, which serves as a crucial source of revenue for transportation projects nationwide. Simultaneously, individual states have the autonomy to establish their own fuel tax rates, leading to variations in funding across different regions (Bureau of Transportation Statistics, 2024; Oxford Academic, 2019). This dual structure not only impacts the availability of financial resources for infrastructure development but also affects the overall condition and maintenance of transportation systems (Bureau of Transportation Statistics, 2024; Oxford Academic, 2019).

Resources collected from federal taxes on gasoline and diesel in the USA are collected by the IRS and placed in the federal Highway Trust Fund (HTF) (The Tax Adviser, 2014). The Highway Trust Fund receives revenue from various taxes, including a motor fuel excise tax, which is 18.4-cents per gallon for gasoline and 24.4-cents per gallon for diesel. These funds are then allocated to states according to formulas established by federal legislation, (FHWA, 2024). According to the calculation of distributions between states and programs for fiscal year (fiscal year) 2024, the initial authorized initial distribution funds are $54,608,583,217 which will be distributed to all states. Of this sum, for the state of Alabama it corresponds to 1.95% (FHWA, 2024).

2.3.3 Challenges and Criticism

Despite being a crucial source of revenue, gasoline taxes face significant challenges and criticisms. Key issues include improvements in fuel efficiency, the increasing adoption of electric vehicles, and a widespread reluctance to raise tax rates, all of which present substantial obstacles to maintaining adequate funding for transportation infrastructure. The rise in fuel-efficient vehicles has led to a reduction in gas consumption, which directly impacts revenue derived from gasoline taxes (The PEW Charitable Trust, 2022). Similarly, the proliferation of electric vehicles further diminishes traditional fuel tax revenues, prompting calls for new funding models (Peter G. Peterson Foundation, 2021; The PEW Charitable Trust, 2022).

Additionally, there is often public resistance to increasing fuel taxes, making it difficult for states to adjust their funding mechanisms in response to these evolving infrastructure needs. To address these challenges effectively, it is essential to assess the current landscape and design strategies that ensure a sustainable and resilient financing model for transportation infrastructure. This could involve exploring alternative revenue sources, such as vehicle miles traveled (VMT) taxes, which could provide a more equitable way to fund road maintenance and construction in light of changing vehicle technologies (Peter G. Peterson Foundation, 2021; The PEW Charitable Trust, 2022).

2.3.4 Variable Gas Tax

In the United States, the 50 states, along with Washington, D.C., and the federal government, impose taxes on gasoline. As can be seen in Table 2-1, 24 states and Washington, D.C., use a variable gasoline taxation system. They have implemented systems to adjust their rates based on different inflation metrics or indices, without requiring legislative action.

According to the Institute of Economic and Tax Policy (ITEP), these states concentrate most of the country's population.

The federal gasoline tax has remained at 18 cents per gallon since 1993, while at least eight states have increased their gas tax during this period (NCSL, 2024). Despite these taxes, many states consider their gasoline tax revenues insufficient to meet transportation financing needs. Challenges arise from the shortcomings of a per-gallon gas tax, as more fuel-efficient vehicles, and less driving among younger generations' impact revenues. Additionally, the rising costs of transportation projects contribute to funding gaps; real spending on infrastructure is reportedly declining despite a nominal increase since 2003, according to the Congressional Budget Office.

Table 2-1. States with Variable Gasoline Taxes (NCSL, 2024)

State	Gas Tax Structure	Year of Last Increase
Alabama	Tax indexed annually to the National Highway Construction Cost.	2019
Arkansas	Tax based on the average wholesale price of gas and diesel, with a floor (prevents the tax from dropping if the 12-month average wholesale price of fuel is less than the previous year) and a ceiling (limits the increase to no more than .1 CPG).	2019
California	Tax varies with inflation.	2020 (per 2017 legislation)
Colorado	Beginning in fiscal year 2032-33 the 8-cent road user fee, which is levied on gasoline, will be indexed to Highway Construction Cost Index inflation.	(2032) (per 2021 legislation)
Connecticut	Tax varies with gas prices.	2013
Florida	Tax varies with CPI.	2015
Georgia	Tax varies with vehicle fuel-efficiency and CPI.	2015

Table 2-1. States with Variable Gasoline Taxes (NCSL, 2024)

State	Gas Tax Structure	Year of Last Increase
Hawaii	Variable rate only because general sales tax applies to gas.	**
Illinois	Tax varies with CPI.	
Indiana	Tax varies with inflation and general sales tax applies to gas.	2017
Kentucky	Tax varies with gas prices.	2015
Maryland	Tax varies with gas prices and CPI.	2013
Michigan	Tax varies with inflation.	2022 (per 2015 legislation)
Minnesota	Tax varies annually with increases in the Minnesota Highway Construction Cost Index. The rate will be 28.3 cents in 2024.	2023
Nebraska	Tax varies with gas prices and appropriation decisions.	2016
New Jersey	Tax varies with gas prices and revenue collection.	2016
New York	Tax varies with gas prices.	2013
North Carolina	Tax varies with population and CPI.	2015
Pennsylvania	Tax varies with gas prices.	2015
Rhode Island	Tax varies with CPI.	2015
Utah	Tax varies with gas prices and CPI.	2015
Vermont	Tax varies with gas prices.	2015
Virginia	Tax varies with CPI.	2020
West Virginia	Tax varies with gas prices.	2017
D.C.	Tax varies with CPI.	2020

2.4 ALTERNATIVE FUNDING STRATEGIES

Considering the challenges posed by traditional fuel taxation models, the exploration of alternative funding strategies becomes imperative. This section discusses innovative approaches and potential solutions to address the funding gap for transportation infrastructure, ensuring financial sustainability and adaptability to evolving economic landscapes.

2.4.1 Vehicle Miles Traveled (VMT) Tax

The Vehicle Miles Traveled (VMT) tax is gaining traction as a viable alternative revenue source for transportation funding. Unlike traditional fuel taxes, which are based on the amount of fuel consumed, the VMT tax directly correlates with the number of miles a vehicle travels. This approach allows states to capture revenue from all vehicles, irrespective of their fuel efficiency, making it a potential solution to the challenges posed by the rise of electric and fuel-efficient vehicles (FHWA, 2024; Peter G. Peterson Foundation, 2021; The PEW Charitable Trust, 2022).

Implementing a VMT tax can help address funding shortfalls caused by declining gas tax revenues while ensuring that all road users contribute fairly to infrastructure maintenance and development. Several states have initiated pilot programs to explore the feasibility of VMT taxation, evaluating its impact on road usage and revenue generation (Bipartisan Policy Center, 2022).

As this concept evolves, it is essential to consider public acceptance, technological requirements for tracking mileage, and the implications for privacy and data security. Overall, the VMT tax represents a forward-thinking approach to ensuring sustainable funding for transportation infrastructure in the face of changing vehicle technologies.

2.4.2 Principles of VMT Taxation

The fundamental premise of the Vehicle Miles Traveled (VMT) tax lies in its departure from the conventional fuel tax model. Rather than levying taxes based on fuel consumption, the VMT tax charges vehicle owners according to the miles they drive. This shift is particularly important in accommodating the evolving landscape of transportation, as it effectively addresses the revenue challenges posed by fuel-efficient and electric vehicles, which contribute less to traditional fuel tax revenues (Peter G. Peterson Foundation, 2021; The PEW Charitable Trust, 2022). By aligning tax structures more closely with actual road usage, the VMT tax can ensure that all road users, regardless of vehicle type, contribute fairly to infrastructure maintenance and improvement. This model not only enhances equity among drivers but also provides a more stable revenue stream for transportation funding.

2.4.3 Equitability and Sustainability

Unlike traditional fuel taxes, the VMT tax is based on the number of miles a vehicle travels, offering a more direct correlation between road usage and taxation. This approach aims to capture revenue from all vehicles, regardless of their fuel efficiency, thus providing a potential solution to the challenges posed by electric and fuel-efficient vehicles (FHWA, 2024; University of Minnesota, 2023). By implementing a system that taxes based on mileage rather than fuel consumption, states can better align funding mechanisms with actual road usage, thereby ensuring a more sustainable revenue stream for transportation infrastructure (NCSL, 2023; ASCE, 2023; Oregon Department of Transportation, 2022).

2.4.4 Technological Implementation

Implementing the VMT tax relies heavily on advanced technological solutions. Mileage tracking can be facilitated through various methods, including GPS systems, odometer readings, and emerging technologies such as smartphone applications that ensure accurate and secure data collection (FHWA, 2024; NCSL, 2023). Additionally, privacy concerns associated with tracking mileage can be effectively addressed through the design of privacy-preserving systems that anonymize data and restrict access to sensitive information (University of Minnesota, 2023;

Oregon Department of Transportation, 2022). These innovations not only enhance the efficiency of tax collection but also help build public trust in the VMT system.

2.4.5 Tolling and Congestion Pricing

Tolling and congestion pricing represent dynamic funding strategies where users pay fees based on the distance traveled or the level of congestion on specific roads. These approaches not only generate significant revenue for infrastructure maintenance and improvements but also promote efficient resource allocation by incentivizing drivers to consider alternative routes and modes of transportation (Farias, A., Zhu, S., & Mardan, A., 2024; Institute on Taxation and Economic Policy - ITEP, 2023; FHWA, 2023). By implementing these pricing strategies, cities can alleviate congestion during peak hours, ultimately enhancing mobility and reducing environmental impacts (Brookings Institution, 2023). As such, tolling and congestion pricing are emerging as critical tools for modern transportation funding and urban planning.

2.4.6 Public-Private Partnerships (PPP)

In the realm of infrastructure financing, Public-Private Partnerships (PPPs) open up a unique avenue for funding and development. These partnerships involve collaboration between public entities and private companies, allowing governments to tap into external investment and expertise for the funding, development, and maintenance of transportation projects (National Conference of State Legislatures - NCSL, 2023; Reinhardt, W., & Utt, R., 2012). This collaborative approach not only diversifies funding sources but also fosters innovation and efficiency within infrastructure initiatives.

PPPs present several advantages. They facilitate risk transfer from taxpayers to private investors, motivating private partners to manage projects efficiently to maintain profitability

(Smet, P., 2019). Additionally, the bundling of services in PPPs—combining design, construction, and maintenance—can streamline delivery and reduce costs, ultimately leading to more effective project execution (NCSL, 2023; Reinhardt, W., & Utt, R., 2012). Successful examples, such as those initiated in Virginia and Texas, showcase how PPPs can mobilize significant capital from private entities while addressing pressing infrastructure needs (Smet, P., 2019).

As federal transportation funding faces constraints, there is increasing bipartisan support for greater private sector involvement through mechanisms like TIFIA (Transportation Infrastructure Finance and Innovation Act) grants, which enhance the role of PPPs in the future of transportation infrastructure financing (Reinhardt, W., & Utt, R., 2012).

2.4.7 Innovative Financing Instruments

Exploring innovative financing instruments, such as infrastructure bonds and green financing, opens new possibilities for funding transportation projects. These instruments attract private investment and align with sustainability goals, providing a nuanced approach to infrastructure financing (FHWA, 2024).

Infrastructure Bonds are designed to mobilize private sector investment for public infrastructure projects. They can be particularly effective in funding large-scale projects, as they allow investors to earn returns while contributing to the development of essential services (WallStreetMojo, 2024). These bonds can finance highways, bridges, and public transit systems, improving connectivity and economic growth.

Green Financing is another crucial area that has gained traction, especially as environmental concerns become increasingly important. Green bonds, for example, are specifically issued to raise funds for projects that have positive environmental impacts, such as renewable energy, sustainable transportation, and energy efficiency initiatives. The International Finance Corporation (IFC) has been instrumental in promoting green bonds, having launched its Green Bond Program in 2010 to support climate-smart investments. This initiative has raised significant capital for sustainable projects, demonstrating the potential of green financing to contribute to climate resilience and reduction in greenhouse gas emissions (International Finance Corporation – IFC, 2023).

Additionally, leveraging innovative financing mechanisms can help reduce the funding gap for infrastructure improvements. By incorporating sustainable practices into project design and execution, governments and agencies can not only attract investment but also ensure that the benefits of these projects extend to future generations (International Finance Corporation – IFC, 2023).

2.4.8 Challenges and Considerations

While the Vehicle Miles Traveled (VMT) tax offers a promising alternative to traditional fuel taxes, several challenges and considerations must be thoughtfully addressed to ensure its effective implementation. Privacy concerns arise from the tracking of vehicle mileage, as some individuals may be apprehensive about the potential misuse of their data or constant surveillance (FHWA, 2024). Additionally, the technological infrastructure requirements are significant; establishing a reliable system for accurately tracking mileage can be costly and complex (NCSL, 2023). Furthermore, there is a risk that the VMT tax could disproportionately impact rural or low-income individuals, who may drive longer distances for work or essential services, thus potentially placing an undue burden on these populations (NCSL, 2023).

Addressing these challenges will be critical for the successful adoption of a VMT tax system. Policymakers must consider implementing safeguards to protect user privacy, invest in the necessary technological infrastructure, and explore ways to mitigate the financial impact on vulnerable populations (FHWA, 2024). Such measures will help ensure that the VMT tax is equitable and sustainable while effectively generating the needed revenue for transportation infrastructure.

2.4.9 Pilot Programs and Success Stories

Several states in the U.S. have initiated pilot programs to explore the feasibility and public acceptance of Vehicle Miles Traveled (VMT) taxation. These pilot programs provide valuable insights into the practical implications, challenges encountered, and the overall public reception of this alternative funding strategy. For instance, Oregon's program has been particularly notable, allowing participants to opt into a mileage tax as an alternative to the state's fuel tax, demonstrating both technical viability and potential public support (NCSL, 2023; FHWA, 2024). Similarly, Washington State has launched its pilot project, which focuses on assessing the effectiveness of VMT taxation while considering the implications for equity and technology (ITEP, 2023).

Additionally, studies from these programs have highlighted concerns regarding privacy, data security, and the potential impact on low-income drivers, emphasizing the need for comprehensive public engagement and transparent communication (NCSL, 2023). As states continue to evaluate these pilot programs, the lessons learned will be crucial in shaping the future of transportation funding across the country.

2.4.10 Future Perspective

As transportation systems evolve and the automotive landscape shifts towards electric and fuel-efficient vehicles, the Vehicle Miles Traveled (VMT) tax emerges as a forward-looking solution. Its adaptability to changes in driving habits and vehicle technologies positions it as a key contender in the quest for a sustainable and equitable funding strategy for transportation infrastructure. The VMT tax addresses the challenges posed by declining fuel tax revenues, allowing states to maintain necessary funding levels for infrastructure projects (FHWA, 2024; NCSL, 2023). As the landscape of alternative financing strategies is navigated, it becomes clear that a diversified and adaptable approach is essential to address the evolving challenges in transportation infrastructure financing (ITEP, 2023; NCSL, 2023).

2.5 CONSTRUCTION COST INDEXING

In “The Making of Index Numbers”, Irving Fisher defines indices as tools for measuring average percentage changes in prices over time, highlighting their fundamental role in economic analysis (Fisher 1922). He discusses their applications for tracking fluctuations in stock markets, wholesale prices, and wages, while emphasizing the need for reliable measurement methods. Fisher presents several methodologies, including arithmetic and geometric approaches, for constructing these indices. His work establishes a fundamental understanding of indices essential for analyzing economic indicators. Accordingly, and for the context of this thesis, a construction cost index (CCI) is defined as a tool used to measure average variations in construction prices over a period.

Historically, indices were primarily used to monitor changes in the stock market, wholesale and retail prices, as well as wages. The use of indices in construction dates back to the Aberthaw Index, which was designed to track changes in the costs of standardized seven-story reinforced concrete buildings (Hubbard 1921; Gill 1933). Since then, the prevalence of construction cost indices (CCIs) has increased, and numerous public and private organizations now publish and maintain various cost indices in the construction field. Beyond financial measures, other indices have emerged to track changes in factors such as safety (Du 2013), quality (Lee 2013), and sustainability (Olson 2013). However, the primary focus of CCIs remains on adjusting unit prices and estimating construction costs based on market trends (Rueda and Gransberg 2015).

Skolnik (2011) further elaborates on the role of price indices, particularly in transportation construction contracts, highlighting how these indices are crucial for risk mitigation. By reflecting market conditions accurately, price indices help to ensure fair compensation over the course of long-term infrastructure projects, thereby fostering financial stability for both public and private stakeholders. Moreover, Skolnik’s insights align with Fisher's foundational concepts, reinforcing the importance of flexible indexing methods in construction cost management.

Erickson and White (2011) describe the Federal Highway Administration’s National Highway Construction Cost Index (NHCCI), a specialized index that tracks changes in highway construction costs across the U.S. Their research emphasizes how this tool supports accurate cost estimation and budgeting, complementing traditional indices used in construction projects. Additionally, White and Erickson (2011) introduced a new cost estimation tool to enhance planning and financial management in large-scale construction efforts. Guerrero (2003) also provides a comparative analysis of state-level highway construction costs, offering insights into regional differences and the broader implications for transportation funding strategies.

The literature further classifies CCIs according to various criteria, such as mathematical approaches (e.g., arithmetic, geometric), index composition (simple, weighted, composite), recalculation frequency (monthly, quarterly, annually), and geographical scope (national, local) (Fisher, 1922; Allen, 1975; Rueda, 2013). CCIs are divided into input indices, which measure price changes in building components, and output indices, which track overall construction prices, including indirect costs (Rueda and Gransberg, 2015). Rueda and Gransberg (2015) also introduce a three-tier classification system for CCIs based on their use. **Input Indices** measure changes in material and labor prices, **Output Indices** reflect overall price shifts including indirect costs, and **Composite Indices** combine both, offering a comprehensive overview of construction price fluctuations. This system provides clarity in understanding and applying CCIs in construction pricing and cost management.

Rueda and Gransberg (2015) introduced a three-tier system of CCIs that reflects the different levels of index applicability, improving clarity in their use for construction projects. They also presented two fundamental principles frequently overlooked in the application of composite indices: the matching and proportionality principles. The matching principle emphasizes the importance of alignment between the components used in a CCI's calculation and the actual project elements it aims to adjust. Once this principle is fulfilled, the proportionality principle comes into play, referring to the alignment between the weights of the index components and their respective contributions to the total project cost. Ideally, perfect CCI application would mean that each contract pay item is matched with a corresponding commodity in the index, and that their weights are proportionate to their impact on the total cost. However, any breach of the matching principle inherently leads to a breach of proportionality (Rueda and Gransberg 2015).

Furthermore, state transportation agencies (STAs) often violate these principles when they assume that (1) market changes impact all construction projects equally, and (2) weighted price changes in a few major materials represent overall construction cost changes. These assumptions distort accurate cost estimation and adjustment, underscoring the need for more precise index application (Rueda and Gransberg, 2015).

2.5.1 Multilevel Construction Cost Index - MCCI

Recent studies have expanded this understanding, introducing the concept of a Multilevel Construction Cost Index. Gransberg and Rueda (2014), Pakalapati and Rueda (2018), and Mayorga (2020) applied this concept in studies for the Minnesota Department of Transportation (MnDOT) and the Alabama Department of Transportation (ALDOT). The Multilevel Construction Cost Index refines cost estimation by incorporating regional, project-specific, and temporal data, offering a more nuanced understanding of construction cost trends at different levels of detail. These indices are crucial for more accurate cost adjustments and estimations in large-scale transportation projects. The MCCI approach is the one adopted for the creation of the ALDOT_CCI in this study. That is basically an extension of Pakalapati and Rueda MCCI (2018) (which was also created for the ALDOT) with some improvements proposed by Mayorga (2020).

2.5.2 Construction Cost Indices vs. Construction Inflation in Alabama

The NHCCI is commonly used as a metric for transportation construction market fluctuations, and this is the index adopted in Alabama to guide fuel tax rate adjustments. In other words, it is assumed that this index appropriately represents transportation construction inflation in Alabama. This study challenges this assumption by comparing the NHCCI against a MCCI developed for ALDOT (ALDOT_CCI). Given the fact that the ALDOT_CCI was developed with historical pricing data provided by ALDOT, and that the MCCI methodology has been successfully validated by the three previous studies referenced in the previous section, his study assumes that the ALDOT_CCI reasonably represents the transportation construction market in Alabama.

Figure 2-1 allows to visually comparing the annual inflation measured by both the NHCCI and the ALDOT_CCI between 2017 and 2023. This figure also includes the Consumer Price Index (CPI), which is used by several states in their TRAMs, as previously shown in Table 2-1. To facilitate the comparison, the three indices were scaled to have an index value of one (1) in 2019. The figure shows how the construction related indices (ALDOT_CCI and NHCCI) experienced a greater increase in their growing rates after the pandemic in comparison with the CCI. This suggests that CCI-based TRAMs may not help transportation agencies to cope with the post-COVID inflationary rates. It should be noted that in Alabama, as in many other states, the pandemic caused substantial supply chain disruptions, labor shortages, and project delays, which have been reflected in higher construction costs (Marcum, 2021; U.S. Bureau of Labor Statistics, “A Look at the Price of Construction,” 2021).

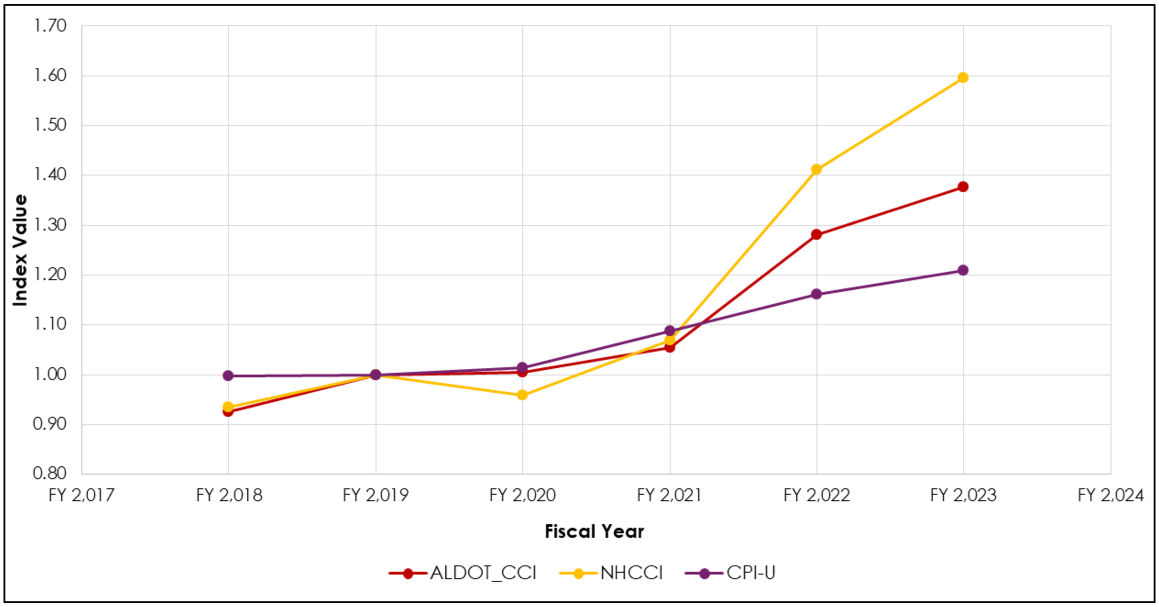


Figure 2-1. ALDOT_CCI vs. NHCCI vs. CPI-U (FY2019 – FY2023)

On the other hand, national transportation construction inflation measured by the NHCCI seems to be considerably greater than the actual inflation affecting ALDOT's construction activities, as per ALDOT_CCI. Given the significant differences between the NHCCI and ALDOT_CCI in the process to calculate their index values, Figure 2-1 should not lead to the conclusion that transportation construction inflation is greater at a national level in comparison with the one experienced in Alabama. An MCCI approach applied at the national level could yield different results. Regardless of the accuracy of the NHCCI at measuring national inflation, Figure 2-1 could only be seen as an indicator that an NHCCI-based TRAM could lead to greater-than-needed fuel adjustment rates in Alabama. However, the Rebuild Alabama Act has, intentionally or unintentionally, addressed this issue by capping fuel tax rate adjustments. The maximum one-cent rate adjustment provided by the Rebuild Alabama Act is discussed in more detail in Section 2.4.

Figure 2-1 only shows index fluctuations over five years. However, the conclusions made from this graph have been confirm latter in this thesis when the three indices were analyzed over longer periods of time to allow for 20-year forecasts. In general, inflation measured by the NHCCI is greater than actual transportation construction inflation in Alabama, while the CPI tends to underestimate that industry-specific inflation.

This observation also led to the consideration of the two alternative TRAMs proposed in this study: 1) a TRAM based on ALDOT_CCI, which should provide the most accurate adjustments but would require efforts to continuously maintain and recalculate the proposed ALDOT_CCI, and 2) a NHCCI-based TRAM, like the current one, but with a more maximum adjustment rate intended to reflect actual inflation level perceived by ALDOT. The two alternative TRAMs proposed in this thesis are aimed at providing tax rate adjustments that match actual transportation construction fluctuations. Thus, a TRAM driven by the CPI would require a multiplier rather than a cap. That option was not considered in this study since such an option might not be positively perceived by various stakeholders. Nonetheless, the CPI was used in this study to quantify the financial capacity of taxpayers along the period of time considered in this study.

2.5.3 Understanding the NHCCI

The National Highway Construction Cost Index (NHCCI) is a crucial metric used to track the cost of highway construction and maintenance. Although it is intended to track fluctuations in the transportation construction market at the national level, it is used in Alabama, and in other states, as a measure of state or local inflation. This index has risen significantly in recent years. According to data from the Federal Highway Administration (FHWA), highway construction costs have climbed by 67% between 2003 and 2017, with asphalt, concrete, and metal prices rising even more steeply. This steady increase presents challenges for state budgets and project planning, requiring adjustments to ensure funding keeps pace with inflation in construction materials and labor (FHWA, 2017).

Moreover, Alabama's reliance on gas taxes and other transportation funding mechanisms faces strain due to increasing infrastructure demands and inflation in construction costs. Reports from the Alabama Transportation Institute highlight the importance of addressing these funding gaps to maintain competitiveness in infrastructure quality. The state's road system is essential for economic growth, and investment in road maintenance and capacity will be critical to support both freight and passenger transport (Alabama Transportation Institute, 2019).

2.5.4 Is the 1-Cent Maximum Fuel Tax Adjustment Rate Appropriate?

While the first and more aggressive phase of the Rebuild Alabama Act contributed to reduce the funding gap affecting transportation agencies in Alabama, this study has found that the one-cent adjustment cap in the indexed second phase of the Act might erase the benefits provided by the first phase. This restriction was initially designed to exert fiscal control and prevent excessive tax fuel increases that could financially impact taxpayers. However, as highway construction costs escalated, driven by the factors captured in the NHCCI, the one-cent cap began to limit the state’s ability to generate enough revenue to fund transportation projects. The gap between available financial resources and the real costs of road maintenance and construction grew wider, creating a funding shortfall that is impacting Alabama's ability to sustain its transportation infrastructure.

This study has found that most future biannual tax rate adjustments provided by the Rebuild Alabama Act will be affected by this one-cent cap, preventing the TRAM from aligning with actual market inflation and continuously increasing the funding gap. Moreover, a long-term implementation of this gap will create a chronic issue that would worsen over time due to the time value of money concept. One-cent in five or ten years is worth less than one-cent today. That means that a TRAM with this type of cap will be increasingly restrictive over time. Taking this into consideration, the maximum tax rate adjustment considered in the second alternative TRAM proposed in this study is set as a maximum percentage change rather than as a fixed number of cents.

Limitation contributed to the dissonance between the resources needed for critical infrastructure updates and the revenues generated from fuel taxes, which historically formed the backbone of Alabama's transportation budget. In response, Alabama policymakers have increasingly explored alternative funding mechanisms and tax reforms to bridge the widening financial gap (FHWA, 2017; Alabama Transportation Institute, 2019).

2.5.5 The Path Forward

As Alabama's transportation challenges are analyzed in light of the NHCCI and escalating construction inflation, it becomes clear that the current one-cent fuel tax adjustment limit is increasingly insufficient. The state faces mounting pressure to realign its transportation funding with the realities of rising costs. A strategic reevaluation of these limits is not only necessary but critical to ensuring that Alabama can maintain and improve its infrastructure. In the chapters that follow, potential solutions will be explored, including alternative revenue models and adjustments to existing tax structures, offering a detailed roadmap to help Alabama navigate the evolving economic landscape.

Policymakers will need to weigh the benefits of increasing taxes against the public's tolerance for higher fuel costs, while also considering more resilient funding mechanisms not addressed in this study, such as tolling, public-private partnerships, or vehicle-miles-traveled taxes (FHWA, 2017). By addressing these issues head-on, Alabama can develop a more sustainable approach to funding its transportation network and ensure long-term infrastructure stability.

CHAPTER THREE: METHODOLOGY

3.1 INTRODUCTION

The chapter presents a detailed description of the methodology adopted in this study and illustrated in Figure 3-1. As shown in that figure, research activities associated with this study started with a considerable data collection and cleaning effort, before proceeding with a three-part research approach. Part I was limited to assessing the observed performance of current Alabama's fuel tax rate adjustment methodology (TRAM) since its implementation in 2019. This assessment is limited to the impact of the TRAM on the financial capacity of the Alabama Department of Transportation (ALDOT) and different types of taxpayers.

While Part I relies on known data reported between FY2018 and FY2023, Part II attempts to predict future unknown values for several indices to determine how the current TRAM might continue affecting ALDOT and Alabama's taxpayers over the next 20 years. It consists of the risk-based (or probabilistic) forecast and analysis of various relevant market and economic indices. Finding for Parts I and II are then analyzed in Part III to proposed two alternative TRAMs. Those two alternatives are mainly intended to maintain rather than improve the financial capacity of ALDOT. That means that ALDOT's financial gap would remain the same. It would not grow. It should be noted that the proposed alternatives are not driven by the financial capacity of Alabama's taxpayers, but that impact is quantified in Part III. Although this impact does not look significant, such determination should be made by policymakers given a potential implementation of one of the proposed TRAMs. The following sections in this chapter discuss the details of each of the three research parts.

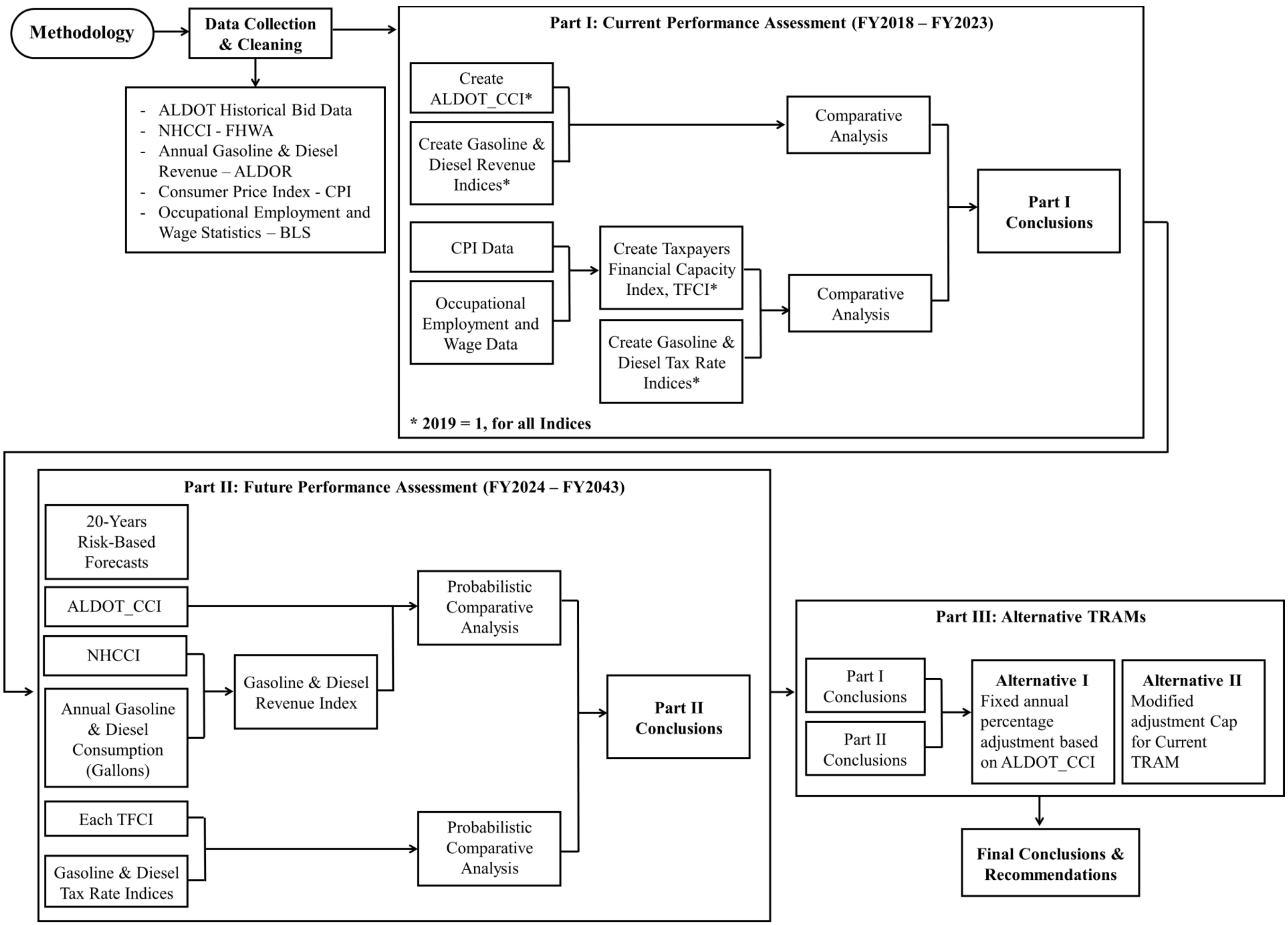


Figure 3-1. Research Methodology

3.2 DATA COLLECTION AND CLEANING

This section presents an overview of the sources and methodologies used for data collection and cleaning in this study, which mainly consisted of the following five datasets:

- ALDOT historical bid data – Source: ALDOT
- National Highway Construction Cost Index (NHCCI) – Source: Federal Highway Administration (FHWA)
- Annual gasoline and diesel tax revenue – Source: Alabama Department of Revenue (ALDOR)
- Consumer Price Index (CPI) – Source: Bureau of Labor Statistics (BLS)
- Occupational employment and wage statistics, all occupations average, and average for 22 different types of occupations – Source: BLS

3.2.1 ALDOT Historical Bid Data

A significant portion of the data collection efforts in this study were focused on this dataset. This collection process involved extracting bid tabulations from ALDOT databases on construction projects awarded from October 2017 to September 2023, spanning a six-year duration. Within this period, a total of 1,513 contracts were awarded, which served as the critical data set for the analysis conducted in this study. Since this is a massive dataset, it cannot be included in this thesis, but it is summarized throughout this section.

ALDOT's website periodically posts all bids submitted for each project to be performed, displaying each pay item listed in the contract along with the unit price submitted by each bidder. It is important to note that ALDOT provides the list of items and quantities of work through its Request for Proposals (RFP). Therefore, all bidders submit their offers under the same specific conditions for each contract, ensuring that all have identical information about the activities and quantities of work to be performed. After receiving and evaluating each bid, ALDOT identifies the lowest and qualified bid to award the contract. Typically, the bidder with the lowest or most favorable bid receives the highest ranking (e.g., ranking 1), indicating that its bid is the most advantageous to ALDOT based on the evaluation criteria. Bidders are then ranked in ascending order, with the highest ranking corresponding to the bidder with the highest values.

Regarding the extraction of historical bid data, it was obtained directly from the ALDOT website in portable document format (PDF). Figure 3-2 illustrates the format of information publication on the ALDOT website, which is PDF format. To manipulate and process data efficiently, all PDF files needed to be converted to Microsoft Excel format. Adobe Acrobat software was used to conduct that data format conversion. However, during the conversion process, errors occurred. Some text was not recognized correctly, causing it to be converted to images, and there were formatting inconsistencies across different sheets of the PDF document. These issues posed challenges during the data collection process.

Once these inconsistencies were addressed and corrected, a series of special formulas were developed within the Excel spreadsheet. These formulas were designed to extract the required information from each cell, ultimately generating an organized and detailed database. This database significantly streamlined the subsequent evaluation process.

Alabama Department of Transportation
Tabulation of Bids

DATE: 10/27/2017
Page: 2

Call Order: 999 **Contract ID:** 20171027999 **County:** TUSCALOOSA
Letting Date: October 27, 2017 **Area/District:** 0502 **Contract Time:** 50 Working Days
Contract Description: **Project(s):** 99-705-630-013-701
SLOPE REPAIR (FRONT SLOPE FAILURE) ON SR-13 (US-43) AT MP 207.700 NORTH OF NORTHPORT

Line No / Item ID Item Description			(1) E. O. BYARS CONSTRUCTION, INC.		(2) W. S. NEWELL & SONS, INC.		(3) IKAROS, LLC	
Alt Set / Alt Member		Quantity and Units	Unit Price	Ext Amount	Unit Price	Ext Amount	Unit Price	Ext Amount
0100	602A000	4.000	250.00	1,000.00	396.00	1,584.00	750.00	3,000.00
Right Of Way Markers		Each						
0110	610D003	2,050.000	2.00	4,100.00	2.82	5,781.00	4.00	8,200.00
Filter Blanket, Geotextile		SQYD						
0120	630A001	575.000	22.00	12,650.00	23.10	13,282.50	23.35	13,426.25
Steel Beam Guardrail, Class A, Type 2		LF						
0130	652A100	1.000	1,050.00	1,050.00	2,000.00	2,000.00	1,300.00	1,300.00
Seeding		Acre						
0140	656A010	1.000	1,050.00	1,050.00	2,000.00	2,000.00	1,300.00	1,300.00
Mulching		Acre						

Figure 3-2. ALDOT's Bid Tabulation in PDF Format.

In data cleaning, organization plays a crucial role. Well-ordered data sets are easier to manipulate, model, and visualize. They follow a specific structure where each variable or attribute corresponds to a column, each observation represents a row, and each type of observation unit forms a table (Wickham, 2014). Accordingly, for every bid submitted for ALDOT projects, essential information was collected and analyzed to ensure effective monitoring and evaluation. A breakdown of the obtained data, including a brief description of each attribute, is provided in Table 3-1.

Table 3-1. Data obtained and used in this study.

Attribute	Description
Number of the item analyzed	Consecutive number applied to each analyzed pay item to facilitate data tracking and organization
Item ID	A unique identifier assigned by ALDOT to each specific pay item or material listed in the contract.
Date	Bid's opening date. It is the date when the bids were reviewed and considered.
Contract ID	A unique identifier assigned to each specific contract or project. It corresponds to the contract in which each pay item was used in.
County	Alabama's County in which the corresponding project was located.
Item Description	Brief description of corresponding pay item.
Contract ID + Item ID	A unique identifier for each pay item in the extracted dataset. By concatenating the Contract ID and tem ID, each work item within a specific contract can be uniquely identified.
Quantity	Bid quantity or number of units listed in the contract for each specific pay item. This quantity is estimated by the owner and only used for contractor selection purposes. Actual work quantities at project completion may differ.
Unit	Unit of measurement used to quantify the amount of work estimated and delivered under each pay item.
Unit Price	Price per unit of work submitted for each pay item by each bidder competing for the corresponding project.
Extent Amount	Total price of a specific pay item or work material, calculated by multiplying the Unit Price by the bid Quantity.
Rank	Position or order in which bidders are ranked based on their bid submissions. The bidder with the lowest or most favorable bid generally receives the highest ranking (ranking 1).

Furthermore, the entirety of data gathered for the 1,513 contracts undertaken by ALDOT during the study period encompasses a total of 2,873 pay items that were available and considered for the projects, resulting in 275,055 rows or observations. Table 3-2 summarizes the volume of data collected for each fiscal year.

Table 3-2. Volume of data collected.

Fiscal Year	Quantities of CONTRACT ID	Quantities of PAY ITEMS	Quantities of Observations or Rows
FY 2018 Oct 2017 - Sept 2018	302	1,698	59,064
FY 2019 Oct 2018 - Sept 2019	297	1,251	51,417
FY 2020 Oct 2019 - Sept 2020	260	1,201	45,141
FY 2021 Oct 2020 - Sept 2021	237	1,349	43,962
FY 2022 Oct 2021 - Sept 2022	216	1,431	37,629
FY 2023 Oct 2022 - Sept 2023	201	1,387	37,842
TOTAL =	**1,513**	**8,317**	**275,055**
	Available Pay Items =	**2,873**	

As can be seen in the previous table, some pay items appear several times in the data sets, since they are used in different projects throughout the study cycle.

3.2.1.1 Selection of Relevant Pay Items – Basket of Pay Items

After compiling the initial dataset, the next step was the selection of frequently used pay items to form the Basket of Pay Items that built the proposed construction cost index for ALDOT (ALDOT_CCI).

The initial dataset contained 2,873 distinct pay items used in ALDOT projects. The focus was on identifying the pay items that were most frequently used and repeated every year throughout the study period. This identification process involved the following steps:

- A frequency analysis was conducted to determine which pay items appeared most frequently in the dataset. This involved counting the occurrences of each pay item across all projects and years.
- Based on the frequency analysis, the top 388 pay items were identified as the most used and consistently repeated items in ALDOT projects during the study period. These items were considered for further analysis due to their prevalence and potential impact on project costs and outcomes.
- Pay items that were paid by Each and Lump Sum were eliminated from the analysis. These items were excluded because it is not possible to generate a meaningful correlation with other items. Their payment structures and inherent variability could introduce significant errors in the calculations and projections made.
- After eliminating the non-correlatable items, *the final list comprised 263 pay items*. These items represent the core set of frequently used pay items that are suitable for analysis and evaluation.

After reducing the initial list of pay items to 263, the next step involved performing a detailed graphical analysis to further narrow down the items based on their correlation between unit prices and work quantities. To create a reliable cost index out of bid data, it is important to identify items whose price fluctuations can be tracked over time. However, due to the economies of scale principles, there is a correlation between unit prices and quantities of work. Therefore, the list of relevant pay items was further refined to leave only items whose unit price-quantity relationship can be reasonably modeled. The following outline summarizes the process of graphing and analyzing the pay items to determine if they meet this requirement:

- For each pay item, the unit price was plotted against the quantity to visualize the relationship between these two variables. The purpose of this visualization was to identify patterns, trends, and correlations that could indicate the reliability of the data for analysis.
- Each graph was evaluated to determine the strength and consistency of the correlation between unit price and quantity. Pay items with clear, consistent correlations were deemed suitable for further study, while those with weak or inconsistent correlations were considered non-suitable.
- Figure 3-3 illustrates one of the selected pay items. The graph shows a clear correlation between unit price and quantity, indicating that the data is reliable and suitable for analysis. The consistent behavior of this item across different projects supports its inclusion in the study.

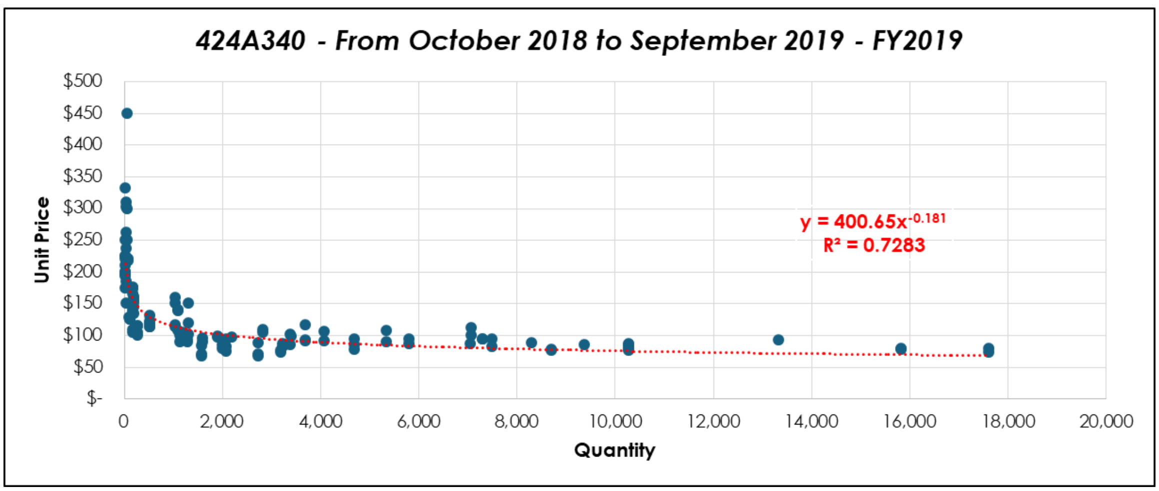


Figure 3-3. Unit Price vs. Quantity Item 424A340 - Selected

- Figure 3-4 represents one of the pay items that were discarded. The graph shows insufficient data points and a lack of correlation between unit price and quantity. This inconsistency suggests that the item is not reliable for analysis and could introduce errors into the study.

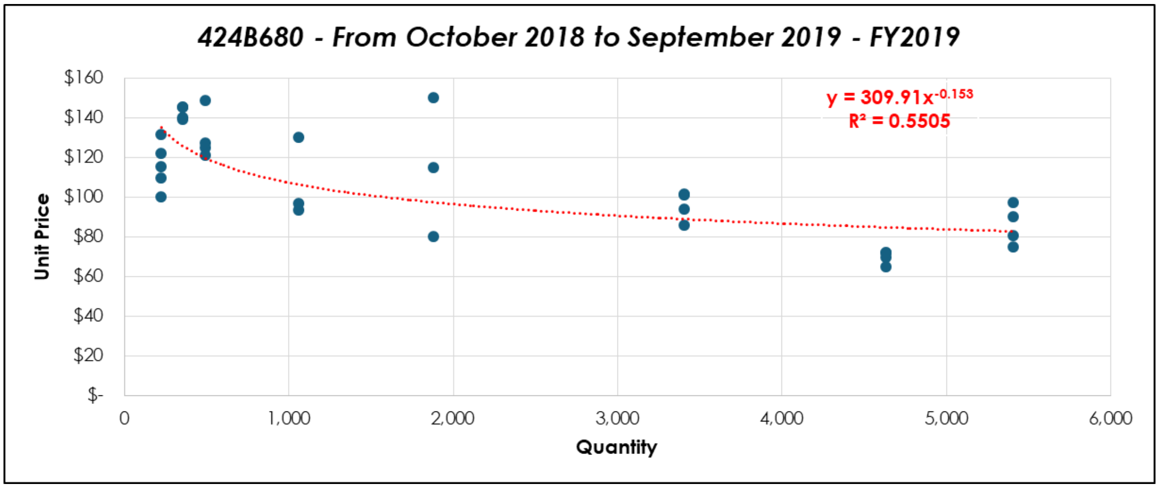


Figure 3-4. Unit Price vs. Quantity Item 424B680 - Discarded

After analyzing the relationship between bid quantities and unit prices, the number of pay items was further reduced from 263 to 60. These 60 items correspond to the final Basket of Pay Items used to create the ALDOT_CCI. The selection process ensured that the final list of pay items provided the best foundation for accurate and meaningful analysis. The final 60 pay items were chosen because they exhibited strong and consistent correlations between unit price and quantity, sufficient data points to support reliable analysis, and consistent behavior across different projects and time periods.

Appendix A contains a detailed table of the 60 selected pay items. The table includes relevant details such as item descriptions, Equation of trend line, and R-squared. It should be noted that the decision to include an item in the calculation of ALDOT_CCI was noted based on R-squared values since sometimes those values could be misleading when used to determine goodness of fit (University of Virginia Library, 2024). The selection of pay items was mainly based on frequency of use and a visual analysis of the non-linear regression models shown in Appendix B.

Appendix B includes the 60 graphs for the selected pay items. Each graph provides a visual representation of the correlation between unit price and quantity, supporting the reliability and validity of the data for analysis. It is worth noting that these 60 pay items collectively resulted in a total of 56,152 data points (rows or observations). This large dataset provided a robust foundation for further analysis and projections.

3.2.1.2 Outliers' detection and removal

An outlier is a data point that deviates significantly from the overall pattern of the distribution. It is numerically far removed from the other observations in the sample. While outliers can occur randomly in any dataset, they frequently arise due to unaccounted factors or unusual causes (Agamennoni, Nieto, and Nebot, 2011). In this study, two primary outlier detection methods were employed during the data cleaning process: the Modified Z-Score method and the Robust Regression and Outlier Removal (ROUT) method. Both techniques operate under the assumption that values are normally distributed around the mean.

3.2.1.3 Modified Z-Score Method

While outliers in historical bid datasets for unit prices may arise from data entry errors or unreasonable unit prices mistakenly submitted by contractors, they may also be the result of unbalanced bids (Rueda, 2016). Regardless of their underlying cause, the Modified Z-Score method could be able to identify those outliers among the bid unit prices received by ALDOT for a given pay item on a given contract. As shown in Figure 3-3, there tend to be a consistent pricing behavior across different bidders and this initial outlier detection filter is intended to identify and discard those unit prices that deviate form that normal behavior.

The Modified Z-Score method is better suited to identify outlier in a small dataset than the traditional Z-Score method, which is based on the mean and standard deviation of the data. Instead, he modified Z-Score method uses the Median ($\tilde{x}$) and Median Absolute Deviation (MAD). This makes it less sensitive to the presence of outliers among less than 10 observations, which is the case for most of the bids received by ALDOT under a single contract.. Following the recommendation of Iglewicz and Hoaglin (1993), unit prices with an absolute Modified Z-Score greater than 3.5 ($|Mi|$ > 3.5) were marked as outliers and removed from the study. The Modified Z-Score for a data point is calculated using Equation 1:

$$Modified\ Z - Score\ (M_i) = 0.6745 * \frac{(X_i - \tilde{x})}{MAD} \qquad (Equation\ N°\ 1)$$

Where,

X_i = Value of the data point (Observation)

$\tilde{x} =$ Median of all Observations

MAD = Median Absolute Deviation

Leveraging the Modified Z-Score method ensures that outlier detection is less influenced by the extreme values themselves, leading to stronger identification of true anomalies in the data set. This method was chosen due to its efficiency and effectiveness in handling asymmetric or non-normally distributed data, which are often found in real-world data sets.

Table 3-3 shows an example of the outcome from the application for the Modified Z-score method on three pay items listed in a given contract. The same method was applied for all projects executed by ALDOT throughout the study period (FY2018 - FY2023). This process was conducted for all observations, detecting 3,544 outliers, since the magnitude of the Modified Z-Score values exceeded 3.5.

Table 3-3. Example Modified Z-Score ALDOT's Projects

ITEM ID	***UNIT PRICE***	***RANK***	***MEDIAN***	***Xi-MEDIAN***	***|Xi-MEDIAN|***	***MAD***	***MODIFIED Z-SCORE***	***OUTLIER***
206D001	$ 5.75	1	6.11	(0.36)	0.36	0.39	(0.62)	OK
206D001	$ 5.00	2	6.11	(1.11)	1.11	0.39	(1.92)	OK
206D001	$ 6.11	3	6.11	0.00	0.00	0.39	0.00	OK
206D001	$ 6.70	4	6.11	0.59	0.59	0.39	1.02	OK
206D001	$ 6.50	5	6.11	0.39	0.39	0.39	0.67	OK
210A000	$ 20.00	1	18.50	1.50	1.50	1.50	0.67	OK
210A000	$ 5.00	2	18.50	(13.50)	13.50	1.50	(6.07)	Outlier
210A000	$ 18.00	3	18.50	(0.50)	0.50	1.50	(0.22)	OK
210A000	$ 18.50	4	18.50	0.00	0.00	1.50	0.00	OK
210A000	$ 28.00	5	18.50	9.50	9.50	1.50	4.27	Outlier
305B077	$ 27.00	1	38.00	(11.00)	11.00	6.51	(1.14)	OK
305B077	$ 31.49	2	38.00	(6.51)	6.51	6.51	(0.67)	OK
305B077	$ 50.00	3	38.00	12.00	12.00	6.51	1.24	OK
305B077	$ 42.00	4	38.00	4.00	4.00	6.51	0.41	OK

3.2.1.4 Robust Regression and Outlier Removal (ROUT) Method

The Robust Regression and Outlier Removal (ROUT) method, proposed by Motulsky and Brown in 2006, is a statistical technique designed to identify and remove outliers during regression analysis. Unlike traditional regression methods, which can be heavily influenced by outliers, the ROUT method aims to provide more accurate results by iteratively refining the model and removing outliers that were not identified or overlooked by the Modified Z-Score method. These overlooked outliers may result from unusual project requirements that drive all contractors to bid outside typical unit price ranges. The Modified Z-Score method compares unit prices for the same item within a given contract, which may not detect outliers if all bidders are forced to submit substantially higher or lower unit prices than those typically paid by the agency for the same item in other projects (Mayorga, 2020). ROUT compares pricing levels among projects, discarding unusual projects that could mislead market tracking.

The key steps involved in the ROUT method are as follows: The process begins with an initial regression analysis of the dataset, providing a baseline model that includes all data points (after applying the first outlier filter). Using the residuals, which are the differences between observed values and those, predicted by the regression model, the ROUT method identifies potential outliers. Residuals that significantly deviate from the expected range are flagged as outliers. The method employs robustness criteria, such as leverage value, Cook's distance, and Studentized residuals, to assess the impact of each data point on the regression model. Points with high leverage or large residuals are identified as potential outliers. These identified outliers are then removed, and the regression analysis is repeated with the remaining data points. This iterative process continues until no significant outliers are detected, resulting in a robust regression model that accurately represents the underlying trend without the distortive effects of outliers. The final regression model is thus obtained, providing a more accurate and reliable estimation of the relationships between the variables in the dataset.

The ROUT method was implemented using GraphPad Prism 10, statistical software equipped with a ROUT function that can be activated during the development of nonlinear regression models. Figure 3-5 illustrates an example of the output generated by this software, where all red data points represent outliers detected by the ROUT method and subsequently excluded from the regression analysis.

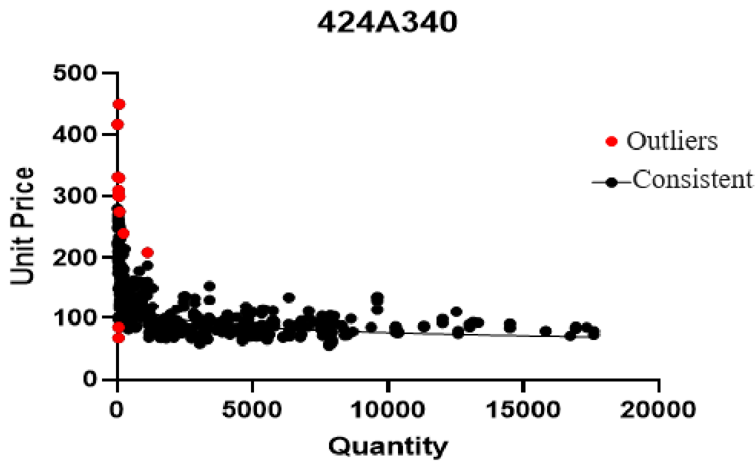


Figure 3-5. GraphPad Prims Software Output Example

3.2.2 NHCCI Collection Data

The data collection process for this study also involved obtaining data from the National Highway Construction Cost Index (NHCCI) from its official website. To begin, the official NHCCI website was accessed through the Federal Highway Administration (FHWA) portal. The website provides historical data on the NHCCI, available for download in various formats, but in order to obtain more precision and organization for analysis; the entire database was downloaded into Microsoft Excel. The NHCCI data set spans multiple years and contains quarterly index values. For this study, all available data, that is, from the first quarter of 2003 to the third quarter of 2023, was selected to align with the study's focus on recent trends and their implications in construction cost analysis.

After initial organization, the data in the downloaded file was consolidated into a single Excel workbook. This integration process involved aligning all data points chronologically, ensuring consistency in data format, and checking for duplicate entries. The organized data underwent a final round of validation checks to ensure its accuracy and reliability. All identified anomalies were corrected, and the cleaned data set was saved as a master file for further analysis.

The next phase involved detailed analysis to uncover trends, correlations, and insights relevant to the study objectives. This analysis process is described in the following sections of this methodology chapter. Table 3-4 shows a sample of NHCCI data downloaded from the official FHWA website, which were the subject of analysis for this study. It includes non-seasonally adjusted and seasonally adjusted index values.

Table 3-4. NHCCI Data Sample

Quarter of quarter	Index Non Adjusted	Index Seasonally Adjusted
2003 Q1	1.000	1.000
2003 Q2	1.010	1.006
2003 Q3	1.024	1.012
2003 Q4	1.022	1.046
2004 Q1	1.046	1.052
2004 Q2	1.101	1.098
2004 Q3	1.143	1.129
2004 Q4	1.149	1.161
2005 Q1	1.241	1.25
2005 Q2	1.281	1.277
2005 Q3	1.371	1.347

Figure 3-6 illustrates the entire collected NHCCI dataset with quarterly changes in the cost of highway construction in the United States from the first quarter of 2003 to the third quarter of 2023. The horizontal axis represents the timeline, divided into quarterly intervals, while the vertical axis indicates NHCCI values, indexed to a base year. The graph shows a general upward trend, indicating an increase in transportation construction costs due to increasing prices for inputs such as materials, labor, and equipment. Despite this general trend, the chart also shows several fluctuations, corresponding to market volatility, supply chain disruptions, or seasonal variations.

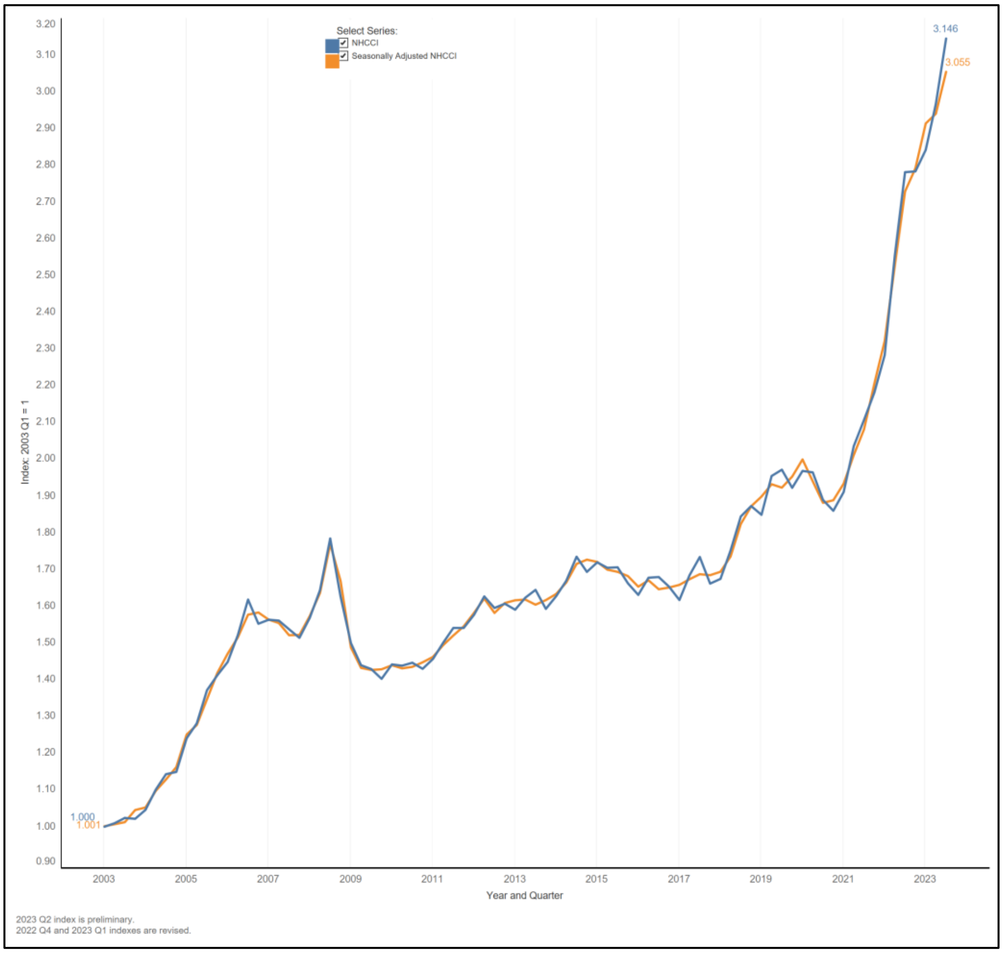
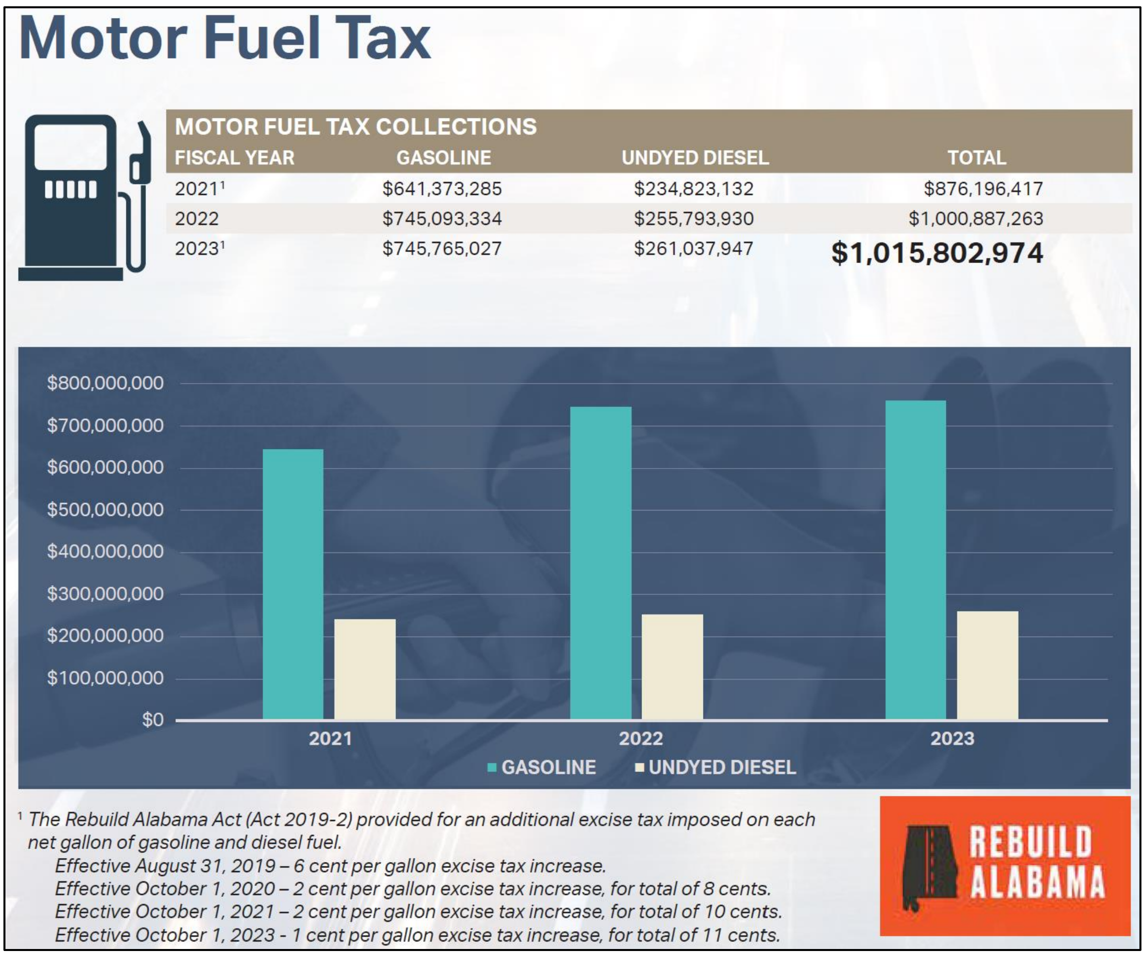


Figure 3-6. NHCCI Chart (FHWA, 2024)

3.2.3 Annual Gasoline and Diesel Revenue Collection Data

The process of collecting tax revenue data from the sale of gasoline and diesel in Alabama involved accessing the official website of the Alabama Department of Revenue (ALDOR). The last 23 annual reports, covering the period from 2001 to 2023, were obtained from this website. Each report contains detailed information on the revenue generated from gasoline and diesel taxes within the state. To gather this data, the ALDOR website was navigated to locate and download the relevant annual reports. These reports were typically available in PDF format, which were then systematically reviewed to extract the necessary revenue information. The extracted data was organized chronologically and compiled into a single dataset for analysis. This comprehensive dataset, spanning over two decades, provided a basis for analyzing trends and patterns in fuel tax revenues, which is crucial for understanding the financial aspects of transportation infrastructure funding in Alabama.

Figure 3-7 illustrates how ALDOR presents revenue data for gasoline and diesel taxes in its annual reports.



Motor Fuel Tax

MOTOR FUEL TAX COLLECTIONS

FISCAL YEAR	GASOLINE	UNDYED DIESEL	TOTAL
2021[1]	$641,373,285	$234,823,132	$876,196,417
2022	$745,093,334	$255,793,930	$1,000,887,263
2023[1]	$745,765,027	$261,037,947	**$1,015,802,974**

[1] *The Rebuild Alabama Act (Act 2019-2) provided for an additional excise tax imposed on each net gallon of gasoline and diesel fuel.*
Effective August 31, 2019 – 6 cent per gallon excise tax increase.
Effective October 1, 2020 – 2 cent per gallon excise tax increase, for total of 8 cents.
Effective October 1, 2021 – 2 cent per gallon excise tax increase, for total of 10 cents.
Effective October 1, 2023 - 1 cent per gallon excise tax increase, for total of 11 cents.

Figure 3-7. Gasoline and Diesel Revenue FY 2023 (ALDOR, 2023)

Table 3-5 provides detailed information on the revenue from gasoline and diesel taxes, as obtained from each of the ALDOR annual reports, while Figure 3-8 presents these collections graphically.

Table 3-5. ALDOR Motor Fuel Excise Tax Report

Fiscal Year	Gasoline Excise Tax	Diesel Excise Tax
FY 2,002	$ 393,369,093	$ 117,824,674
FY 2,003	$ 396,188,934	$ 119,564,454
FY 2,004	$ 405,895,173	$ 128,913,729
FY 2,005	$ 410,838,439	$ 149,602,200
FY 2,006	$ 407,818,668	$ 159,780,250
FY 2,007	$ 412,509,182	$ 155,521,724
FY 2,008	$ 404,264,195	$ 135,802,013
FY 2,009	$ 403,192,402	$ 119,541,444
FY 2,010	$ 410,024,751	$ 125,773,070
FY 2,011	$ 406,458,810	$ 131,151,880
FY 2,012	$ 402,115,624	$ 130,418,789
FY 2,013	$ 402,453,425	$ 135,527,062
FY 2,014	$ 405,673,470	$ 141,362,799
FY 2,015	$ 420,986,781	$ 142,718,002
FY 2,016	$ 395,840,727	$ 137,024,967
FY 2,017	$ 437,949,547	$ 148,926,932
FY 2,018	$ 477,105,898	$ 169,024,874
FY 2,019	$ 444,789,298	$ 158,581,271
FY 2,020	$ 570,979,916	$ 202,130,280
FY 2,021	$ 641,373,285	$ 234,823,132
FY 2,022	$ 745,093,334	$ 255,793,930
FY 2,023	$ 745,765,027	$ 261,037,947

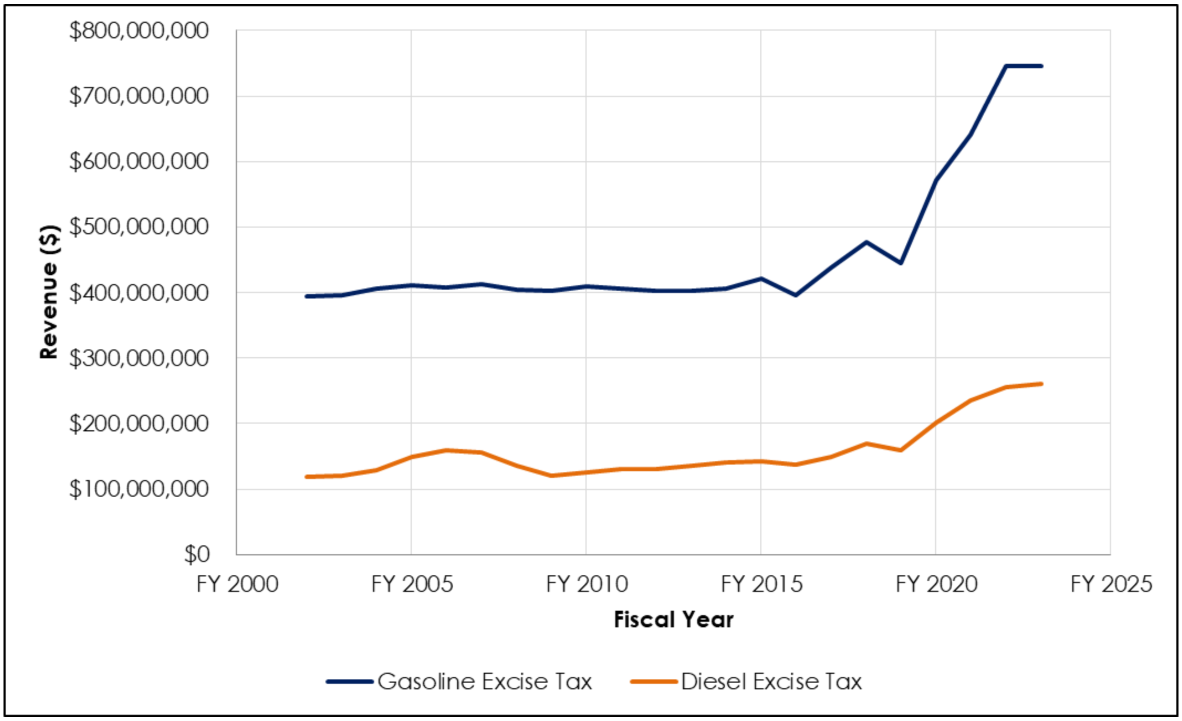


Figure 3-8. Annual Gasoline & Diesel Tax Revenue

3.2.4 Consumer Price Index Collection Data

The Consumer Price Index (CPI) data from 2018 to 2023 was collected from the official website of the U.S. Bureau of Labor Statistics (BLS). More specifically, this study used CPI data for the East South-Central Region, which includes Alabama. This regional data provides a more localized measure of inflation, which is crucial for our analysis. However, the study required older data which was not available for this region. To expand the range of data, CPI data for the national average from 2002 to 2017 was also collected. Before using the national data, a correlation analysis was conducted to verify the relationship between the CPI for the East South-Central region and the national average. This verification ensures that the national data is a reliable proxy for regional trends, allowing it to be used to extend the data set and provide a more comprehensive analysis over a longer time period. The combined dataset was mainly used to model the financial capacity of different types of Alabama's taxpayers.

Figure 3-9 and Figure 3-10 display the data obtained from the official BLS website for the East South-Central CPI.

Consumer Price Index for All Urban Consumers (CPI-U)
Original Data Value

Series Id:	CUUR0360SA0
Not Seasonally Adjusted	
Series Title:	All items in East South Central, all urban consumers, not seasonally adjusted
Area:	East South Central
Item:	All items
Base Period:	DECEMBER 2017=100
Years:	2017 to 2024

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	HALF1	HALF2
2017												100.000			
2018	100.553	100.987	101.314	101.786	102.112	102.204	102.203	101.993	101.879	102.217	101.814	100.929	101.666	101.493	101.839
2019	101.116	101.712	102.336	102.541	102.455	102.478	102.724	102.590	102.397	102.457	102.530	102.426	102.314	102.106	102.521
2020	102.776	102.771	102.751	101.878	101.703	102.401	103.319	103.617	103.581	103.820	103.710	104.179	103.042	102.380	103.704
2021	105.077	105.706	106.817	107.669	108.861	109.882	110.293	110.235	110.370	111.341	111.793	111.575	109.135	107.335	110.935
2022	112.368	113.558	115.235	116.043	117.285	119.152	119.130	118.532	118.540	118.947	118.830	118.814	117.203	115.607	118.799
2023	119.810	120.973	121.282	122.069	122.567	123.082	123.385	123.838	123.999	123.920	123.556	123.186	122.639	121.631	123.647
2024	124.107	125.231	126.131												

Figure 3-9. CPI Data

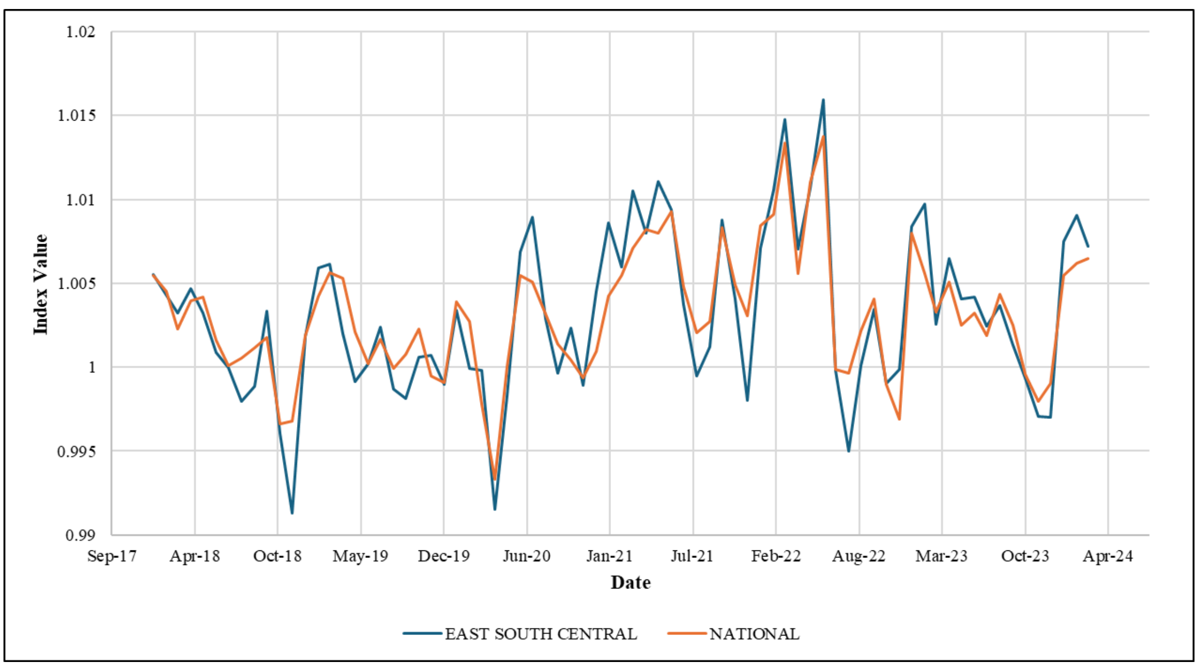


Figure 3-10. CPI Comparison

3.2.5 Occupational Employment & Wage Statistics Collection Data

The data collection process for this study involved obtaining Occupational Employment and Wages Statistics (OEWS) data from the official website for the period 2003 to 2023. The official OEWS website was accessed through the U.S Bureau of Labor Statistics (BLS) portal. The website provides salary estimates for 702 professions within the 22 major groups and an all occupations average category specific to the state of Alabama. The impact of fuel tax adjustment methodologies on Alabama's taxpayers was focused on the "All Occupations" average and the 22 major groups listed in Table 3-6. **Occupational Groups**This table also shows the code use by BLS to refer to each of those occupation categories.

Table 3-6. Occupational Groups

CODE	OCC_TITLE
00-0000	All Occupations
11-0000	Management Occupations
13-0000	Business and Financial Operations Occupations
15-0000	Computer and Mathematical Occupations
17-0000	Architecture and Engineering Occupations
19-0000	Life, Physical, and Social Science Occupations
21-0000	Community and Social Service Occupations
23-0000	Legal Occupations
25-0000	Education, Training, and Library Occupations
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations
29-0000	Healthcare Practitioners and Technical Occupations
31-0000	Healthcare Support Occupations
33-0000	Protective Service Occupations
35-0000	Food Preparation and Serving Related Occupations
37-0000	Building and Grounds Cleaning and Maintenance Occupations
39-0000	Personal Care and Service Occupations
41-0000	Sales and Related Occupations
43-0000	Office and Administrative Support Occupations
45-0000	Farming, Fishing, and Forestry Occupations
47-0000	Construction and Extraction Occupations
49-0000	Installation, Maintenance, and Repair Occupations
51-0000	Production Occupations
53-0000	Transportation and Material Moving Occupations

Relevant salary data files were downloaded, in Excel format, making them easy to organize and initially review. Salary data for each occupation group was organized chronologically and ensuring consistency in format. This clean and organized data set was then prepared for further analysis, ensuring that the study findings were based on accurate and complete information from the OEWS database.

3.3 PART I: CURRENT PERFORMANCE ASSESSMENT (FY 2018 – FY 2023)

This section is limited to describing the research methodology followed during Part I of this study. However, results, conclusions, and observations resulting from the application of this methodology are detailed in Chapter 3 and 4 of this thesis.

This part of the study is intended to assess the current performance of Alabama's new TRAM since its implementation until the end of FY2023. It consisted of two main quantitative, comparative analyses. The first comparative analysis was aimed at assessing TRAM impacts on ALDOT's available construction funding, and the second one was associated with impacts in the 23 groups of taxpayers listed in Table 3-6. The first comparative analysis is between ALDOT_CCI, developed for this study and intended to represent the transportation construction market in Alabama, and indexed gasoline and diesel tax revenues reported by ALDOR during the same time period. The following two sections describe the process followed to develop the proposed ALDOT_CCI and for the indexing of fuel tax revenues.

The second comparative analysis is focused on assessing the observed impact of the current TRAM on Alabama's taxpayers. It first required the creation of a Taxpayer Financial Capacity Index (TFCI) for each of the 23 occupation groups considered in this study. TFCI's fluctuations were compared against actual gasoline tax rate changes (also indexed to facilitate comparison) to determine changes in the capacity of taxpayers to support continued infrastructure financing.

3.3.1 Create ALDOT_CCI

To create the Agency Level Index (ALDOT_CCI), the Basket of Pay Items was first developed as described in Section 3.2.1.1.Once this set of relevant pay items was defined, the study proceeded with the development of the ALDOT_CCI based on a Multilevel Construction Cost Indexing system previously developed by Gransberg and Rueda (2014) for MnDOT, and refined and validated by Pakalapati (2018) and Mayorga (2020).

The ALDOT_CCI developed in this study is a hierarchical structure and comprises 4 levels constructed with 92 different cost indices as illustrated in Figure 3-11. The lowest level, the Pay Item Level, contains cost indices for all 60 items, such as 424A340, 424A360, 424B650, and so on, which are listed in Table 3-7. This level is the most specific, with each of the 60 indices intended only for its respective pay item. Using a bottom-up calculation approach, pay items with a similar scope of work are combined through a weighted average calculation to form a less specific index at the next level. The weight of each item is calculated as shown in Equation 2 and based on the frequency of occurrence of each item within the indexing period.

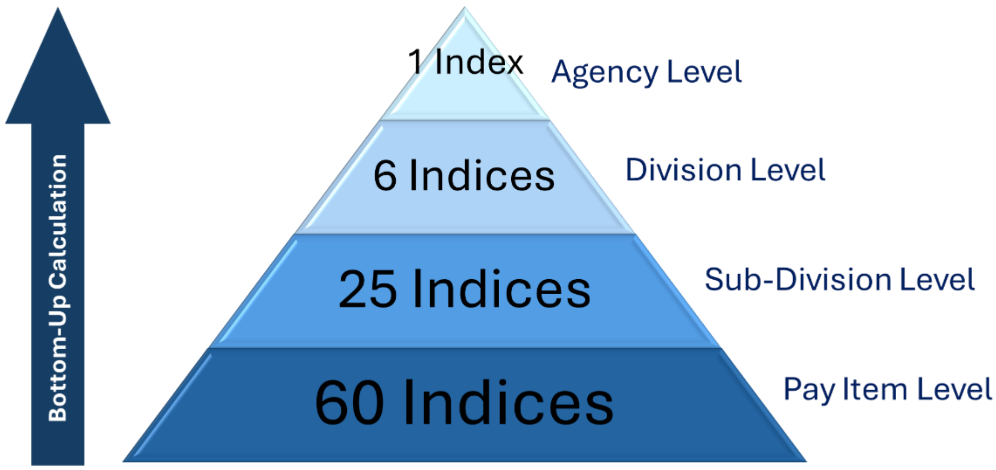


Figure 3-11. ALDOT MCCI

Table 3-7. ALDOT MCCI - Basket of Pay Items

No.	ITEM ID	DESCRIPTION	No.	ITEM ID	DESCRIPTION
1	206C000	Removing Concrete Sidewalk	31	408B000	Micro-Milling Existing Pavement(Approximately 0.00" Thru 1.00" Thick)
2	206C001	Removing Concrete Pavement	32	408B001	Micro-Milling Existing Pavement(Approximately 1.10" Thru 2.00" Thick)
3	206C002	Removing Concrete Slope Paving	33	424A340	Superpave Bituminous Concrete Wearing Surface Layer, 1/2" Maximum Aggregate Size Mix, ESAL Range A/B
4	206C003	Removing Concrete Flumes	34	424A360	Superpave Bituminous Concrete Wearing Surface Layer, 1/2" Maximum Aggregate Size Mix, ESAL Range C/D
5	206C010	Removing Concrete Driveway	35	424A369	Superpave Bituminous Concrete Wearing Surface Layer, Widening, 1/2" Maximum Aggregate Size Mix, ESAL Range C/D
6	206D000	Removing Pipe	36	424B650	Superpave Bituminous Concrete Upper Binder Layer, 3/4" Maximum Aggregate Size Mix, ESAL Range C/D
7	206D001	Removing Guardrail	37	430B043	Aggregate Surfacing (1" Down, Crusher Run)
8	206D002	Removing Curb	38	502A000	Steel Reinforcement

Table 3-7. ALDOT MCCI - Basket of Pay Items

No.	ITEM ID	DESCRIPTION	No.	ITEM ID	DESCRIPTION
9	206D003	Removing Curb and Gutter	39	508A000	Structural Steel
10	206D005	Removing Gutter	40	510A007	Bridge Substructure Concrete
11	206D011	Removing Fence	41	510E000	Grooving Concrete Bridge Decks
12	210A000	Unclassified Excavation	42	524A010	Culvert Concrete
13	210D001	Borrow Excavation (Loose Truck bed Measurement)	43	524B011	Culvert Concrete Extension (Cast in Place)
14	210D011	Borrow Excavation (A4 Or Better)	44	610D003	Filter Blanket, Geotextile
15	210D021	Borrow Excavation (Loose Truck bed Measurement)(A4 or Better)	45	618A000	Concrete Sidewalk, 4" Thick
16	212A000	Machine Grading Shoulders	46	630A001	Steel Beam Guardrail, Class A, Type 2
17	214A000	Structure Excavation	47	650A000	Topsoil
18	214B001	Foundation Backfill, Commercial	48	652C000	Mowing Acre
19	230A000	Roadbed Processing	49	654A001	Solid Sodding (Bermuda)
20	301A012	Crushed Aggregate Base Course, Type B, Plant Mixed, 6" Compacted Thickness	50	665B001	Temporary Mulching
21	305B077	Crushed Aggregate, Section 825, For Miscellaneous Use	51	665I000	Temporary Riprap, Class 2
22	305B078	Crushed Aggregate, Section 825, Type B, For Miscellaneous Use	52	665J002	Silt Fence
23	401A000	Bituminous Treatment A	53	665O001	Silt Fence Removal
24	401B100	Bituminous Treatment E (With Polymer Additive)	54	701A227	Solid White, Class 2, Type A Traffic Mile Stripe (5" Wide)
25	401B108	Bituminous Treatment G (With Polymer Additive)	55	701A230	Solid Yellow, Class 2, Type A Traffic Mile Stripe (5" Wide)
26	405A000	Tack Coat Gal	56	701C000	Broken Temporary Traffic Stripe
27	408A051	Planning Existing Pavement (Approximately 0.00" Thru 1.0" Thick)	57	701C001	Solid Temporary Traffic Stripe
28	408A052	Planning Existing Pavement (Approximately 1.10"	58	703A002	Traffic Control Markings, Class 2, Type A

Table 3-7. ALDOT MCCI - Basket of Pay Items

No.	ITEM ID	DESCRIPTION	No.	ITEM ID	DESCRIPTION
		Thru 2.0" Thick)			
29	408A053	Planning Existing Pavement (Approximately 2.10" Thru 3.0" Thick)	59	703D001	Temporary Traffic Control Markings
30	408A054	Planning Existing Pavement (Approximately 3.10" Thru 4.0" Thick)	60	740B000	Construction Signs

$$Weight = \frac{TPIL}{TSDL} \qquad (Equation\ N° \ 2)$$

Where,

TPIL = How many Times an item appears at the Pay Item Level in a specific fiscal year (e.g. 424A340)

TSDL = How many Times a sub-division appears at the Sub-division Level in a specific fiscal year (e.g. 424)

The degree of similarity between items is determined by taking advantage of ALDOT's pay item ID system. Similar Item IDs are expected from items for similar types of work. For example, ALDOT has a list of 159 standard pay items for different types of "Superpave Bituminous Concrete Wearing Surface Layers." The Item ID for all those pay items start with the same three numbers: 424. Most of those items are seldom used. However, Table 3-7 shows that the Basket of Items used to build ALDOT_CCI includes four of them, which are probably ALDOT's most relevant and frequently used items. Each of those four items has its own index at ALDOT_CCI Pay Item Level. They are later combined to create a broader index at the Sub-

Division Level (see Figure 3-11). That resulting index is intended to represent all similar pay items starting with 424.

The pay item level indices are aggregated to calculate the 25 sub-division level indices. These sub-division level indices are then similarly used to calculate 6 broader division level indices representing six of ALDOT's eight standard construction divisions. ALDOT's construction divisions are listed in Table 3-8. Divisions 1 and 8 are not represented in the ALDOT_CCI because all Division 1 pay items are Lump Sum items, making them unsuitable for price tracking purposes. Likewise, none the materials used by ALDOT (and associated to Division 8) is directly used a single pay item. The price of construction materials is considered under different divisions depending on their intended use. Ultimately, the six Division Level Indices are combined to produce a single overall index used at the agency level. That final Agency Level Index is the one used in this study to represent the fluctuations in ALDOT's construction market.

Table 3-8. ALDOT's Division

Division	Description
100	General Provisions
200	Earthwork
300	Bases
400	Surfacing and Pavements
500	Structures
600	Incidentals
700	Traffic control devices and Highway lighting
800	Materials

The following a step-by-step description of process described above to develop the proposed annual ALDOT_CCI:

- First, the 60 indices at the pay item level were calculated by fiscal year (e.g. 424A340). Each cost index has a starting period used as a reference point to measure price changes, with an initial index value of 1 assigned to this period (Gransberg and Rueda, 2014). For this study, fiscal year 2019 was designated as the starting period (Index Value FY2019 = 1).
- To advance to the sub-division level, a weighting average bottom-up calculation approach is conducted. The item weights from the lowest level were used to create next level indices, represented by the broader level (e.g., 424).
- To continue advancing to the next level, "Division Level" (e.g., 4), a similar weighted average calculation is conducted, combining the 25 Sub-Division Level Indices into six Division Level Indices.
- Finally, to calculate the Agency Level Index (ALDOT_CCI) for each fiscal year, a final weighted average calculation is conducted to combined the sic Division Level indices into a single index. This calculation provides the overall Index at the Agency Level for each year of the study period (FY2018 to FY2023).

Table 3-9 illustrates how the indices were grouped and labelled using ALDOT's item coding system. A complete version of this table is shown in Appendix C.

Table 3-9. Index Hierarchical Structure by Levels

Pay Item Level	Sub-Division Level	Division Level
424A340	424	4
424A360		
424A369		
424B650		
430B043	430	
502A000	502	5
508A000	508	
510A007	510	
510E000		
524A010	524	
524B011		

3.3.2 Create Gasoline and Diesel Revenue Indices

To explain the creation of the Gasoline and Diesel Revenue Indices, the process began by compiling data from the Alabama Department of Revenue (ALDOR) annual reports covering 2002 through 2023. These reports provided complete details on fuel tax collections from gasoline and diesel sales. Annual fuel tax revenues were then indexed as shown in Equation 3 and setting FY2019 as the base index period (Index Value FY2019 = 1), as done for the ALDOT_CCI, and to facilitate their comparison. Two separate indices were produced from this process, one for gasoline and one for diesel revenues.

$$FRI_i = \frac{FR_i}{FR_{2019}} \qquad (Equation\ N°\ 3)$$

Where,

$FRI_i = Fuel\ revenue\ index\ value\ at\ year\ i$ (calculated for gasoline and diesel)

$FR_i = Fuel\ revenue\ collected\ in\ dollars\ at\ year\ i$ (for gasoline and diesel)

$FR_{2019} = Fuel\ revenue\ collected\ in\ dollars\ at\ FY19$ (for gasoline and diesel)

3.3.3 Create Taxpayers' Financial Capacity Index (TFCI)

TFCIs are intended to represent changes in the financial capacity of different types of taxpayers classified by occupation. A TFCI for each of the 23 taxpayer occupational groups (see Table 3-5) was developed in three basic steps:

1. Collect Alabama annual median salary data for each occupational group from the OEWS database.
2. Collect CPI data for All Urban Consumers (CPI-U) for the East South-Central Area (which includes Alabama).
3. Convert OEWS annual salary data to 2019 dollars using collected CPI data
4. Use the time series resulting from Step 3 (in 2019 dollars) to create an index to represent the annual fluctuations in that time series. That is the final TFCI for the occupation under consideration. All TFCIs were developed with a 2019 index value of one (1).

Alabama's median annual salaries for the 23 taxpayer occupational groups were extracted from the OEWS database, covering the period from 2003 to 2023. It should be noted that the BLS publishes labor statistics data in May of each year. To ensure accuracy, it was decided to compare annual salary data against CPI values for the month of May of each year.

To achieve more precise and localized data for the area of influence of the study, which is the State of Alabama, the study used the Consumer Price Index for All Urban Consumers (CPI-U) for the East South-Central Area. The collected CPI-U data is shown in Table 3-10.

Table 3-10. CPI-U - East South Central

Consumer Price Index for All Urban Consumers (CPI-U)	Area: East South Central
CPI - May 2018	102.112
CPI - May 2019	102.455
CPI - May 2020	101.703
CPI - May 2021	108.861
CPI - May 2022	117.285
CPI - May 2023	122.567

The conversion to 2019 mentioned above at Step 3 was conducted as shown in Equation 4. Subsequently, the indexation process for the values resulting from Step 3 was conducted following Equation 5, yielding the final annual TFCI values for each occupation with a 2019 index value of one (1) for each TFCI.

$$MAS_{i,j,2019} = MAS_{i,j,i}\frac{CPI_{2019}}{CPI_i} \qquad (Equation\ N°\ 4)$$

Where,

$MAS_{i,j,2019} = Median\ Annual\ Salary\ at\ year\ i\ for\ occupation\ j\ in\ 2019\ dollars$

$MAS_{i,j,i} = Median\ Annual\ Salary\ at\ year\ i\ for\ occupation\ j\ in\ year\ i\ dollars$

$CPI_{2019} = CPI\ value\ at\ year\ 2019\ (102.455, as\ per\ Table\ 3-10)$

$CPI_i = CPI\ value\ at\ year\ i\ (based\ on\ Table\ 3-10)$

$$TFCI_{i,j} = \frac{MAS_{i,j,2019}}{MAS_{2019,j}} \qquad (Equation\ N°\ 5)$$

Where,

$TFCI_{i,j} = Taxpayer\ Financial\ Capacity\ index\ at\ year\ i\ for\ occupation\ j$

$MAS_{i,j,2019} = Median\ Annual\ Salary\ at\ year\ i\ for\ occupation\ j\ in\ 2019\ dollars$

$MAS_{2019,j} = Median\ Annual\ Salary\ at\ 2019\ for\ occupation\ j\ in\ year\ i\ dollars$

3.3.4 Create Gasoline and Diesel Tax Rate Indices

Unlike the fuel tax revenue indices explained in Section 3.3.2, indices associated with this section are intended to track changes in the gasoline tax rate, which is set as a number of cents per purchased gallon. While revenue indices are more appropriate to assess the TRAM impact on ALDOT's available funding, they should not be used to determine the financial impact on taxpayers. Statewide fuel tax revenues depend on statewide fuel consumption, which might not represent the level of consumption of each individual. In other words, a 10% increase in the gasoline tax revenue may not represent a 10% increase in the fuel taxation load imposed on a given taxpayer. However, a 10% increase in the cents-per-gallon gasoline tax rate will most likely represent a 10% increase in gasoline taxes paid by that taxpayer, assuming a constant gasoline consumption rate. That explains the need for the Gasoline Tax Rate Index addressed in this section.

The creation of the gasoline tax rate index began by obtaining historical tax rates from the official website of the Federal Highway Administration (FHWA, 2024). This data includes the tax rate (cents/gallon) applied to gasoline purchases along the period covered by the study. In particular, it was noted that there had been no adjustments to this rate since 1993 until the enactment of the Rebuild Alabama Act in 2019. To ensure the accuracy of this information, it was cross-referenced with data published in the annual reports of the Alabama Department of Revenue (ALDOR).Once the historical tax rate information was verified, it was organized into a table for each fiscal year. This structured approach facilitated detailed analysis and comparison between different years.

Finally, Equation 6 was used to calculate the Gasoline Tax Rate Index. This equation essentially converted tax rate values into index values that reflect relative rate fluctuations during the study period. It is important to note, as mentioned in Section 3.3.1, that fiscal year 2019 was designated as the base period for this study, therefore, the values of the index at 2019 is equal to one (1). It is also important to mention that the assessment of the TRAM impacts on taxpayers was only conducted taking into consideration the gasoline tax rate since that is assumed to be the most common type of fuel used by regular taxpayers, while diesel tends to be mainly used for commercial purposes.

$$GTRI_i = \frac{GTR_i}{GTR_{2019}} \qquad Equation\ N°\ 6$$

Where,

$GTRI_i = Gasoline\ Tax\ Rate\ Index\ for\ year\ i$

$GTR_i = Gasoline\ Tax\ Rate\ at\ year\ i$ *(Cents per gallon)*

$GTR_{2019} = Gasoline\ Tax\ Rate\ at\ year\ 2019$ *(Cents per gallon)*

3.3.5 Comparative Analysis

After the creation of ALDOT agency-level index (ALDOT_CCI), the Gasoline and Diesel Revenue Indices, the Taxpayer Financial Capacity Indices (TFCI), and the Gasoline Tax Rate Index, the study continued with the two comparative analyses mentioned in Section 3.1.

These deterministic analyses were aimed at determining the impact of Alabama's recently implemented TRAM on ALDOT's funding levels and on different types of taxpayers classified by occupation. The first comparative analysis was intended to quantify the impact on ALDOT and was conducted between the ALDOT_CCI and the Gasoline and Diesel Revenue Indices. To perform this analysis, ALDOT_CCI values were plotted alongside gasoline and diesel revenue indices over the study period. This visual representation allowed for a clear comparison of trends and fluctuations. As mentioned several time throughout this thesis, all indices used in this study were developed or scaled to set 2019 as their base year with an index value of one (1). That means that all charts used to visualize and compare indices converge in the year 2019. Having the fuel tax revenue indices moving along the ALDOT_CCI, in the same direction would mean that the 2019 funding gap associated with tax collections has been proportionally maintained. On the other hand, it can be concluded that the funding gap has increased or reduced, in comparison with the financial needs in 2019, if the ALDOT_CCI diverges from the fuel tax revenue indices. The gap would reduce if the fuel tax revenue indices grew above the ALDOT_CCI. The opposite can be concluded if at any given year ALDOT_CCI index values are greater than the tax revenue indices.

The second comparative analysis is between each TFCI and the gasoline and tax rate index. Similar to the first analysis, TFCI values were compared to gasoline tax rate index values and visually analyzed. This comparison was conducted for each of the 23 taxpayer groups, and allows determining if tax rate increases provided by the Rebuild Alabama Act are outpacing the financial capacity of different types of taxpayers. A TFCI value greater than the gasoline tax rate index for the same year allow to conclude that, in comparison with 2019, during that year, the taxpayer group under consideration is in a better financial capacity to pay fuel taxes at the corresponding rate. Conversely, their ability to pay fuel taxes is assumed to have reduced (in comparison with year 2019) at those year where gasoline tax rate index is greater than the TFCI.

The findings from these comparatives analyses were instrumental in drawing the final conclusions of this part of the study. By systematically comparing the ALDOT_CCI to gasoline and diesel revenue indices and the TFCI to the gasoline tax rate index, the study was able to highlight key relationships and potential causal factors associated with the performance of the TRAM implemented through the Rebuild Alabama Act. These insights are crucial to inform policy decisions and strategic planning related to transportation financing and tax rate adjustments.

3.4 PART II: FUTURE PERFORMANCE ASSESSMENT.

To conduct a comprehensive assessment of future performance, it was crucial to collect sufficient historical data to understand variations and trends in each of the developed indices. Consequently, the decision was made to extend the data collection period to 2003, thus ensuring a complete 21-year data set. This historical data spans from 2003 to 2023, providing a solid foundation for projecting trends and performance 20 years into the future, from 2024 to 2043.

However, for the ALDOT data, complete records were only available from 2017. To address this gap and improve the reliability of the study, data was incorporated from the index created by Pakalapati in 2018. This inclusion allowed for expanding the data set up to 2006, which has been considered to be sufficient data for the purposes of this study. The integration of Pakalapati's index provided a more complete dataset, which increased the robustness and credibility of future performance projections. It should be noted that the ALDOT_CCI proposed in this study is based on the same methodology used and validated by Pakalapati.

This approach ensures that forecasts are based on a substantial amount of historical data, providing a reliable basis for understanding how each index could evolve over the next two decades. The expanded data set not only improves the accuracy of projections, but also contributes to more informed decision-making and strategic planning for future transportation financing and infrastructure development. It should be noted that all forecasting calculations conducted in this study followed a risk-based (or probabilistic) approach.

3.4.1 20-Year Risk-Based Forecasting

The 20-year risk-based forecasting process involved a series of systematic steps designed to predict the future behavior of the indices developed and described in Section 3.3, allowing the extension of the comparative analyses explained in above over the next 20 years

Risk-based forecasting was conducted via simulation. Simulated values for a given year are calculated by applying a random index growth rate to the previous year's value, as shown in Equations 7 and 8. The simulated index value for year 2024 is based on the known index value for year 2023 and random value generated from the probability distribution of the annual index growth rate (see Equation 7). Subsequently, the simulated index value for year 2025 is calculated by applying another random annual growth rate to the previously simulated 2024 value (see Equation 8). The same process continues until generating a simulated index value for the year 2043, resulting in a 20-year time series of simulated index values. This process was repeated 10,000 times (simulation iterations), yielding 10,000 different simulated time series, allowing for the modeling of uncertainty at year over the forecasting time horizon. Equation 7 and 8 represent a single iteration.

$$If\ n = 2024 \quad \rightarrow \quad SI_{2024} = I_{2023} * \left(1 + P(AGR)\right) \qquad Equation\ N° \ 7$$

$$If\ n > 2024 \quad \rightarrow \quad SI_{n} = SI_{n-1} * \left(1 + P(AGR)\right) \qquad Equation\ N° \ 8$$

Where,

$n = year$

$SI_n = Simulated\ Index\ Value\ at\ year\ n$

$I_{2023} = Known\ Index\ Value\ at\ year\ 2023$

$P(AGR) = Probability\ distribution\ of\ Index\ Annual\ Growth\ Rate$

The first step in the simulation of future index values consisted in the use of the chi-square goodness-of-fit statistical test to determine the most appropriate probability distribution to model annual growth rate observed in the collected historical data for each index. This test is essential to verify how well the observed data fits a specific distribution, ensuring that the models chosen accurately to represent historical data patterns.

To facilitate this complex statistical analysis, the @Risk software package was used. @Risk is known for its ability to perform robust statistical tests and simulations, making it an ideal tool for calculating the goodness-of-fit of various probability distributions. Leveraging @Risk, the study was able to perform extensive simulations for all indices under consideration.

After running the 10,000 iterations for a given index, there were 10,000 simulated index values for each year. This allowed the study to model the variability at each year in the form of three confidence levels: 50%, 80%, and 95% confidence level. The median was also identified at each year and used as the measure of central tendency. In statistical terms, the median is a measure of central tendency that indicates the mean value of a set of data when ordered from least to greatest. It is particularly useful in skewed distributions because it is less affected by outliers and extremes compared to the mean. According to "Statistics for Business and Economics" by Paul Newbold, William L. Carlson, and Betty Thorne, the median is an important summary statistic that represents the 50th percentile of a data set (Newbold, Carlson, and Thorne, 2013).

3.4.2 Forecast of Gasoline and Diesel Annual Tax Revenue Indices

Part I relied on known historical gasoline and diesel tax collections, which were then indexed, as explained in Section 3.2.3. Given that the recently implemented TRAM is expected to change fuel tax revenue trends, it was not considered appropriate to make a projection of the currently known historical revenue values. Those are only briefly impacted by the new TRAM. Alternatively, it was considered more appropriate to forecast gasoline and diesel annual statewide consumption levels (in gallons), along with forecast of fuel tax rates. Multiplying the forecasted number of gallons sold in Alabama by their corresponding forecasted gasoline and diesel tax rates, yielded an estimate of future gasoline and diesel tax revenues for each forecasted year.

The process to perform these forecasts was like the one described above in Section 3.4.1. Fuel consumption data was indexed and forested using equations 7 and 8. The chi-square goodness-of-fit statistical test revealed that the growth rate for gasoline and diesel consumption follows a normal distribution. This finding is based only on data from the period 2003 to 2019, which precedes the onset of the Covid-19 pandemic. This period was chosen to avoid any anomalies introduced by the pandemic's economic impact and the usual low fuel consumption levels during the pandemic Fuel consumption data was extracted from the Alabama Department of Revenue (ALDOR) website.

The forecast of fuel tax rates was slightly more complex, since it is was intended to generate future tax rate values to be produced by the new Alabama's TRAM implemented through the Rebuild Alabama Act. The act mandates that gasoline and diesel tax rates be adjusted every two years by no more than one-cent. Therefore, it was first necessary to forecast NHCCI values through 10,000 simulation iterations. Biannual tax rate adjustments were then calculated based on NHCCI fluctuations, starting with the latest known tax rate in 2023, and limiting every two-year adjustment to maximum one-cent.

It was observed that the biannual growth value of the NHCCI will almost always be greater than the one-cent increase permitted by the TRAM. Thus, the current TRAM is expected to provide for a one-cent tax rate increase every two years. This underscores the importance of the “time-value-for-money” issue discussed in Section 2.5.4. Currently, a one-cent increase is insufficient to offset construction inflation. This problem will worsen over time as the value of one-cent continues to diminish.

The next step involved multiplying the forecasted values of taxable gallons by the forecasted fuel tax rates across the 10,000 iterations. It produced a probabilistic 20-year forecast for gasoline and diesel tax revenues. These revenue values were then indexed, setting 2019 as the based year with a value of one (1), as done with all the other indices in this study.

To extend the second comparative analysis (TFCIs vs. Gasoline Tax Rate Index) 20 years into the future, forecasted gasoline tax rates calculated as explained above were also indexed (Index Value at 2019 = 1) to project the gasoline tax rate index developed in Part I two decades into de future.

3.4.3 Probabilistic Comparative Analysis

At this point in the analysis, a 20-year risk-based forecast has been established for the ALDOT_CCI, Gasoline Tax Revenue Index, Diesel Tax Revenue Index, all TFCIs, and the Gasoline Tax Rate Index. The next step in the proposed methodology involved the extension of the two comparative analyses from Part I 20 years into the future using the probabilistic forecasts. Thus, while the comparative analysis in Part I was deterministic, their extension into the future in Part II followed a stochastic approach to account for the uncertainty of the unknown future.

Both probabilistic comparative analyses were conducted using Monte Carlo Simulation techniques to produce risk-based Comparative Rations (CR). Equations 9 and 10 were used for the first probabilistic comparative analysis (ALDOT_CCI vs. Gasoline and Diesel Tax

Revenues), while Equation 11 was used for the second one (TFCIs vs. Gasoline Tax Rate Index). The Monte Carlo Simulation Process was applied every year over the 20-year forecasting time horizon and it involved running 10,000 simulations for the inputs on the right side of Equations 9 to 11, to produce the probabilistic outputs on the left. In this context, simulations were used to generate a wide range of possible future values for each of the indices, based on their historical distributions and expected trends. The probabilistic outputs are illustrated in Chapter 4 with their 50%, 80% and 95% confidence intervals, and using again the median as the measure for central tendency. The same was done for all probabilistic forecasting outputs presented later in this thesis.

$$P\left(CR_{1\_G\_i}\right) = \frac{P(GTRI_i)}{P(ALDOT\_CCI_i)} \qquad Equation\ N°\ 9$$

$$P\left(CR_{1\_D\_i}\right) = \frac{P(DTRI_i)}{P(ALDOT\_CCI_i)} \qquad Equation\ N°\ 10$$

$$P\left(CR_{2\_i\_j}\right) = \frac{P\left(TFCI_{i\_j}\right)}{P(GTRaI_i)} \qquad Equation\ N°\ 11$$

Where,

$P\left(CR_{1\_G\_i}\right) =$ *Probability Dist. of Comparative Ratios at Year i; First Comparative Analysis; ALDOT_CCI vs. Gasoline Tax Revenue Index*

$P\left(CR_{1\_D\_i}\right) =$ *Probability Dist. of Comparative Ratios at Year i; First Comparative Analysis; ALDOT_CCI vs. Diesel Tax Revenue Index*

$P\left(CR_{2\_i\_j}\right) =$ *Probability Dist. of Comparative Ratios at Year i; Second Comparative Analysis; TFCI for Occupation j vs. Gasoline Tax Rate Index*

$P(GTRI_i) =$ *Probability Dist. of Gasoline Tax Revenue Index at Year i*

$P(DTRI_i) =$ *Probability Dist. of Diesel Tax Revenue Index at Year i*

$P(ALDOT\_CCI_i) =$ *Probability Dist. of ALDOT_CCI at Year i*

$P(TFCI_{i\_j}) =$ *Probability Dist. of TFCI for Occupation j at Year i*

$P(GTRaI_i) =$ *Probability Dist. of Gasoline Tax Rate Index at Year i*

It is worth clarifying that, for Equations 9, if the value of the Comparative Ratio is greater than 1, it means that the gasoline tax revenue is proportionally more than what ALDOT received in 2019, meaning a reduction of the funding gap. On the other hand, if it is less than 1, it means that gasoline tax revenue is proportionally less than what ALDOT received in 2019. The same applies to the diesel tax revenue with the CR value from Equation 10. Similarly, CR values lower than 1 in Equation 11 at any given year would mean that, for that group of taxpayers (*j*), their financial ability to meet fuel taxation obligations is lower in comparison to year 2019.

It is important to note that if the simulation were executed while ignoring the correlation coefficients between the indices; it would imply that there is no relationship between the different indices being simulated at the same time for the same year. This assumption would oversimplify the real-world interactions between these variables and could lead to inaccurate forecasts.

Since both the NHCCI and the ALDOT_CCI measure changes in the construction market, it is reasonable to expect some level of correlation between them. Periods with high values in the NHCCI are likely to correspond to periods with high values in the ALDOT_CCI, reflecting broader market trends in construction costs and economic activity.

To address this complexity, a correlation coefficient matrix was used in the simulation process. This is a function allowed by @Risk. This matrix attempts to capture the correlations between all simulation inputs (indices), ensuring that the probabilistic analysis reflects the interdependencies between them. By incorporating correlation coefficients, Monte Carlo simulations provide a more realistic and nuanced forecast that considers the dynamic interaction between different economic indicators.

3.5 PART III: ALTERNATIVE TRAM

In this chapter, the focus is on the development of two Alternative Tax Rate Adjustment Methodologies (TRAMs) following the overall process illustrated in Figure 3-12. The proposed two alternatives were developed through careful review of findings and conclusions from the first two parts of this study. These findings provide critical information on trends and relationships between various indices, including the ALDOT_CCI, Gasoline Tax Revenue, and Diesel Tax Revenue indices.

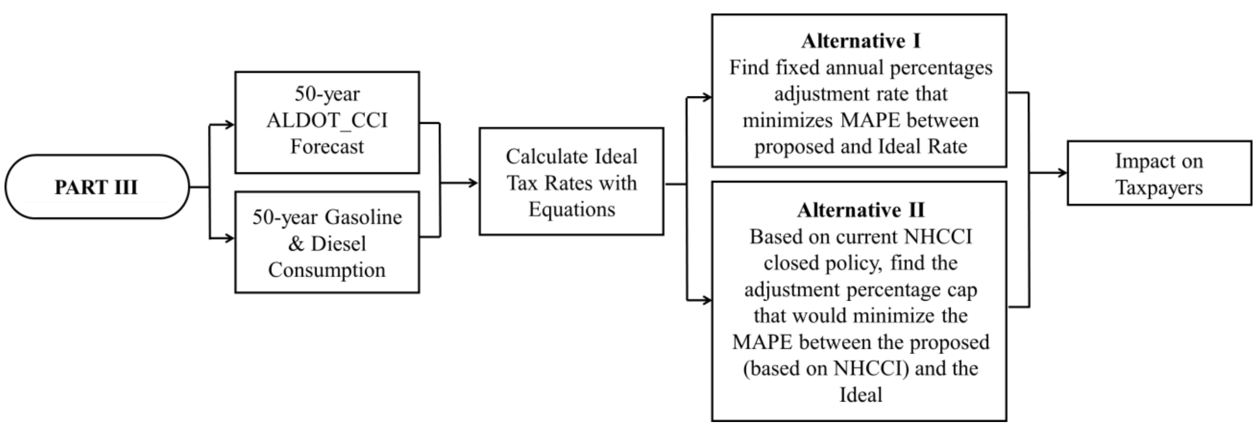


Figure 3-12. Part III Methodology

Both alternatives were designed to proportionally maintain the financial gap experienced by ALDOT in 2019. After projecting Part II forecasts 30 more years into the future, to obtain a more meaningful 50-year forecasting time horizon required for this part of the study, efforts were put in the calculation of Ideal Tax Rates (ITRs) using Equations 12 and 13, for gasoline and diesel ITRs, respectively. These rates allow for a perfect overlap of the 50-year median projections of the ALDOT_CCI and the gasoline and diesel tax revenue indexes. This overlap means that ALDOT's 2019 funding gap has been proportionally maintained along the entire forecasting time horizon.

$$ITR_{G\_i} = \frac{ALDOT\_CCI_{median\_i} \times GTR_{2019}}{GC_{median\_i}} \qquad Equation\ N°\ 12$$

$$ITR_{D\_i} = \frac{ALDOT\_CCI_{median\_i} \times DTR_{2019}}{DC_{median\_i}} \qquad Equation\ N°\ 13$$

Where,

$ITR_{G\_i} = Ideal\ Gasoline\ Tax\ Rate\ for\ Year\ i\ (dollars\ per\ gallon)$

$ITR_{D\_i} = Ideal\ Diesel\ Tax\ Rate\ for\ Year\ i\ (dollars\ per\ gallon)$

$ALDOT\_CCI_{median\_i} = Median\ Forecasted\ ALDOT\_CCI\ Value\ at\ Year\ i$

$GTR_{2019} = Gasoline\ Tax\ Revenue\ at\ Year\ 2019$

$DTR_{2019} = Diesel\ Tax\ Revenue\ at\ Year\ 2019$

$GC_{median\_i} = Median\ Forecasted\ Gasoline\ Consumption\ at\ Year\ i$

$DC_{median\_i} = Median\ Forecasted\ Diesel\ Consumption\ at\ Year\ i$

The 20 forecasted ITR values for gasoline and obtained from Equations 12 and 13 were then modeled with a polynomial regression equation and projected 30 more years into the future along that equation. Various regression equations were considered using Microsoft Excel, but polynomial regression was the best fit for the forecasted values, with the highest r-squared value (almost 1). The original 20 forecasted ITR values for gasoline, its corresponding polynomial equation, and its projection until 2073 are illustrated in Figure 3-13. A similar graphical analysis was conducted for diesel ITR values.

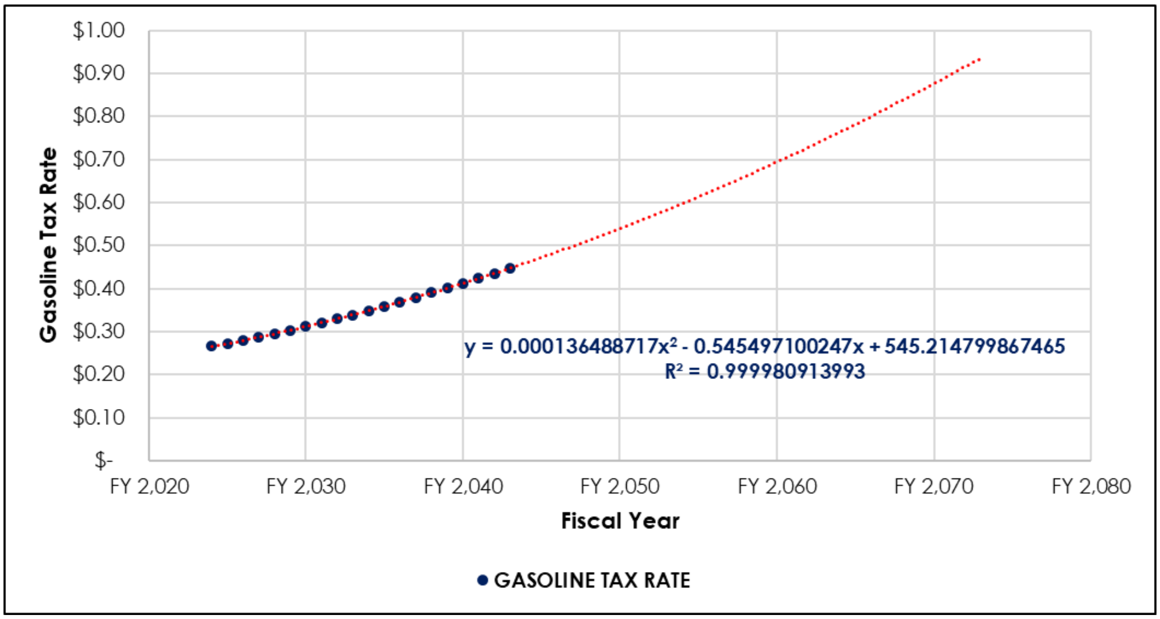


Figure 3-13. Gas Tax Rate Forecasting

A proposed schedule of annual or biannual adjustments based on those ideal rates along the regression formula on Figure 3-13 could sound like the most effective alternative. However, that would violate the principle of simple and concise communication in public policy. Effective public policy should be communicated in a clear and straightforward manner (MIT Communication Lab, n.d.). It should be easy to understand by all stakeholders, facilitating public acceptance and support. It is unlikely for an average taxpayer to understand a complex tax adjustment schedule derived from a polynomial equation. The proposed two alternatives described in the following sections are intended to be straightforward and easy to implement, while approximating future fuel tax rate adjustment to the calculated ideal rates.

It should be noted that none of the two proposed alternatives are driven by taxpayers' financial needs or capacities. They are rather focused on preventing ALDOT's funding gap from continuing growing. However, both alternatives are presented along with anticipated average wage increases required by each BLS occupation to compensate for the projected gasoline rate increase. A more detailed description of the process to develop the proposed two alternatives is presented in the next two sections.

3.5.1 Alternative I: Fixed Annual Percentage Adjustment Based on ALDOT_CCI

This alternative represents the simplest version of a TRAM, with two fixed annual percentage adjustment rates (one for gasoline and one for diesel), and calculated from the analysis of projected ALDOT_CCI annual growth rate and taking into consideration fuel consumption trends. The development of this alternative started with Equations 12 and 13, leading to the projection shown in Figure 3-13 (and its corresponding projection for diesel ITRs). However, the 50 ITRs were then modeled with an exponential regression equation, from which the fixed annual percentage adjustment rate can be calculated. The exponential regression equation does not fit the data points as good as the polynomial equation, but it allows for the simplicity of proposing a single fixed percentage annual adjustment rate.

In order to determine the potential impact of Alternative I on the 23 different groups of taxpayers considered in this study, it was first necessary to determine the average magnitude of the increase in the amount of gasoline taxes paid by an average driver in Alabama after every annual tax rate adjustment. This value was calculated using Equation 14 and considering the

Annual Average Distance Driven Per Car by Year, estimated by the FHWA at 14,263 miles per year (The Zebra, 2023), and the Average Fuel Efficiency of 24.4 MPG (U.S. Department of Energy, 2023). This value is the same for all occupational taxpayer groups at any given year.

$$GTPI_i = (GTR_i - GTR_{i-1}) \times \left(\frac{AADD}{AFE}\right) \qquad Equation\ N°\ 14$$

Where,

$GTPI_i = Forecasted\ Gasoline\ Tax\ Payment\ Increase\ at\ Year\ i$

$GTR_i = Forecasted\ Gasoline\ Tax\ Rate\ at\ Year$ i

$AADD = Annual\ Average\ Distance\ Driven\ per\ Car\ \left(Fixed\ Value = 14{,}500\ \frac{Miles}{Year}\right)$

$AFE = Average\ Fuel\ Efficiency\ (Fixed\ Value = 24.4\ MPG)$

An increase in the gasoline tax rate does not necessarily mean a negative financial impact on the finances of a taxpayer since a regular income increase could potentially offset the impact of the additional taxation burden. For that reason, it is necessary to compare forecasted gasoline tax payment increases calculated with Equation 14 against forecasted annual salaries forecasted for the same years. More specifically, the study calculated the percentage that the tax payment increase represents within the whole annual salary. It is calculated using Equation 15 every year and for each taxpayer group. In general, financial impacts calculated with Equation 15 do not look significant and could be easily offset by a small annual salary increase. However, such determination should be made by policymakers given a potential implementation of one of the proposed TRAMs.

$$AI_{i\_j} = \frac{GTPI_i}{AMW_{i\_j}} \qquad Equation\ N°\ 15$$

Where,

$AI_{i\_j} = Forecasted\ Annual\ Impact\ of\ Tax\ Increase;\ Occupation\ j\ at\ Year\ i$ (%)

$GTPI_i = Forecasted\ Gasoline\ Tax\ Payment\ Increase\ at\ Year\ i; in\ dollars$

$AMW_{i\_j} = Forecasted\ Annual\ Median\ Wage;\ Occupation\ j\ at\ Year\ i; in\ dollars$

3.5.2 Alternative II: Modified Adjustment Cap for Current TRAM

This alternative proposes two key modifications to the current NHCCI-based TRAM: 1) a change in maximum allowed adjustment 2) and a change in adjustment frequency, making it annual instead of biannual. There are two elements considered in the proposed change to the rate adjustment cap, which is currently one-cent every two years. Considering the depreciation of the currency's value, the rate adjustment cap is set as a fixed percentage value rather than a fixed number of cents. That would make the TRAM more sustainable as it would now consider the time value of value. One-cent today is not the same as one-cent in 20 years.

The other element considered is the magnitude of the adjustment cap. As discussed in Section 2.5.2, the national transportation construction inflation measured by the NHCCI tends to be greater than the actual inflation perceived by ALDOT. Therefore, limiting NHCCI-driven tax rate adjustments seems appropriate. However, the study found that the current rate adjustment cap is too low and is contributing to the increase in ALDOT's funding gap. Thus, the rate adjustment cap proposed in this alternative TRAM was calculated to reduce NHCCI inflation until it matches inflation levels given by the ALDOT_CCI.

The median forecasted NHCCI was first projected until the year 2073. A Linear Programming (LP) model was then developed to find a rate adjustment cap that would produce tax rates similar to the ITRs previously calculated for gasoline and diesel (see Figure 3-14). The LP model was designed to minimize the Mean Absolute Percentage Error (MAPE), which represents the gap between the rates produced by this alternative TRAM and the ITRs. MAPE values were calculated as shown in Equation 16.

The financial impact of Alternative II on the different groups of taxpayers was quantified following the same process and using the same equation applied on Alternative I. The only difference in the fuel tax rates. The impact was now calculated with the tax rates provided by this NHCCI-driven TRAM.

$$MAPE = \frac{\sum \left| \frac{(GDTR_i) - (ITR_i)}{ITR_i} \right|}{SP} \qquad (Equation\ N°\ 16)$$

Where,

MAPE = Mean Absolute Percentage Error

$GDTR_i$ = Gasoline or Diesel Tax Rate for year i; in dollars

ITR_i = Ideal Gasoline or Diesel Tax Rate for year i; in dollars

SP = Study Period, (SP = 50-year period)

CHAPTER FOUR:
RESULTS AND ANALYSIS

4.1 INTRODUCTION

This chapter presents and analyzes the results of the first two parts of the research methodology presented in the previous chapter (seen Figure 3-1 Research Methodology, Section 3.1). Results for the third and final part of the proposed research methodology are presented in the next chapter (Chapter 5). IT should be noted that this chapter is limited to the presentation and analysis of research results. Research methods and procedures will not be discussed again as they are explained in detail in Chapter 3.

4.2 PART I: CURRENT PERFORMANCE ASSESSMENT (FY2018 – FY2023)

This section evaluates the effectiveness of the recently implemented TRAM in addressing ALDOT's funding needs and its impact on taxpayers' financial capacity from its inception through the end of FY 2023. The assessment was divided into two comparative analyses:

- **ALDOT_CCI Vs Gasoline & Diesel Revenue Indices:** This analysis examines whether the adjustments in gasoline and diesel tax rates under the TRAM have been aligned with ALDOT's evolving financial requirements. By comparing the ALDOT_CCI with the corresponding revenue indices, the analysis aims to determine if the tax adjustments have adequately met ALDOT's funding demands.
- **Taxpayers' Financial Capacity Vs Gasoline Tax Rates:** This analysis assesses the financial impact of the TRAM on taxpayers by examining how the implemented tax rate changes have affected their financial capacity.

Both analyses use Fiscal Year 2019 as a baseline, allowing for a clear comparison of whether ALDOT's and taxpayers' financial situations have improved, deteriorated, or remained the same since the implementation of the TRAM.

4.2.1 ALDOT_CCI Vs Gasoline & Diesel Revenue Indices

This section presents a comparative analysis of the ALDOT_CCI against the Gasoline and Diesel Revenue Indices over the fiscal years 2018 to 2023. The aim is to understand the relationship between construction costs and fuel tax revenues, which are critical for funding transportation projects.

- **ALDOT Construction Cost Index (ALDOT_CCI).**

The ALDOT_CCI is an index that reflects the average growth per period of the prices for construction projects funded by ALDOT. It captures trends in the cost of materials, labor and equipment required for constructing and maintaining highways. Table 4-1 presents the ALDOT_CCI values for fiscal years 2018 through 2023. This cost index was developed through the process explained in Section 3.3.1, with an index value or one (1) at FY 2019.

Table 4-1. ALDOT_CCI Results

FISCAL YEAR	AGENCY LEVEL INDEX (ALDOT_CCI)	ANNUAL CHANGE
FY 2018	0.925	-
FY 2019	1.000	+8.1%
FY 2020	1.005	+0.5%
FY 2021	1.054	+4.9%
FY 2022	1.281	+21.5%
FY 2023	1.377	+7.5%

- **The Gasoline and Diesel Revenue Indices.**

The Gasoline and Diesel Revenue Indices track the revenue generated from gasoline and diesel taxes, respectively. Table 4-2 and Table 4-3 show the Revenue Indices for gasoline and diesel taxes from FY 2018 through FY 2023, as well as the annual fuel rates and reported sales used in the calculation of index values. These fuel revenue indices were developed as explained in Section 3.3.2. These tables also show annual changes in index values.

Table 4-2. Gasoline Revenue Index - GRI.

Date	Gas Tax Rate	Gallons Sold	Gasoline Tax Revenue	GRI	ANNUAL CHANGE
FY 2,018	$ 0.18	2,650,588,322.22	$ 477,105,898.00	1.073	-
FY 2,019	$ 0.18	2,471,051,655.56	$ 444,789,298.00	1.000	-6.8%
FY 2,020	$ 0.24	2,379,082,983.33	$ 570,979,916.00	1.284	+28.4%
FY 2,021	$ 0.26	2,466,820,326.92	$ 641,373,285.00	1.442	+12.3%
FY 2,022	$ 0.28	2,661,047,621.43	$ 745,093,334.00	1.675	+16.2%
FY 2,023	$ 0.28	2,663,446,525.00	$ 745,765,027.00	1.677	+0.1%

Table 4-3. Diesel Revenue Index – DRI.

Date	Diesel Tax Rate	Gallons Sold	Diesel Tax Revenue	DRI	ANNUAL CHANGE
FY 2,018	$ 0.19	889,604,600.00	$ 169,024,874.00	1.066	-
FY 2,019	$ 0.19	834,638,268.42	$ 158,581,271.00	1.000	-6.2%
FY 2,020	$ 0.25	808,521,120.00	$ 202,130,280.00	1.275	27.5%
FY 2,021	$ 0.27	869,715,303.70	$ 234,823,132.00	1.481	16.2%
FY 2,022	$ 0.29	882,048,034.48	$ 255,793,930.00	1.613	8.9%
FY 2,023	$ 0.29	900,130,851.72	$ 261,037,947.00	1.646	2.1%

- **ALDOT_CCI vs. GRI & DRI: Analysis and Conclusions**

Figure 4-1 illustrates the ALDOT_CCI, and the gasoline and diesel revenue indices presented in Table 4-1, Table 4-2, and Table 4-3. All indices have been scaled to set FY 2019 as their based year to facilitate their comparison. A review of the ALDOT_CCI shows that

ALDOT has been experiencing a continues increase in transportation construction prices between FY 2018 and FY 2023, with considerable increase of 21.5% in FY 2022, which could be explained by the COVID-19 pandemic.

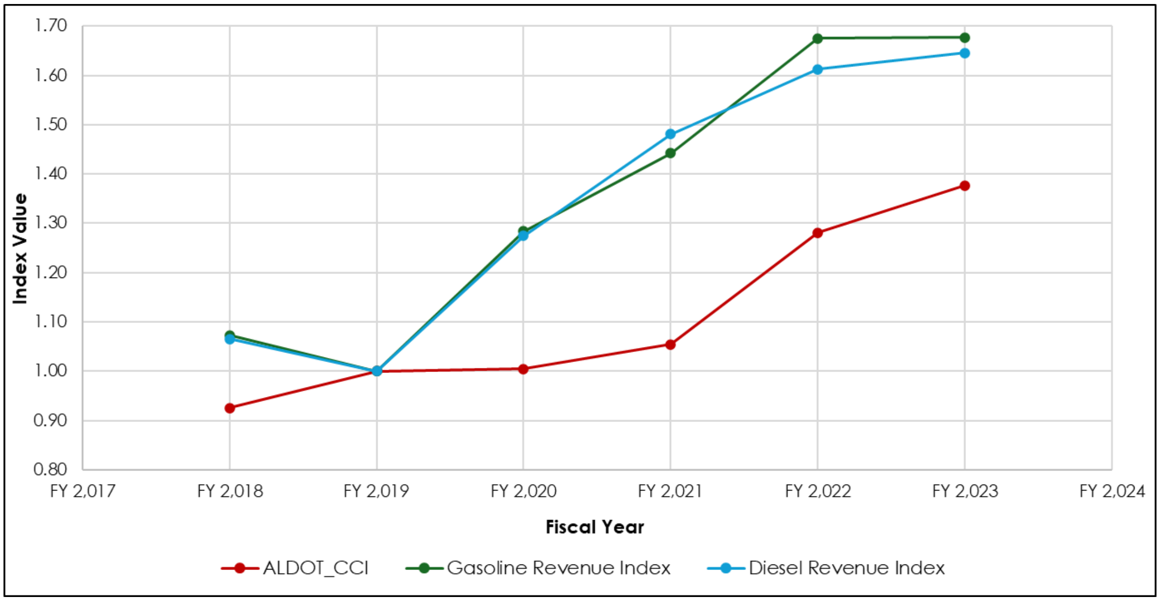


Figure 4-1. Comparative Analysis of ALDOT_CCI and Gasoline & Diesel Revenue Indices.

On the other hand, gasoline and diesel tax revenues present similar fluctuations for fiscal years 2018 through 2023, with an average growing rate greater than the one for ALDOT_CCI. It allows the study to conclude that ALDOT's 2019 funding gap was narrower between FY 2020 and FY 2023 since fuel tax revenues increased above the inflation levels measured by ALDOT_CCI. That was an intentional impact of the TRAM implemented through Rebuild Alabama Act. Regardless of the decrease in gasoline and diesel consumption (Gallons Sold in Table 4-2 and Table **4-3**) reported by the Alabama Department of Revenue (ALDOR) in FY 2019 and 2020, and which could be a consequence of the COVID-19 pandemic, there is a continuous increase in gasoline and diesel tax revenues starting in FY 2019. This happened because the initial fuel tax increments proposed by the Rebuild Alabama Act during the first three years of the implementation of the new TRAM (FY 2020 to 2022) were considerably higher than the decrease in fuel consumption.

Fuel tax revenue curves in Figure 4-1 start to flatten after FY 2022 because no fuel tax rate adjustments were performed during FY 2023. It should be noted that after the two-cents added to the gasoline and diesel tax rates in FY 2022, rate adjustments started to be performed every two years following NHCCI fluctuations, and not exceeding one-cent per adjustment period. Capped NHCCI-based rate adjustments are lower than those made during the first three years of the new TRAM.

It is also important to note that tax rate adjustments mandated by the Rebuild Alabama Act were determined prior to 2019, meaning that this assessment did not consider external events that could significantly alter these trends, such as the COVID-19 pandemic that impacted fiscal year 2020. The pandemic caused unexpected increases in market prices, causing the ALDOT_CCI and NHCCI to increase more dramatically than anticipated. Based on this, it is reasonable to conclude that legislators expected and greater initial reduction in ALDOT's funding gap after the implementation of the new TRAM.

In summary, results from this part of the study revealed that the current TRAM has had a positive impact on ALDOT's financial capacity. However, the lower revenue growth rates expected in future years due to the capped NHCCI indexed TRAM could eliminate those financial benefits if future tax rate adjustments do not match or exceed transportation construction inflation levels given by ALDOT_CCI. That issue will be evaluated in Part II of this thesis.

4.2.2 Taxpayers' Financial Capacity Index Vs Gasoline Tax Rates Index

It has been already concluded that ALDOT's financial capacity has been positively impacted by the new TRAM. Nonetheless, that is mostly explained by the three initial adjustments ordered by the Rebuild Alabama Act, suggesting that this positive outcome could have an equivalent negative counterpart to the financial capacity of taxpayers. Under the Rebuild Alabama Act, the initial three tax adjustments were: six cents per gallon in FY 2020; two-cents per gallon in FY 2021; and two-cents per gallon in FY 2022, totaling 10 cents per gallon over three years.

This section presents a comparative analysis of the Taxpayers' Financial Capacity Index (TFCI) against the Gasoline Tax Rate Index for fiscal years 2018 to 2023, as described in Section 3.3.5. The objective is to understand the relationship between the financial capacity of taxpayers and the increases in tax rates according to the new TRAM.

- **Taxpayers' Financial Capacity Indices**

TFCIs are indices that measure the financial capacity of different types of taxpayers to bear the burden of gasoline and diesel tax rates. They consider several economic indicators, such as average income, inflation rates, and cost of living. These indices were designed to reflect the overall economic health and financial resilience of taxpayers and were developed as described in Section 3.3.3. Table 3-6 (in Section 3.2.5) shows the 23 taxpayer groups considered in this study, classified by occupation, and with their respective occupational code assigned by the Bureau of Labor Statistics (BLS).

Table 4-4 shows the 21 years of TFCI values for five selected occupations (see occupation at the bottom of the table). Given the significant data processing efforts conducted to analyze the impact of the new TRAM on all 23 groups, it is not possible to present all those results in the body of this thesis. The rest of this section will be mainly limited to the five groups shown in Table 4-4, but the results for all 23 groups are summarized in Appendix E. Although this section does not show the results of all occupational groups, conclusions and analyses presented below consider all groups.

Table 4-4. TFCIS' Example

YEAR / CODE	00-0000	11-0000	17-0000	47-0000	53-0000
FY 2,003	0.961	0.938	0.915	0.943	1.004
FY 2,004	0.952	0.954	0.911	0.930	1.009
FY 2,005	0.951	0.948	0.934	0.914	1.004
FY 2,006	0.944	0.949	0.924	0.902	0.996
FY 2,007	0.965	0.969	0.952	0.907	1.002
FY 2,008	0.956	0.965	0.943	0.914	1.001
FY 2,009	0.999	1.008	0.978	0.939	1.041
FY 2,010	0.997	1.044	0.994	0.944	1.037
FY 2,011	0.972	1.064	0.984	0.934	1.004
FY 2,012	0.959	1.069	0.991	0.943	0.984
FY 2,013	0.960	1.087	1.004	0.957	0.987
FY 2,014	0.954	1.075	1.012	0.956	0.993
FY 2,015	0.976	1.098	1.045	0.975	1.004
FY 2,016	0.983	1.091	1.038	0.987	0.997
FY 2,017	0.986	1.084	1.043	0.991	1.014
FY 2,018	0.973	1.025	0.988	0.989	1.004
FY 2,019	1.000	1.000	1.000	1.000	1.000
FY 2,020	1.049	1.023	1.014	1.014	1.042
FY 2,021	1.007	0.951	0.925	0.908	0.975
FY 2,022	0.966	0.895	0.911	0.897	1.036
FY 2,023	0.993	0.890	0.954	0.973	1.047

Note:
Code 00-0000 is for All Occupations
Code 11-0000 is for Management Occupations
Code 17-0000 is for Architecture and Engineering Occupations
Code 47-0000 is for Construction and Extraction Occupations
Code 53-0000 is for Transportation and Material Moving Occupations

- **Gasoline Tax Rate Index**

The Gasoline Tax Rate Index is essential for tracking changes in fuel tax rates over the specified period. This index was developed as explained in Section 3.3.4. While ALDOT's financial capacity was evaluated in the previous section using fuel tax revenue levels, the financial capacity of taxpayers is evaluated using gasoline tax rate values (see Section 3.3.4).

Table 4-5 presents the Gasoline Tax Rate Index - GTRaI values for fiscal years 2018 through 2023, illustrating the annual changes in gasoline tax rates. The index values provide a clear view of how tax rates have evolved over the specified period. It is important to mention that gasoline tax rates in Alabama remained constant between 1993 to 2019. Therefore, all index values along that period of time would be equal to one (1), according to the index shown in Table 4-5.

Table 4-5. Gasoline Tax Rate Index - GTRaI

Fiscal Year	Gasoline Tax Rate	Gasoline Tax Rate Index
FY 2018	$ 0.18	1.000
FY 2019	$ 0.18	1.000
FY 2020	$ 0.24	1.333
FY 2021	$ 0.26	1.444
FY 2022	$ 0.28	1.556
FY 2023	$ 0.28	1.556

- **TFCIs vs. GTRaI: Analysis and Conclusions**

Once the TFCIs and GTRaI were developed, Figure 4-2 was developed to facilitate a visual comparison between the GTRaI and the five selected occupational groups. This figure highlights the disparity between the rapid increase in fuel taxes and the slower growth in taxpayer financial capacity, particularly since the initial adjustment under the TRAM. In other words, fuel tax rates are growing faster than the financial capacity of taxpayers, which actually decreased between 2019 and 2023 for most of the occupational groups. Similar figures were obtained across the 23 groups (see Appendix F). Almost 70% of the taxpayer groups (16 out of 23) showed a reduction in their financial capacity along the period of time shown in Figure 4-2.

The highest TFCI value by FY 2023 was around 1.07, more than 30% lower than the GTRaI at the same year.

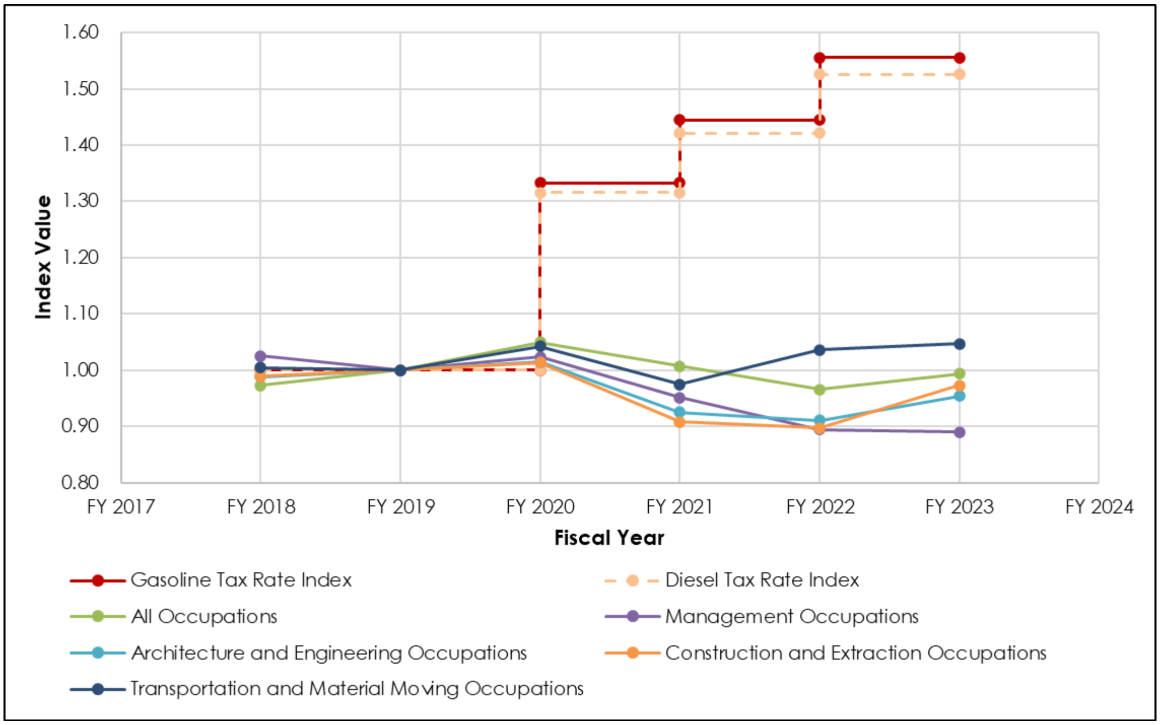


Figure 4-2. TFCI Vs GTRaI

This observation suggests that while the tax rate adjustments were effective in generating additional revenue for ALDOT, they may have inadvertently put pressure on the financial capacity of all the occupational groups considered in this study, potentially affecting their economic stability. Although TFCIs and GTRaI values clearly followed different trends increasing their gap over time, Figure 4-2 does not allow to estimate the magnitude of that gap in dollars. Legislators had no doubt that this would be a negative outcome from the implementation of the TRAM. Before enacting the Rebuild Alabama Act, they estimated that after the three initial tax rate adjustments, “the total 10 cent per gallon gas tax increase will only cost the average driver $4.58 a month (A cup of coffee)” (Rebuild Alabama Act, 2019). Section 5.4

shows the result of the quantitative assessment conducted on this gap, which confirms the taxpayer impact estimate made by Alabama's legislators

4.3 PART II: FUTURE PERFORMANCE ASSESSMENT

This section delves into the future performance assessment of the indices developed in this study, projecting trends and evaluating potential outcomes over the next 20 years (form 2024 to 2043). This section presents and analyzes the risk-based forecasts for various indices and discusses the results of the probabilistic comparative analysis following the methodology described in Section 3.4.

Quantitative procedures under this part of the study can be summarized into the Equation 9, 10, and 11, presented in Section 3.4.3. Those equations are outlined again as Equations 17, 18, and 19. The following section first presents the risk-based forecasts that correspond to the inputs for those three equations. Subsequently, the thesis presents and discusses the risk-based forecasts for the comparative ratios.

$$P\left(CR_{1\_G\_i}\right) = \frac{P(GTRI_i)}{P(ALDOT\_CCI_i)} \qquad Equation\ N°\ 17$$

$$P\left(CR_{1\_D\_i}\right) = \frac{P(DTRI_i)}{P(ALDOT\_CCI_i)} \qquad Equation\ N°\ 18$$

$$P\left(CR_{2\_i\_j}\right) = \frac{P\left(TFCI_{i\_j}\right)}{P(GTRaI_i)} \qquad Equation\ N°\ 19$$

Where,

$P\left(CR_{1\_G\_i}\right) =$ *Probability Dist. of Comparative Ratios at Year i; First Comparative Analysis; ALDOT_CCI vs. Gasoline Tax Revenue Index*

$P(CR_{1\_D\_i}) =$ *Probability Dist. of Comparative Ratios at Year i; First Comparative Analysis; ALDOT_CCI vs. Diesel Tax Revenue Index*

$P(CR_{2\_i\_j}) =$ *Probability Dist. of Comparative Ratios at Year i; Second Comparative Analysis; TFCI for Occupation j vs. Gasoline Tax Rate Index*

$P(GTRI_i) =$ *Probability Dist. of Gasoline Tax Revenue Index at Year i*

$P(DTRI_i) =$ *Probability Dist. of Diesel Tax Revenue Index at Year i*

$P(ALDOT\_CCI_i) =$ *Probability Dist. of ALDOT_CCI at Year i*

$P(TFCI_{i\_j}) =$ *Probability Dist. of TFCI for Occupation j at Year i*

$P(GTRaI_i) =$ *Probability Dist. of Gasoline Tax Rate Index at Year i*

4.3.1 ALDOT_CCI and Fuel Tax Revenue Indices: 20-Year Risk-Based Forecasting

Table 4-6, Table 4-7, and Table 4-8 present that annual median forecasted values for the ALDOT_CCI, GTRI, and DTRI, respectively, and with their corresponding annual confidence boundaries at 50%, 80%, and 95% confidence levels. Figure 4-3, Figure 4-4, and Figure 4-5 illustrate the risk-based forecasts represented by each of the three tables. The values shown in these tables under each year form the probability distribution functions that served as inputs for Equations 17 and 18. Figure 4-6 portrays the forecasted annual median values for each of the three indices to facilitate an initial visual comparison between them.

Table 4-6. ALDOT_CCI 20-year forecast

ALDOT_CCI	95.0%		80.0%		50.0%		Median
	2.5th %tile	97.5th %tile	10th %tile	90th %tile	25th %tile	75th %tile	50th %tile
FY 2,024	1.31	1.62	1.34	1.53	1.38	1.47	1.42
FY 2,025	1.31	1.76	1.36	1.64	1.41	1.55	1.47
FY 2,026	1.31	1.89	1.38	1.74	1.44	1.63	1.52
FY 2,027	1.32	2.02	1.40	1.84	1.48	1.71	1.58
FY 2,028	1.34	2.15	1.43	1.94	1.52	1.79	1.64
FY 2,029	1.36	2.29	1.46	2.05	1.57	1.87	1.71
FY 2,030	1.37	2.42	1.49	2.16	1.62	1.95	1.77
FY 2,031	1.40	2.56	1.53	2.26	1.67	2.04	1.84
FY 2,032	1.43	2.71	1.57	2.37	1.72	2.13	1.91
FY 2,033	1.46	2.86	1.61	2.49	1.77	2.22	1.98
FY 2,034	1.49	3.01	1.66	2.61	1.83	2.32	2.05
FY 2,035	1.52	3.18	1.70	2.74	1.89	2.42	2.13
FY 2,036	1.56	3.34	1.75	2.86	1.95	2.52	2.21
FY 2,037	1.60	3.52	1.80	3.00	2.02	2.63	2.29
FY 2,038	1.63	3.69	1.85	3.14	2.08	2.75	2.38
FY 2,039	1.67	3.89	1.90	3.28	2.15	2.87	2.47
FY 2,040	1.71	4.09	1.96	3.44	2.22	2.98	2.56
FY 2,041	1.75	4.31	2.02	3.60	2.30	3.10	2.67
FY 2,042	1.79	4.51	2.07	3.77	2.37	3.25	2.77
FY 2,043	1.83	4.73	2.13	3.94	2.45	3.39	2.87

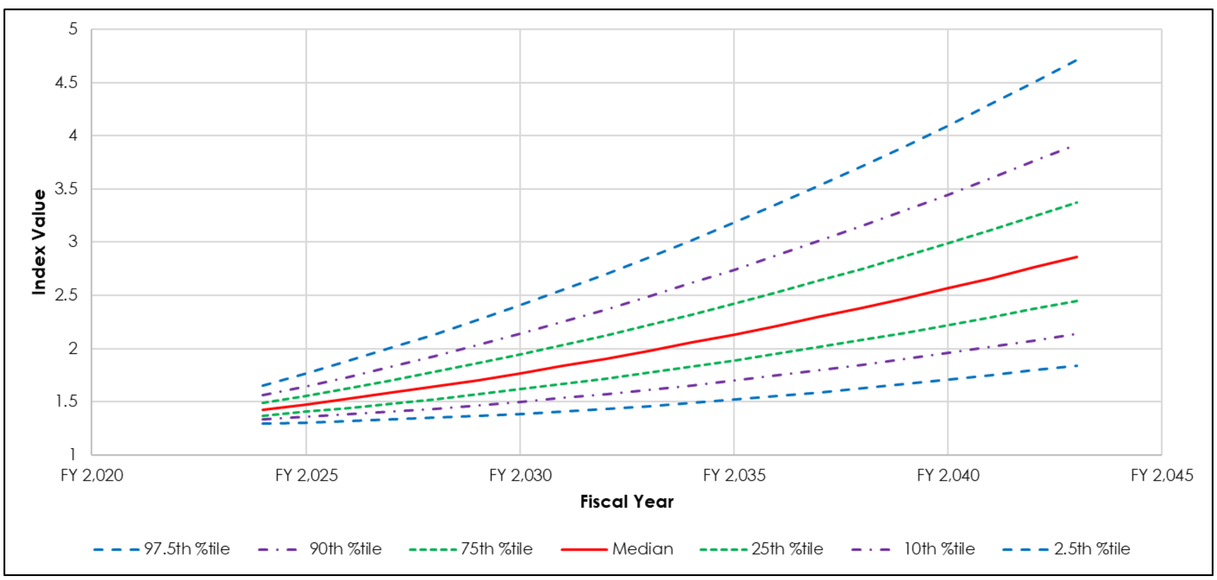


Figure 4-3. ALDOT_CCI 20-year forecast

Table 4-7. GTRI 20-year forecast

GRI	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	1.42	1.67	1.47	1.62	1.51	1.58	1.55
FY 2,025	1.39	1.73	1.45	1.66	1.50	1.61	1.55
FY 2,026	1.23	1.84	1.38	1.75	1.50	1.67	1.60
FY 2,027	1.23	1.88	1.38	1.78	1.50	1.69	1.60
FY 2,028	1.17	1.98	1.34	1.85	1.49	1.75	1.63
FY 2,029	1.17	2.02	1.34	1.88	1.49	1.77	1.63
FY 2,030	1.11	2.11	1.31	1.96	1.48	1.82	1.66
FY 2,031	1.10	2.15	1.31	1.98	1.49	1.83	1.66
FY 2,032	1.08	2.25	1.30	2.05	1.49	1.88	1.68
FY 2,033	1.08	2.28	1.30	2.07	1.48	1.89	1.69
FY 2,034	1.06	2.37	1.28	2.14	1.48	1.93	1.71
FY 2,035	1.06	2.41	1.28	2.16	1.49	1.95	1.72
FY 2,036	1.04	2.48	1.28	2.22	1.49	1.99	1.74
FY 2,037	1.04	2.51	1.28	2.24	1.49	2.00	1.75
FY 2,038	1.02	2.59	1.27	2.30	1.50	2.04	1.77
FY 2,039	1.02	2.63	1.27	2.32	1.51	2.06	1.78
FY 2,040	1.02	2.71	1.27	2.38	1.51	2.10	1.80
FY 2,041	1.01	2.75	1.27	2.40	1.52	2.11	1.80
FY 2,042	1.00	2.83	1.27	2.46	1.52	2.15	1.82
FY 2,043	1.00	2.86	1.27	2.47	1.53	2.17	1.83

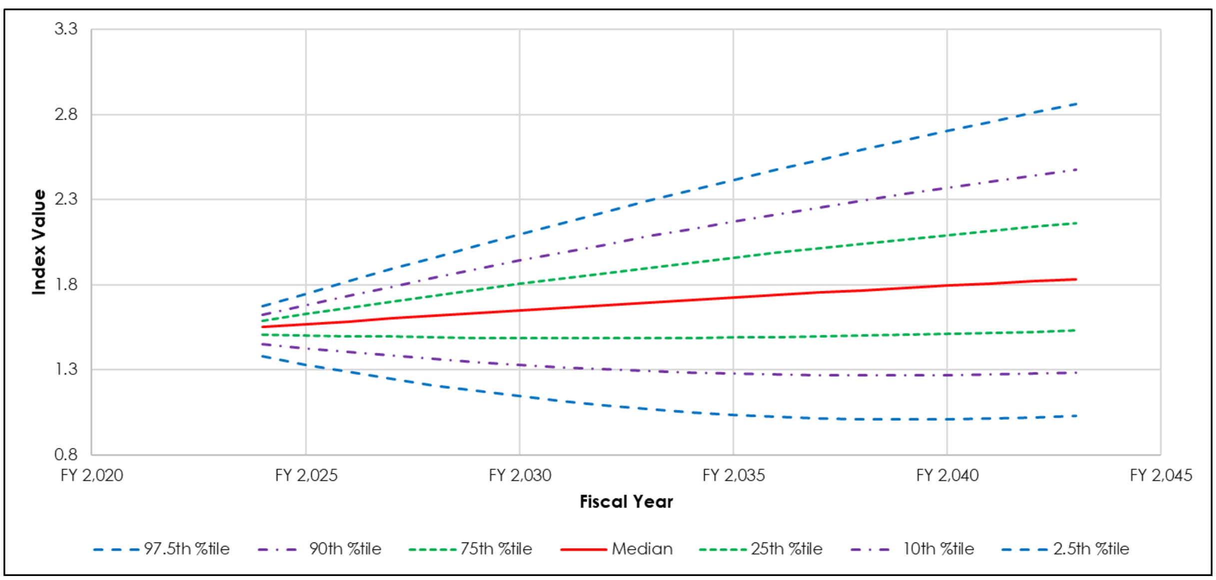


Figure 4-4. GTRI 20-year forecast

Table 4-8. DTRI 20-year forecast

DRI	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	1.49	2.14	1.55	1.95	1.62	1.82	1.71
FY 2,025	1.41	2.35	1.51	2.10	1.61	1.91	1.75
FY 2,026	1.29	2.60	1.46	2.28	1.62	2.04	1.80
FY 2,027	1.27	2.78	1.44	2.40	1.62	2.11	1.84
FY 2,028	1.20	3.06	1.42	2.59	1.62	2.23	1.90
FY 2,029	1.19	3.22	1.42	2.70	1.64	2.30	1.93
FY 2,030	1.15	3.52	1.40	2.88	1.65	2.41	1.99
FY 2,031	1.14	3.73	1.40	2.98	1.67	2.48	2.04
FY 2,032	1.13	3.99	1.40	3.17	1.69	2.59	2.08
FY 2,033	1.13	4.20	1.40	3.28	1.72	2.67	2.13
FY 2,034	1.11	4.44	1.41	3.47	1.74	2.79	2.19
FY 2,035	1.11	4.64	1.41	3.61	1.75	2.86	2.24
FY 2,036	1.09	4.97	1.42	3.81	1.79	2.96	2.30
FY 2,037	1.10	5.19	1.43	3.93	1.81	3.06	2.35
FY 2,038	1.07	5.51	1.43	4.17	1.83	3.18	2.41
FY 2,039	1.07	5.76	1.44	4.28	1.88	3.29	2.47
FY 2,040	1.07	6.08	1.45	4.52	1.90	3.38	2.52
FY 2,041	1.07	6.36	1.47	4.64	1.91	3.49	2.58
FY 2,042	1.07	6.66	1.47	4.81	1.95	3.62	2.66
FY 2,043	1.08	6.92	1.49	5.00	1.98	3.72	2.73

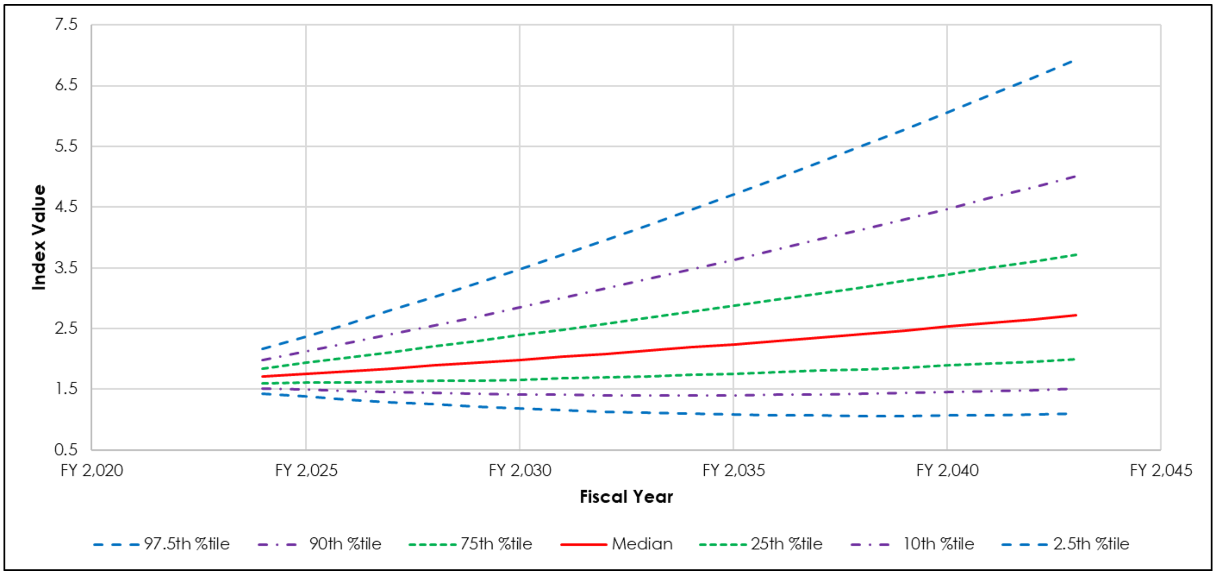


Figure 4-5. DTRI 20-year forecast

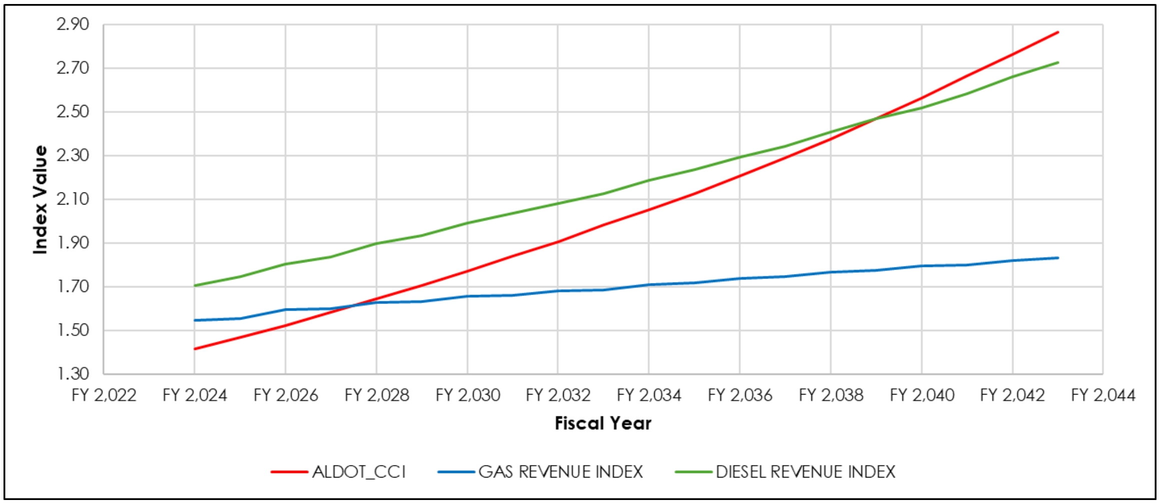


Figure 4-6. Forecasted Medians: ALDOT_CCI; GTRI; and DTRI.

A more complete probabilistic comparison is discussed later in Section 4.3.4. However, Figure 4-6 allows to approximate how long the boosts to ALDOT's financial capacity provided by the initial tax rate adjustments will last if the current TRAM remains unchanged. It should be noted that all index forecasts performed in this study still considered FY 2019 as the base year (index value = 1). Thus, it can be concluded that funding associated with gasoline tax collections will return to 2019 levels in FY 2027, while that breakpoint for diesel tax revenues is expected to appear about 12 years later, by FY 2039. After those breakpoints, the funding situation associated with each tax source is expected to increasingly worsen if those trends continue further into the future.

4.3.2 TFCIs and GTRaI: 20-year Risk-Based Forecast

Considerable research efforts were invested in developing risk-based forecasts for each of the 23 TFCIs, as well as the probabilistic forecast for the GTRaI. Those probabilistic forecasts were similar to those presented in the previous section. They also cover a 20-year forecasting time horizon and define confidence boundaries at 50%, 80%, and 95% confidence levels. The distributions of TFCI and GTRaI values for each year correspond to the inputs for Equation 19.

Figure 4-7 shows the forecasted annual median values for the TFCIs for the five selected occupational groups, along with the forecasted median values for the GTRaI. The figure also shows expected future median values for a Diesel Tax Rate Index (DTRaI), but only to allow for a comparison against the other indices. DTRaI was not considered in the probabilistic comparative process discussed later in this chapter because this study assumes that an average taxpayer represented by the 23 occupational groups is a gasoline consumer (see Section 3.3.5).

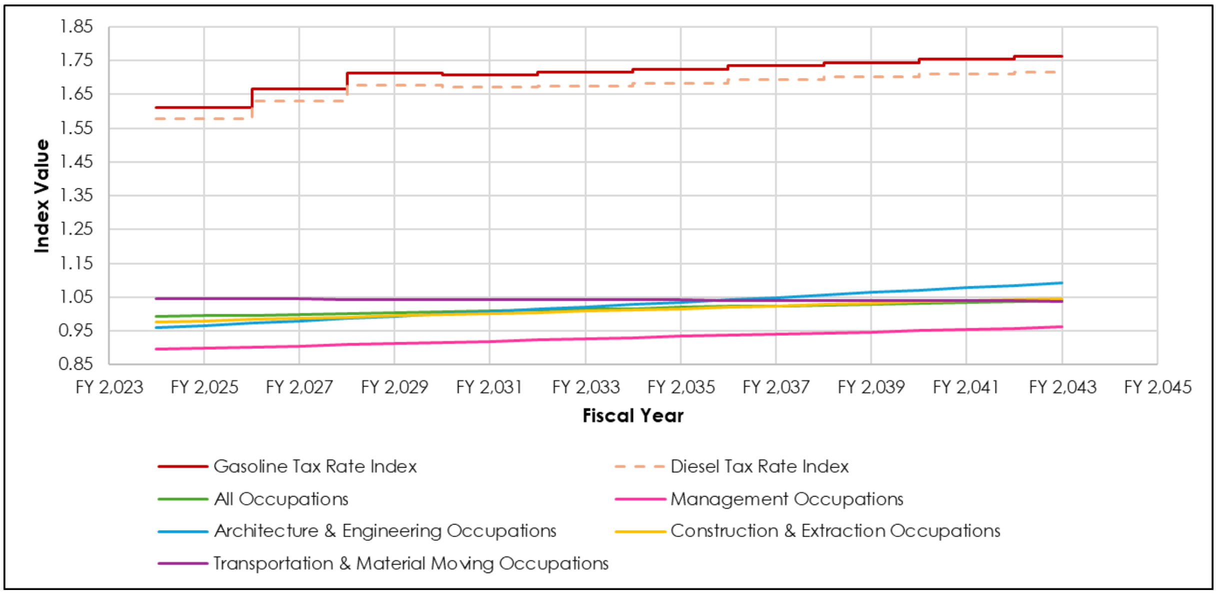


Figure 4-7. Forecasted Medians: TFCIs and GTRaI.

Figure 4-7 shows a relatively constant gap between TFCIS and the GTRaI. The five occupational groups considered in this figure seem to be representative of all 23 occupations since those not shown in this figure also revealed overall similar trends. It is important to mention that forecasts were based on pre-COVID-19 historical values and trends, assuming the no similar situations will occur over the next 20 years.

4.3.3 First Probabilistic Comparative Analysis: ALDOT_CCI Vs GTRI and DTRI

Table 4-9 and Figure 4-8 summarize and illustrate the probabilistic comparative analysis between ALDOT_CCI and GTRI (Equation 17), while Table 4-10 and Figure 4-9 correspond to the comparison between ALDOT_CCI and DTRI (Equation 18). The probabilistic comparative analysis is performed as described in Section 3.4.3, with the use of @Risk software to simulate 10,000 iterations for Equations 17 and 18 at each year. This means that 10,000 comparative ratio values are randomly generated for each given the distributions of the input probabilities.

Table 4-9. Gasoline Revenue Analysis

GR ANALYSIS	95.0%		80.0%		50.0%		Median
	2.5th %tile	97.5th %tile	10th %tile	90th %tile	25th %tile	75th %tile	50th %tile
FY 2,024	0.974	1.172	1.018	1.144	1.052	1.117	1.086
FY 2,025	0.911	1.179	0.961	1.136	1.005	1.095	1.052
FY 2,026	0.850	1.188	0.916	1.133	0.970	1.085	1.029
FY 2,027	0.806	1.179	0.871	1.114	0.932	1.059	0.996
FY 2,028	0.761	1.174	0.837	1.107	0.902	1.040	0.972
FY 2,029	0.724	1.162	0.799	1.086	0.866	1.013	0.941
FY 2,030	0.687	1.156	0.768	1.072	0.838	0.999	0.918
FY 2,031	0.657	1.134	0.737	1.047	0.807	0.972	0.889
FY 2,032	0.623	1.124	0.709	1.033	0.782	0.953	0.869
FY 2,033	0.594	1.104	0.679	1.011	0.753	0.929	0.840
FY 2,034	0.574	1.095	0.658	0.995	0.729	0.910	0.817
FY 2,035	0.548	1.070	0.629	0.970	0.703	0.886	0.792
FY 2,036	0.527	1.059	0.609	0.955	0.683	0.867	0.772
FY 2,037	0.504	1.038	0.582	0.936	0.657	0.844	0.747
FY 2,038	0.483	1.027	0.564	0.916	0.639	0.824	0.728
FY 2,039	0.462	1.002	0.543	0.894	0.615	0.802	0.705
FY 2,040	0.445	0.989	0.525	0.878	0.598	0.783	0.688
FY 2,041	0.424	0.968	0.505	0.855	0.577	0.761	0.666
FY 2,042	0.409	0.955	0.487	0.840	0.559	0.746	0.649
FY 2,043	0.394	0.932	0.469	0.818	0.538	0.725	0.629

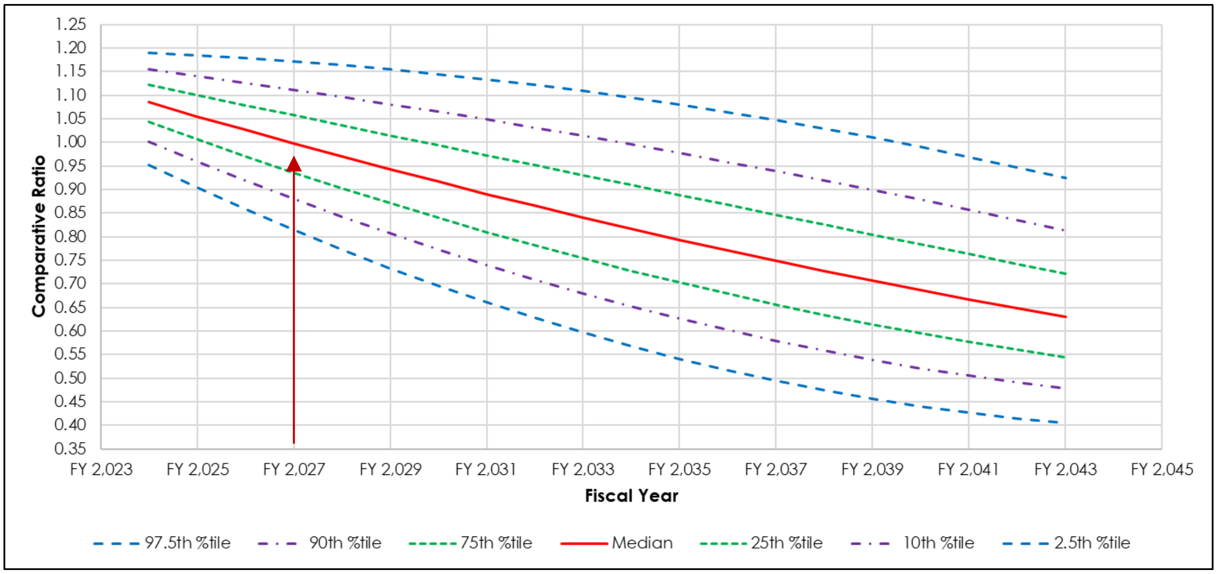


Figure 4-8. Gasoline Revenue Analysis

Table 4-10. Diesel Revenue Analysis

DR ANALYSIS	95.0%		80.0%		50.0%		Median
	2.5th %tile	97.5th %tile	10th %tile	90th %tile	25th %tile	75th %tile	50th %tile
FY 2,024	1.004	1.506	1.071	1.377	1.130	1.285	1.201
FY 2,025	0.915	1.612	0.997	1.434	1.078	1.305	1.180
FY 2,026	0.841	1.718	0.942	1.499	1.043	1.323	1.170
FY 2,027	0.785	1.774	0.894	1.518	1.008	1.331	1.152
FY 2,028	0.735	1.861	0.854	1.564	0.976	1.347	1.139
FY 2,029	0.690	1.911	0.818	1.576	0.947	1.347	1.122
FY 2,030	0.653	1.997	0.783	1.611	0.924	1.355	1.112
FY 2,031	0.621	2.017	0.753	1.615	0.897	1.348	1.096
FY 2,032	0.589	2.094	0.731	1.649	0.874	1.350	1.085
FY 2,033	0.567	2.120	0.702	1.661	0.857	1.341	1.067
FY 2,034	0.545	2.173	0.683	1.682	0.838	1.335	1.054
FY 2,035	0.517	2.201	0.659	1.691	0.818	1.334	1.036
FY 2,036	0.498	2.235	0.642	1.703	0.798	1.334	1.025
FY 2,037	0.480	2.269	0.617	1.701	0.781	1.329	1.013
FY 2,038	0.455	2.333	0.602	1.714	0.764	1.328	0.998
FY 2,039	0.439	2.340	0.580	1.722	0.747	1.313	0.987
FY 2,040	0.421	2.386	0.564	1.727	0.732	1.319	0.979
FY 2,041	0.407	2.366	0.548	1.724	0.715	1.298	0.961
FY 2,042	0.392	2.411	0.529	1.733	0.702	1.300	0.952
FY 2,043	0.376	2.380	0.515	1.732	0.686	1.294	0.938

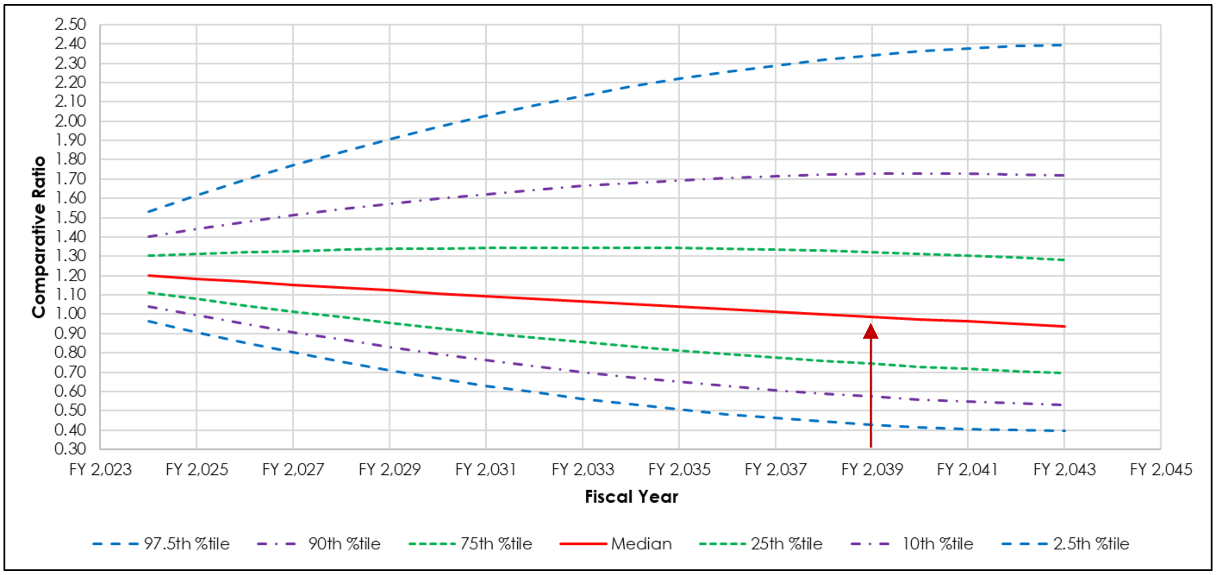


Figure 4-9. Diesel Revenue Analysis

Comparative ratio values greater than one (1) mean that, at that year, gasoline or diesel tax revenues are proportionally greater than what ALDOT received in 2019, meaning a reduction of the funding gap. On the other hand, comparative ratios lower than one indicate that gasoline or diesel tax revenues are proportionally less than what ALDOT received in 2019, corresponding to a funding gap increase. There is an arrow in Figure 4-8 and Figure 4-9 showing the breakpoints where the comparative ratios are equal to one. In other words, these breakpoints mark the moment when gasoline (Figure 4-8) or diesel (Figure 4-9) tax revenues are proportionally lower than those received by ADLOT in 2019. A downward trend in comparative ratio values represents and an increasingly growing funding gap, with the gap reaching its 2019 level at the marked breakpoint.

While these breaking points are the same as those shown in Figure 4-6 (Section 4.3.1), the probabilistic outcomes presented in this section provide more information which could facilitate better-informed decisions. For example, the expected funding associated with fluctuation in diesel tax revenues is expected to be greater in 2043 than its corresponding value in 2019.

However, there is an over 40% chance that the diesel related funding gap will be narrower in 2043. The probabilistic analysis of gasoline tax revenues reveals a different situation for future gasoline related funding gaps. A scenario in which the 2043 funding gap is equivalent to the 2019 gap is outside the 95% confidence boundaries, making this scenario statistically unlikely. Based on this observation, and taking into consideration gasoline tax revenues are about 2.8 greater that diesel tax revenues (on average), ***it can be concluded, with high degree of certainty, that the continuation of the current TRAM would result on a progressive, rapid increase of ALDOT's funding gap***.

4.3.4 Second Probabilistic Comparative Analysis: TFCIs Vs GTRaI

This section presents the results of the probabilistic comparative analysis of the Taxpayer Financial Capacity Indices (TFCI) versus the Gasoline Tax Rate Index (GTRaI) by running 10,000 iterations of Equation 19 for each occupation group at each year. The process to process to perform this comparative analysis is the same as the one followed for the first comparative analysis presented in the previous section, but this second analysis comprises 23 probabilistic comparisons. Each of the 23 TFCIs is compared against the GTRaI risk-based forecast.

Table 4-11 to Table 4-15, and Figure 4-10 to Figure 4-14 presents the probabilistic forecasts of comparative ratios for each of the five representative taxpayer groups and the GTRaI. The interpretation of comparative ratio values is the same as in the first probabilistic comparative analysis in Section 4.3.3. The almost horizontal trend of the projected median in some occupational groups suggests a constant financial capacity to pay fuel taxes by taxpayers within those groups. Appendix G shows the probabilistic outputs for all other occupational groups. In summary, if the current time remains unchanged, the forecasted ability of taxpayers to fulfill their fuel taxation obligations either remains relatively constant or decrease over time, with the Legal Occupations (Code: 23-0000) presenting the greatest capacity reduction, with an expect comparative ratio reduction of almost 20% over the next 20 years.

Table 4-11. All Occupations Index Vs GTRaI Analysis

$TFCI_{00\text{-}0000}$	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	0.602	0.645	0.606	0.632	0.610	0.624	0.616
FY 2,025	0.596	0.656	0.602	0.640	0.609	0.629	0.617
FY 2,026	0.570	0.768	0.579	0.681	0.588	0.627	0.602
FY 2,027	0.567	0.770	0.578	0.684	0.588	0.630	0.604
FY 2,028	0.546	0.812	0.558	0.711	0.571	0.643	0.595
FY 2,029	0.543	0.814	0.557	0.715	0.572	0.646	0.597
FY 2,030	0.525	0.857	0.540	0.732	0.559	0.654	0.593
FY 2,031	0.523	0.860	0.540	0.734	0.560	0.655	0.595
FY 2,032	0.507	0.879	0.525	0.747	0.549	0.659	0.592
FY 2,033	0.505	0.883	0.526	0.749	0.550	0.661	0.594
FY 2,034	0.490	0.907	0.513	0.765	0.541	0.666	0.592
FY 2,035	0.489	0.908	0.514	0.768	0.542	0.668	0.594
FY 2,036	0.475	0.940	0.502	0.775	0.535	0.671	0.591
FY 2,037	0.475	0.939	0.503	0.776	0.536	0.674	0.592
FY 2,038	0.463	0.966	0.492	0.783	0.531	0.677	0.590
FY 2,039	0.463	0.966	0.493	0.787	0.531	0.680	0.591
FY 2,040	0.452	0.984	0.484	0.793	0.524	0.684	0.590
FY 2,041	0.451	0.989	0.484	0.796	0.525	0.686	0.591
FY 2,042	0.442	1.000	0.475	0.804	0.520	0.686	0.589
FY 2,043	0.442	1.008	0.476	0.806	0.521	0.689	0.592

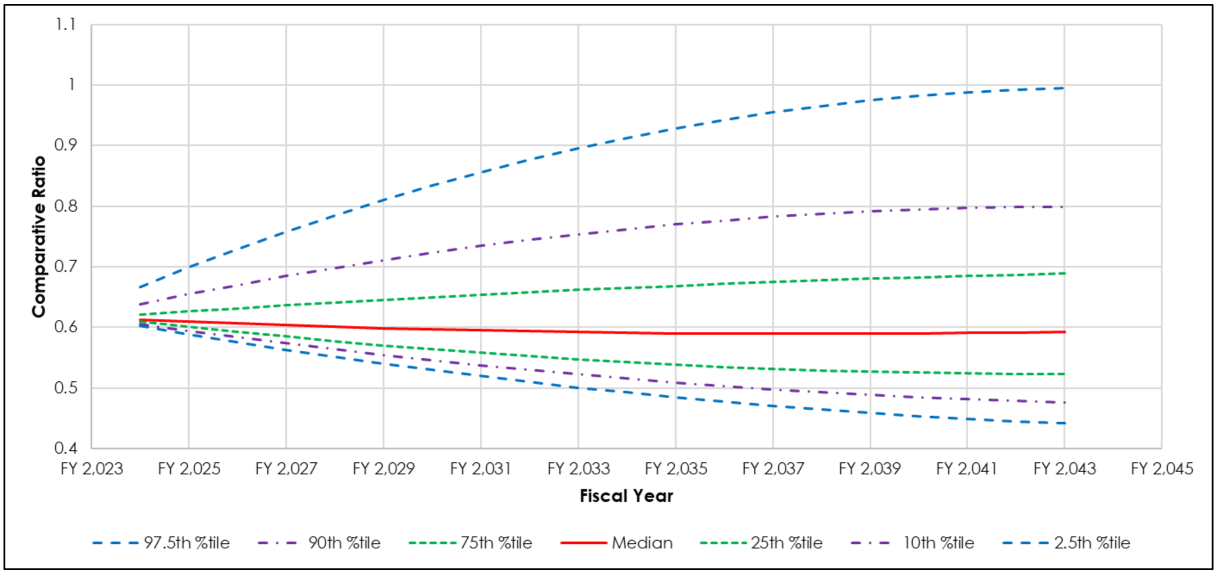


Figure 4-10. TFCI$_{00\text{-}0000}$ Analysis

Table 4-12. Management Occupations Index Vs GTRaI Analysis

TFCI$_{11\text{-}0000}$	95.0%		80.0%		50.0%		Median
	2.5th %tile	97.5th %tile	10th %tile	90th %tile	25th %tile	75th %tile	50th %tile
FY 2,024	0.527	0.576	0.536	0.571	0.546	0.565	0.556
FY 2,025	0.519	0.591	0.532	0.581	0.544	0.571	0.558
FY 2,026	0.496	0.695	0.511	0.619	0.526	0.570	0.545
FY 2,027	0.491	0.699	0.510	0.623	0.527	0.575	0.548
FY 2,028	0.472	0.744	0.492	0.650	0.513	0.587	0.541
FY 2,029	0.469	0.747	0.491	0.653	0.513	0.590	0.544
FY 2,030	0.453	0.789	0.477	0.672	0.503	0.598	0.540
FY 2,031	0.452	0.792	0.477	0.675	0.504	0.601	0.544
FY 2,032	0.438	0.817	0.465	0.691	0.496	0.607	0.541
FY 2,033	0.436	0.821	0.466	0.693	0.497	0.610	0.542
FY 2,034	0.425	0.849	0.455	0.705	0.489	0.615	0.541
FY 2,035	0.425	0.855	0.456	0.710	0.491	0.618	0.544
FY 2,036	0.414	0.877	0.446	0.720	0.484	0.622	0.542
FY 2,037	0.414	0.882	0.447	0.723	0.486	0.624	0.544
FY 2,038	0.402	0.896	0.439	0.730	0.481	0.629	0.542
FY 2,039	0.402	0.901	0.440	0.735	0.483	0.632	0.545
FY 2,040	0.393	0.919	0.432	0.743	0.477	0.636	0.544
FY 2,041	0.391	0.924	0.433	0.747	0.478	0.640	0.546
FY 2,042	0.384	0.953	0.426	0.756	0.474	0.642	0.545
FY 2,043	0.382	0.960	0.426	0.760	0.475	0.645	0.547

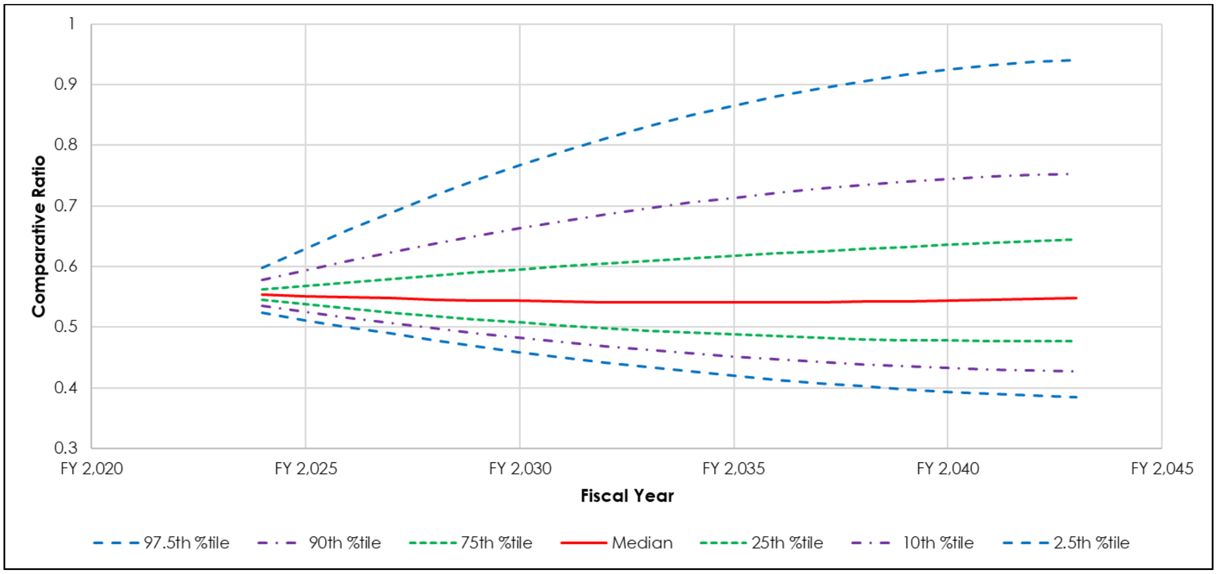


Figure 4-11. TFCI$_{11\text{-}0000}$ Analysis

Table 4-13. Architecture and Engineering Occupations Vs GTRaI Analysis

TFCI$_{17\text{-}0000}$	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	0.571	0.621	0.581	0.611	0.589	0.604	0.596
FY 2,025	0.566	0.636	0.578	0.623	0.589	0.612	0.600
FY 2,026	0.544	0.739	0.559	0.661	0.573	0.613	0.589
FY 2,027	0.543	0.747	0.560	0.666	0.575	0.620	0.594
FY 2,028	0.524	0.787	0.545	0.694	0.563	0.631	0.588
FY 2,029	0.523	0.792	0.546	0.701	0.566	0.638	0.594
FY 2,030	0.508	0.840	0.533	0.720	0.557	0.647	0.591
FY 2,031	0.508	0.846	0.535	0.726	0.560	0.652	0.596
FY 2,032	0.497	0.866	0.524	0.744	0.552	0.659	0.595
FY 2,033	0.498	0.876	0.526	0.749	0.556	0.665	0.599
FY 2,034	0.486	0.902	0.517	0.764	0.549	0.671	0.599
FY 2,035	0.488	0.910	0.519	0.770	0.552	0.676	0.604
FY 2,036	0.477	0.935	0.511	0.781	0.547	0.683	0.604
FY 2,037	0.479	0.942	0.514	0.787	0.551	0.687	0.608
FY 2,038	0.470	0.965	0.505	0.799	0.548	0.696	0.608
FY 2,039	0.472	0.975	0.508	0.807	0.551	0.701	0.612
FY 2,040	0.462	1.000	0.502	0.814	0.546	0.707	0.613
FY 2,041	0.465	1.005	0.504	0.821	0.550	0.712	0.618
FY 2,042	0.456	1.029	0.498	0.836	0.547	0.715	0.618
FY 2,043	0.457	1.040	0.500	0.840	0.550	0.721	0.623

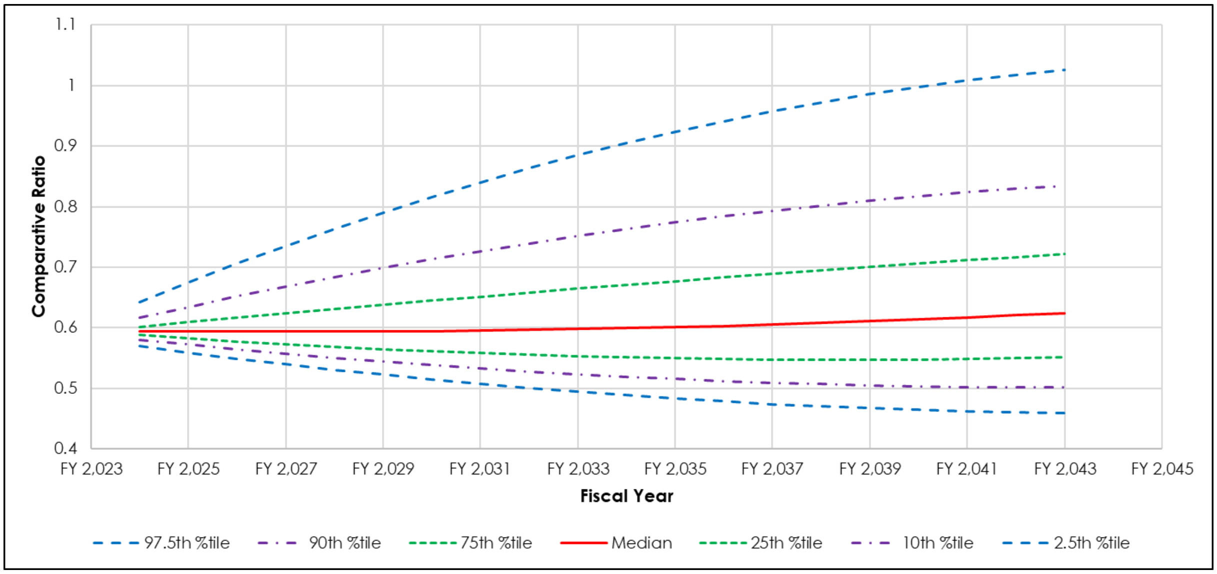


Figure 4-12. TFCI$_{17\text{-}0000}$ Analysis

Table 4-14. Construction and Extraction Occupations Vs GTRaI Analysis

TFCI$_{47\text{-}0000}$	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	0.591	0.621	0.596	0.616	0.601	0.611	0.606
FY 2,025	0.587	0.630	0.594	0.623	0.601	0.616	0.608
FY 2,026	0.566	0.732	0.575	0.658	0.584	0.612	0.595
FY 2,027	0.565	0.735	0.575	0.660	0.585	0.616	0.598
FY 2,028	0.547	0.768	0.559	0.684	0.572	0.627	0.589
FY 2,029	0.546	0.770	0.560	0.687	0.574	0.630	0.592
FY 2,030	0.530	0.812	0.546	0.703	0.562	0.637	0.588
FY 2,031	0.530	0.814	0.547	0.707	0.564	0.640	0.590
FY 2,032	0.517	0.830	0.535	0.717	0.555	0.644	0.588
FY 2,033	0.517	0.832	0.536	0.720	0.557	0.647	0.591
FY 2,034	0.505	0.851	0.525	0.732	0.549	0.652	0.589
FY 2,035	0.506	0.855	0.526	0.734	0.551	0.654	0.592
FY 2,036	0.495	0.875	0.517	0.741	0.544	0.658	0.589
FY 2,037	0.495	0.880	0.519	0.745	0.546	0.660	0.592
FY 2,038	0.485	0.889	0.510	0.752	0.541	0.664	0.590
FY 2,039	0.486	0.895	0.512	0.756	0.543	0.667	0.593
FY 2,040	0.477	0.914	0.504	0.757	0.537	0.669	0.592
FY 2,041	0.478	0.915	0.505	0.761	0.539	0.672	0.594
FY 2,042	0.470	0.932	0.498	0.769	0.534	0.673	0.593
FY 2,043	0.470	0.936	0.499	0.772	0.536	0.676	0.595

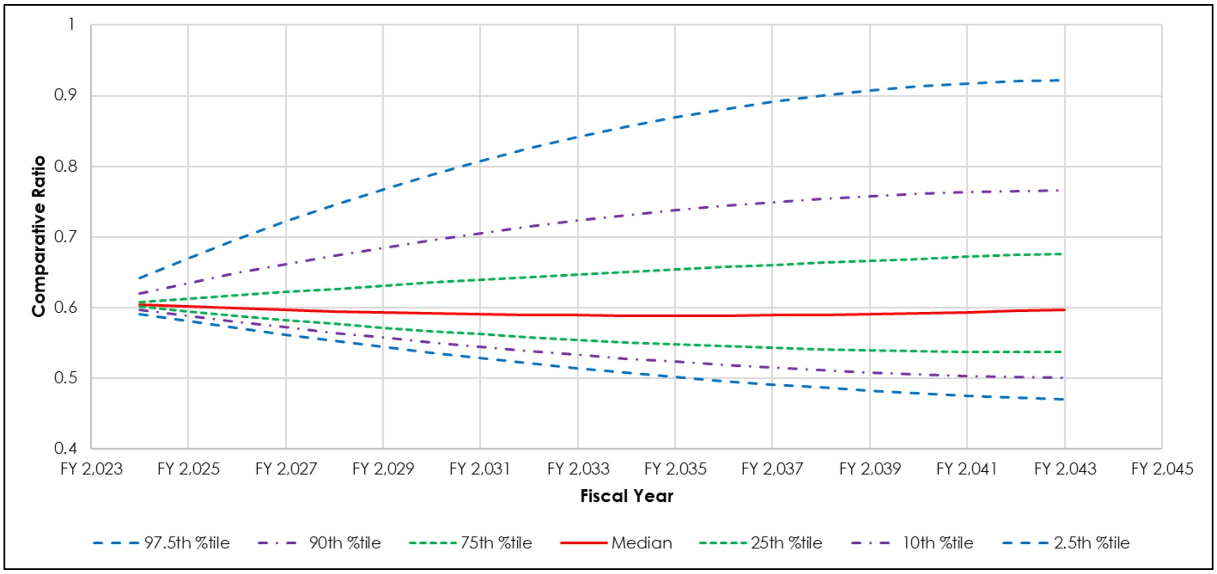


Figure 4-13. TFCI$_{47\text{-}0000}$ Analysis

Table 4-15. Transportation and Material Moving Occupations Vs GTRaI Analysis

TFCI$_{53\text{-}0000}$	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	0.632	0.671	0.639	0.662	0.644	0.655	0.649
FY 2,025	0.625	0.679	0.633	0.667	0.641	0.658	0.649
FY 2,026	0.600	0.774	0.611	0.698	0.621	0.653	0.633
FY 2,027	0.596	0.776	0.608	0.699	0.619	0.656	0.634
FY 2,028	0.576	0.810	0.589	0.720	0.603	0.661	0.624
FY 2,029	0.572	0.808	0.587	0.722	0.602	0.662	0.624
FY 2,030	0.554	0.840	0.571	0.733	0.589	0.666	0.617
FY 2,031	0.551	0.840	0.569	0.734	0.589	0.667	0.618
FY 2,032	0.535	0.854	0.555	0.743	0.577	0.669	0.613
FY 2,033	0.533	0.858	0.554	0.743	0.577	0.669	0.613
FY 2,034	0.519	0.871	0.542	0.751	0.567	0.670	0.608
FY 2,035	0.517	0.871	0.541	0.751	0.567	0.671	0.609
FY 2,036	0.504	0.896	0.530	0.756	0.558	0.671	0.605
FY 2,037	0.503	0.891	0.529	0.757	0.557	0.671	0.605
FY 2,038	0.491	0.897	0.518	0.761	0.550	0.673	0.600
FY 2,039	0.489	0.896	0.517	0.762	0.550	0.673	0.600
FY 2,040	0.478	0.913	0.508	0.763	0.543	0.672	0.597
FY 2,041	0.477	0.915	0.507	0.762	0.542	0.672	0.597
FY 2,042	0.466	0.929	0.498	0.767	0.535	0.671	0.593
FY 2,043	0.465	0.927	0.498	0.768	0.535	0.671	0.593

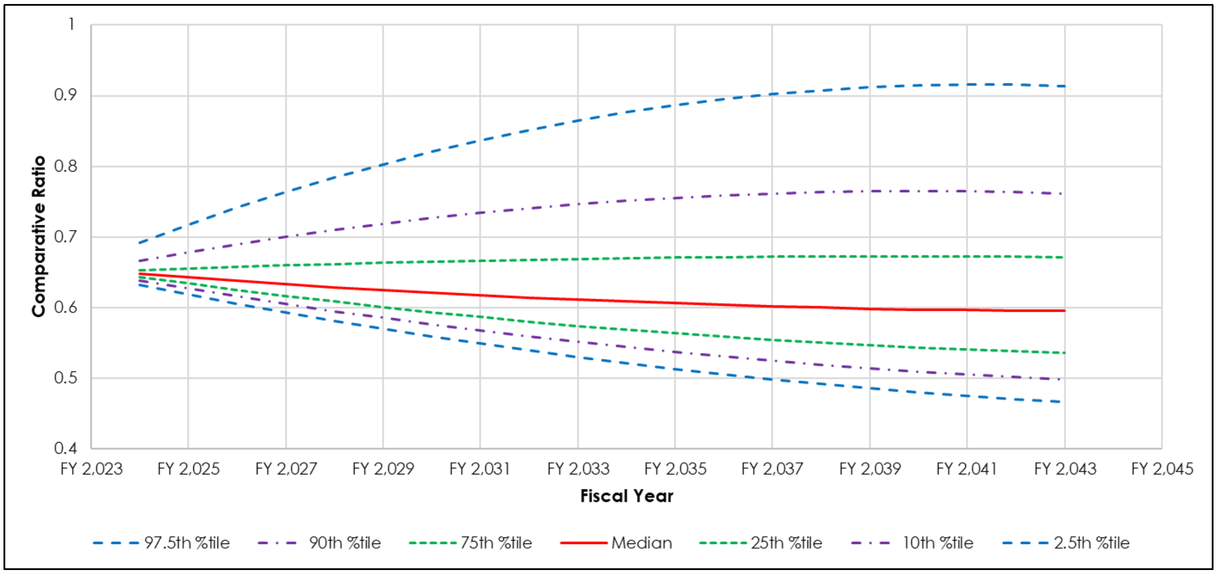


Figure 4-14. TFCI$_{53\text{-}0000}$ Analysis

The relative constant gap observed between TFCI projections and the GTRaI forecast suggests that the capped NHCCI-based TRAM was designed to maintain that gap. Thus, the implementation of the new TRAM could be summarized in two phases. First, increase the taxation burden on Alabama's fuel consumers with a rapid fuel rate increase of 10 cents executed over three years. This aggressive adjustment, which is estimated to correspond to "a cup of coffee per month," was intended to close the funding gap affecting Alabama's transportation infrastructure.

The second phase was then intended to align subsequent fuel rate adjustment with expected changes in the financial capacity of taxpayers. This means that the long-term implementation of the new TRAM is guided by taxpayers' financial capacities rather than by projected transportation infrastructure needs. Nonetheless, as observed in Section 4.3.1, a long-term implementation of this taxpayer-oriented philosophy will likely lead to continuously increasing funding gap, preventing ALDOT from effectively maintaining the public transportation infrastructure in Alabama. In order to consider a different perspective, the two alternative

TRAMs proposed in the next chapter attempt to maintain ALDOT's financial capacity constant, preventing a further growth of its funding gap, while monitoring their impact on the different taxpayer groups.

CHAPTER FIVE:
PROPOSE ALTERNATIVE TRAM

5.1 INTRODUCTION

Findings from this study discussed in Chapter 4 led to the conclusion that Alabama's current Fuel Tax Rate Adjustment Methodology (TRAM) implement through the Rebuild Alabama Act was mainly intended to minimize financial impacts on taxpayers after a 10-cent increase in both gasoline and diesel tax rates. This increase was made over the first three years after the implementation of the new TRAM. It seems reasonable to conclude that the first phase of the TRAM (the 10-cent increase) was motivated by the need to reduce or control the increasing transportation infrastructure funding gap. Subsequently, the second phase of the TRAM that guides rate adjustment based on National Highway Construction Cost index (NHCCI) fluctuations, attempts to sustain the new taxation burden imposed on Alabama drivers by phase one, preventing it from growing or shrinking. It means that the average growth rate of fuel tax rates moves almost in parallel to the average financial capacity of Alabama's taxpayers. The one-cent rate cap adjustment adopted during the second phase seems to contribute to maintaining the constant taxation burden. Without that cap, fuel tax rates would be expected to grow faster than the financial capacity of taxpayers.

This thesis does not criticize the taxpayer-driven focus during the second implementation phase of the new TRAM. However, as discussed in Chapter 4, if the capped NHCCI-based TRAM remains unchanged, ALDOT's funding gap will start to increasingly grow again in the future, eliminating any financial benefits gained during the first phase of the TRAM. Gap reductions associated with increased gasoline and diesel tax revenues are expected to be completely reversed by 2027 and 2039, respectively. At those years, ALDOT would return to the financial conditions that limited ALDOT operations in 2019, when the Rebuild Alabama Act was enacted, and with a funding gap that will continue growing into the future.

This thesis recognizes the positive impact of Alabama's new TRAM. Even if it capped and performed on a biannual basis (like the new TRAM), any type of fuel tax rate adjustment would be better for ALDOT's financial capacity than the two decades of constant fuel tax rates that were paid by Alabama's drivers since 1993. However, the current TRAM is not reducing or controlling the funding gap. It is only reducing its grow rate, but it continues growing. This thesis has found that the new TRAM does not offer a sustainable solution and additional legislation actions could be soon required.

The two alternative TRAMs outlined below and explained throughout this chapter are aimed at offering better sustainability in terms of maintaining ALDOT's financial capacity. This approach is based on the premise that although the funding gap normally affecting ALDOT's operations is significant, it could be partially addressed with the help of taxpayers through marginal fuel tax rate increases. This chapter also quantifies the financial impact of every forecasted tax rate on taxpayers under each of the two alternative TRAMS.

Although legislators and relevant agencies should decide on the appropriateness of the magnitude of any additional taxation burden imposed on taxpayers, it seems reasonable to conclude that those impacts are not significant in comparison to average salaries and normal annual compensation adjustments experienced by taxpayers across the 23 occupational groups considered in this study. The following is a short description of the two proposed TRAMs, whose final versions are described in detail in the next sections. Likewise, more information about the process followed to design these two alternatives in presented in Section 3.5. The following sections are mainly limited to presenting the final product with little information about the process, since it was already discussed in this thesis. It should be noted that both alternatives are expected to yield similar tax rates, representing similar financial impacts on taxpayers. The main difference is that Alternative TRAM II still relies on the NHCCI like the current TRAM. This could make its implementation smoother and easier to accept by taxpayers.

- Alternative TRAM I: Two fixed annual percentage tax adjustment rates, one for gasoline and one for diesel tax collections, intended to match the forecasted ALDOT_CCI annual growth rate and taking into consideration forecasted fuel consumption rates. This option is presented along with the anticipated average wage increases required by each BLS occupation to compensate for the projected gasoline rate increase.
- Alternative TRAM II: A modified tax rate adjustment cap for the current NHCCI-based TRAM. The rate adjustment cap is set as a fixed percentage value rather than a fixed number of cents, making the TRAM more sustainable. It is also set to allow for greater tax rate adjustments in an attempt to match the higher transportation construction inflation levels measured by ALDOT_CCI. This alternative still maintains the biannual rate adjustment schedule of the current TRAM.

5.2 ALTERNATIVE TRAM I: FIXED ANNUAL PERCENTAGE ADJUSTMENT BASED ON ALDOT_CCI

The research methodology discussed in Section 3.5.1 led to conclude that annual gasoline and diesel fixed tax adjustment rates of <u>***+2.4% and +1.1%*** would prevent ALDOT's funding gap from growing, maintain the financial capacity of FY 2019. Expected gasoline and diesel tax rates</u>

(in dollars per gallon) over the next 50 years (from 2024 to 2073 are shown in Table 5-1, and Table 5-2, respectively.

Table 5-1. Alternative TRAM I - Future Expected Gasoline Tax Rates

Fixed Annual Adjustment Rate (FAAR) = +2.4%			
Fiscal Year	**Alternative I**	**Fiscal Year**	**Alternative I**
FY 2,024	$ 0.290	FY 2,049	$ 0.523
FY 2,025	$ 0.297	FY 2,050	$ 0.536
FY 2,026	$ 0.304	FY 2,051	$ 0.549
FY 2,027	$ 0.311	FY 2,052	$ 0.562
FY 2,028	$ 0.318	FY 2,053	$ 0.575
FY 2,029	$ 0.326	FY 2,054	$ 0.589
FY 2,030	$ 0.334	FY 2,055	$ 0.603
FY 2,031	$ 0.342	FY 2,056	$ 0.617
FY 2,032	$ 0.350	FY 2,057	$ 0.632
FY 2,033	$ 0.358	FY 2,058	$ 0.647
FY 2,034	$ 0.367	FY 2,059	$ 0.663
FY 2,035	$ 0.376	FY 2,060	$ 0.679
FY 2,036	$ 0.385	FY 2,061	$ 0.695
FY 2,037	$ 0.394	FY 2,062	$ 0.712
FY 2,038	$ 0.403	FY 2,063	$ 0.729
FY 2,039	$ 0.413	FY 2,064	$ 0.746
FY 2,040	$ 0.423	FY 2,065	$ 0.764
FY 2,041	$ 0.433	FY 2,066	$ 0.782
FY 2,042	$ 0.443	FY 2,067	$ 0.801
FY 2,043	$ 0.454	FY 2,068	$ 0.820
FY 2,044	$ 0.465	FY 2,069	$ 0.840
FY 2,045	$ 0.476	FY 2,070	$ 0.860
FY 2,046	$ 0.487	FY 2,071	$ 0.881
FY 2,047	$ 0.499	FY 2,072	$ 0.902
FY 2,048	$ 0.511	FY 2,073	$ 0.924

Table 5-2. Alternative TRAM I – Future Expected Diesel Tax Rates

Fixed Annual Adjustment Rate (FAAR) = +1.1%			
Fiscal Year	**Tax Rate**	**Fiscal Year**	**Tax Rate**
FY 2,024	$0.300	FY 2,049	$0.393
FY 2,025	$0.303	FY 2,050	$0.397
FY 2,026	$0.306	FY 2,051	$0.401
FY 2,027	$0.309	FY 2,052	$0.405
FY 2,028	$0.312	FY 2,053	$0.409
FY 2,029	$0.315	FY 2,054	$0.413
FY 2,030	$0.318	FY 2,055	$0.418
FY 2,031	$0.321	FY 2,056	$0.423
FY 2,032	$0.325	FY 2,057	$0.428
FY 2,033	$0.329	FY 2,058	$0.433
FY 2,034	$0.333	FY 2,059	$0.438
FY 2,035	$0.337	FY 2,060	$0.443
FY 2,036	$0.341	FY 2,061	$0.448
FY 2,037	$0.345	FY 2,062	$0.453
FY 2,038	$0.349	FY 2,063	$0.458
FY 2,039	$0.353	FY 2,064	$0.463
FY 2,040	$0.357	FY 2,065	$0.468
FY 2,041	$0.361	FY 2,066	$0.473
FY 2,042	$0.365	FY 2,067	$0.478
FY 2,043	$0.369	FY 2,068	$0.483
FY 2,044	$0.373	FY 2,069	$0.488
FY 2,045	$0.377	FY 2,070	$0.493
FY 2,046	$0.381	FY 2,071	$0.498
FY 2,047	$0.385	FY 2,072	$0.503
FY 2,048	$0.389	FY 2,073	$0.509

While the gasoline tax rate would grow 3.2 times over the considered 50-year period, the diesel tax rate would only increase 1.7 times over the same period of time, which would equate to 2,579,224,151 gallons of gasoline sold and 2,266,445,837 gallons of diesel sold to see same period of time. That was an expected outcome since diesel tax revenues were projected to grow at a higher rate than forecasted gasoline tax revenues, requiring lower annual adjustments. It should be noted that lower tax rate adjustments do not necessarily mean lower tax revenues since tax collections also depend on fuel consumption levels.

Table 5-3 shows annual forecasted gasoline tax payment increases (GTPIs) calculated as explained in Section 3.5.1. This is the additional amount, in dollars, that an average fuel taxpayer would have to pay given the proposed annual gasoline tax rate adjustments shown in Table 5-1.

Table 5-3. Gasoline Tax Payment Increase - GTPI, Alternative TRAM I Results

Fiscal Year	GTPI Alternative I	Fiscal Year	GTPI Alternative I
FY 2,024	-	FY 2,049	$7.13
FY 2,025	$4.16	FY 2,050	$7.73
FY 2,026	$4.16	FY 2,051	$7.73
FY 2,027	$4.16	FY 2,052	$7.73
FY 2,028	$4.16	FY 2,053	$7.73
FY 2,029	$4.75	FY 2,054	$8.32
FY 2,030	$4.75	FY 2,055	$8.32
FY 2,031	$4.75	FY 2,056	$8.32
FY 2,032	$4.75	FY 2,057	$8.91
FY 2,033	$4.75	FY 2,058	$8.91
FY 2,034	$5.35	FY 2,059	$9.51
FY 2,035	$5.35	FY 2,060	$9.51
FY 2,036	$5.35	FY 2,061	$9.51
FY 2,037	$5.35	FY 2,062	$10.10
FY 2,038	$5.35	FY 2,063	$10.10
FY 2,039	$5.94	FY 2,064	$10.10
FY 2,040	$5.94	FY 2,065	$10.70
FY 2,041	$5.94	FY 2,066	$10.70
FY 2,042	$5.94	FY 2,067	$11.29
FY 2,043	$6.54	FY 2,068	$11.29
FY 2,044	$6.54	FY 2,069	$11.89
FY 2,045	$6.54	FY 2,070	$11.89
FY 2,046	$6.54	FY 2,071	$12.48
FY 2,047	$7.13	FY 2,072	$12.48
FY 2,048	$7.13	FY 2,073	$13.07

Although deciding the level of significance of the financial impact that Alternative TRAM I would impose on taxpayers should be a task for policy makers, it may be possible to argue that GTPI values in Table 5-3 do not represent a considerable impact on Alabama's taxpayers. When compared with the cost of the proverbial monthly cup of coffee used by Rebuild Alabama Act proponents to represent the financial impact that the initial phase of the new TRAM (the 10-cent increase) was expected to have on Alabama's taxpayers, it seems reasonable to conclude that Alternative I would have a considerably lower financial impact on taxpayers. The annual impact of that alternative on an average taxpayer in 2025 ($4.16) would be lower than the monthly impact associated with the initial implementation of the current TRAM ($4.58) calculated in 2019.

In order to better understand the significance of GTPI values in Table 5-3, the study proceeded with the calculation of annual impact (AI) values for the different occupational groups, in the form of percentages of their corresponding annual median wage values. A detailed description of the process to calculate AI values is presented in Section 3.5.1. AI values associated with the following five representative occupational groups are shown in Table 5-4, but those values are calculated for all 23 taxpayer groups.

- All Occupations (Code 00-0000)
- Management Occupations (Code 11-0000)
- Architecture and Engineering Occupations (Code 17-0000)
- Construction and Extraction Occupations (Code 47-0000)
- Transportation and Material Moving Occupations (Code 53-0000)

Table 5-4. Annual Impact of Gasoline Tax Rate Increases (AI) – Alternative TRAM I

FISCAL YEAR	Annual Gasoline Tax Increase	00-0000	11-0000	17-0000	47-0000	53-0000
FY 2,024						
FY 2,025	$ 4.16	0.012%	0.005%	0.005%	0.011%	0.014%
FY 2,026	$ 4.16	0.012%	0.005%	0.005%	0.011%	0.014%
FY 2,027	$ 4.16	0.012%	0.005%	0.005%	0.011%	0.014%
FY 2,028	$ 4.16	0.012%	0.005%	0.005%	0.011%	0.014%
FY 2,029	$ 4.75	0.014%	0.006%	0.006%	0.012%	0.016%
FY 2,030	$ 4.75	0.014%	0.006%	0.006%	0.012%	0.016%
FY 2,031	$ 4.75	0.014%	0.006%	0.006%	0.012%	0.016%
FY 2,032	$ 4.75	0.014%	0.005%	0.006%	0.012%	0.016%
FY 2,033	$ 4.75	0.013%	0.005%	0.006%	0.012%	0.016%
FY 2,034	$ 5.35	0.015%	0.006%	0.006%	0.013%	0.018%
FY 2,035	$ 5.35	0.015%	0.006%	0.006%	0.013%	0.018%
FY 2,036	$ 5.35	0.015%	0.006%	0.006%	0.013%	0.018%
FY 2,037	$ 5.35	0.015%	0.006%	0.006%	0.013%	0.018%
FY 2,038	$ 5.35	0.015%	0.006%	0.006%	0.013%	0.018%
FY 2,039	$ 5.94	0.017%	0.007%	0.007%	0.015%	0.020%
FY 2,040	$ 5.94	0.017%	0.007%	0.007%	0.015%	0.020%
FY 2,041	$ 5.94	0.016%	0.007%	0.007%	0.014%	0.020%
FY 2,042	$ 5.94	0.016%	0.007%	0.007%	0.014%	0.020%
FY 2,043	$ 6.54	0.018%	0.007%	0.007%	0.016%	0.022%
FY 2,044	$ 6.54	0.018%	0.007%	0.007%	0.016%	0.022%
FY 2,045	$ 6.54	0.018%	0.007%	0.007%	0.016%	0.022%
FY 2,046	$ 6.54	0.018%	0.007%	0.007%	0.016%	0.022%
FY 2,047	$ 7.13	0.019%	0.008%	0.008%	0.017%	0.024%
FY 2,048	$ 7.13	0.019%	0.008%	0.008%	0.017%	0.024%
FY 2,049	$ 7.13	0.019%	0.008%	0.007%	0.017%	0.024%
FY 2,050	$ 7.73	0.021%	0.008%	0.008%	0.018%	0.026%
FY 2,051	$ 7.73	0.021%	0.008%	0.008%	0.018%	0.026%
FY 2,052	$ 7.73	0.021%	0.008%	0.008%	0.018%	0.026%
FY 2,053	$ 7.73	0.021%	0.008%	0.008%	0.018%	0.026%
FY 2,054	$ 8.32	0.022%	0.009%	0.008%	0.019%	0.028%
FY 2,055	$ 8.32	0.022%	0.009%	0.008%	0.019%	0.028%
FY 2,056	$ 8.32	0.022%	0.009%	0.008%	0.019%	0.028%
FY 2,057	$ 8.91	0.024%	0.009%	0.009%	0.021%	0.030%
FY 2,058	$ 8.91	0.024%	0.009%	0.009%	0.020%	0.030%

Table 5-4. Annual Impact of Gasoline Tax Rate Increases (AI) – Alternative TRAM I

FISCAL YEAR	Annual Gasoline Tax Increase	00-0000	11-0000	17-0000	47-0000	53-0000
FY 2,059	$ 9.51	0.025%	0.010%	0.009%	0.022%	0.032%
FY 2,060	$ 9.51	0.025%	0.010%	0.009%	0.022%	0.032%
FY 2,061	$ 9.51	0.025%	0.010%	0.009%	0.022%	0.032%
FY 2,062	$ 10.10	0.026%	0.011%	0.010%	0.023%	0.034%
FY 2,063	$ 10.10	0.026%	0.010%	0.010%	0.023%	0.034%
FY 2,064	$ 10.10	0.026%	0.010%	0.010%	0.023%	0.034%
FY 2,065	$ 10.70	0.028%	0.011%	0.010%	0.024%	0.036%
FY 2,066	$ 10.70	0.028%	0.011%	0.010%	0.024%	0.036%
FY 2,067	$ 11.29	0.029%	0.012%	0.010%	0.025%	0.038%
FY 2,068	$ 11.29	0.029%	0.012%	0.010%	0.025%	0.038%
FY 2,069	$ 11.89	0.031%	0.012%	0.011%	0.026%	0.040%
FY 2,070	$ 11.89	0.030%	0.012%	0.011%	0.026%	0.040%
FY 2,071	$ 12.48	0.032%	0.013%	0.011%	0.027%	0.042%
FY 2,072	$ 12.48	0.032%	0.013%	0.011%	0.027%	0.042%
FY 2,073	$ 13.07	0.033%	0.013%	0.012%	0.028%	0.044%

All occupational groups yielded AI values that increase along the forecasting time horizon. That means that the highest AI value for each group is in year 2073, and the highest AI value among the five selected occupational groups is 0.044% for Transportation and Material Moving Occupations (Code 53-0000). This means that in its worst year, the additional amount of gasoline taxes to be paid by an average individual in that occupational group would represent 0.044% if his/her annual salary, and that will happen in the year 2073. Table 5-5 presents the highest AI value for each occupation group (at year 2047). The highest AI value across all 23 groups is 0.062% and corresponds to the 2073 AI values for Food Preparation and Service Related Occupations (Code 35-0000).

Table 5-5. AI Values for each Occupational Group at 2073

CODE	DESCRIPTION	AI_{2073}
00-0000	All Occupations	0.033%
11-0000	Management Occupations	0.013%
13-0000	Business and Financial Operations Occupations	0.021%
15-0000	Computer and Mathematical Occupations	0.016%
17-0000	Architecture and Engineering Occupations	0.012%
19-0000	Life, Physical, and Social Science Occupations	0.024%
21-0000	Community and Social Service Occupations	0.020%
23-0000	Legal Occupations	0.031%
25-0000	Education, Training, and Library Occupations	0.032%
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	0.031%
29-0000	Healthcare Practitioners and Technical Occupations	0.020%
31-0000	Healthcare Support Occupations	0.053%
33-0000	Protective Service Occupations	0.042%
35-0000	Food Preparation and Serving Related Occupations	0.062%
37-0000	Building and Grounds Cleaning and Maintenance Occupations	0.046%
39-0000	Personal Care and Service Occupations	0.043%
41-0000	Sales and Related Occupations	0.058%
43-0000	Office and Administrative Support Occupations	0.035%
45-0000	Farming, Fishing, and Forestry Occupations	0.041%
47-0000	Construction and Extraction Occupations	0.028%
49-0000	Installation, Maintenance, and Repair Occupations	0.026%
51-0000	Production Occupations	0.044%
53-0000	Transportation and Material Moving Occupations	0.044%

5.3 ALTERNATIVE TRAM II: MODIFIED ADJUSTMENT CAP FOR CURRENT TRAM

As explained above in this thesis, Alternative TRAM II modifies a key aspect of the current TRAM: the maximum allowed biannual adjustment is set as a percentage of its previous-year value and is set to allow for greater adjustments. The rest of the current TRAM is maintained, and rate adjustments are still guided by NHCCI fluctuations. The maximum biannual fixed adjustment rate required to equal the anticipated performance of Alternative TRAM I is ***5.0%.***

Table 5-6 and Table 5-7 show the gasoline and diesel tax rates, respectively, that Alternative TRAM II is expected to yield over the next 50 years (from 2024 to 2073). A comparison of these two tables against their corresponding tables for Alternative TRAM I reveals that the tax rates provided by both alternatives are similar. In the case of gasoline tax rates (Table 5-1 and Table 5-6), greater differences appear in the years when the biannual adjustment is performed under Alternative TRAM II, with the greatest difference of 4.66% estimated for the year 2072. For that year, the first and second alternative TRAMs are expected to provide gasoline tax rates of $0.902 and $0.944 per gallon, respectively. Expected diesel tax rate values in Table 5-2 and Table 5-7 are even closer to each other, with an expected greatest difference of 1.00% at year 2025.

Table 5-6. Alternative TRAM II - Future Expected Gasoline Tax Rates

Maximum Biannual Adjustment Rate = 5.0%			
Fiscal Year	**Tax Rate**	**Fiscal Year**	**Tax Rate**
FY 2,024	$ 0.290	FY 2,049	$ 0.525
FY 2,025	$ 0.290	FY 2,050	$ 0.551
FY 2,026	$ 0.305	FY 2,051	$ 0.551
FY 2,027	$ 0.305	FY 2,052	$ 0.579
FY 2,028	$ 0.320	FY 2,053	$ 0.579
FY 2,029	$ 0.320	FY 2,054	$ 0.608
FY 2,030	$ 0.336	FY 2,055	$ 0.608
FY 2,031	$ 0.336	FY 2,056	$ 0.638
FY 2,032	$ 0.353	FY 2,057	$ 0.638
FY 2,033	$ 0.353	FY 2,058	$ 0.670
FY 2,034	$ 0.371	FY 2,059	$ 0.670
FY 2,035	$ 0.371	FY 2,060	$ 0.704

Table 5-6. Alternative TRAM II - Future Expected Gasoline Tax Rates			
Maximum Biannual Adjustment Rate = 5.0%			
Fiscal Year	**Tax Rate**	**Fiscal Year**	**Tax Rate**
FY 2,036	$ 0.390	FY 2,061	$ 0.704
FY 2,037	$ 0.390	FY 2,062	$ 0.739
FY 2,038	$ 0.410	FY 2,063	$ 0.739
FY 2,039	$ 0.410	FY 2,064	$ 0.776
FY 2,040	$ 0.431	FY 2,065	$ 0.776
FY 2,041	$ 0.431	FY 2,066	$ 0.815
FY 2,042	$ 0.453	FY 2,067	$ 0.815
FY 2,043	$ 0.453	FY 2,068	$ 0.856
FY 2,044	$ 0.476	FY 2,069	$ 0.856
FY 2,045	$ 0.476	FY 2,070	$ 0.899
FY 2,046	$ 0.500	FY 2,071	$ 0.899
FY 2,047	$ 0.500	FY 2,072	$ 0.944
FY 2,048	$ 0.525	FY 2,073	$ 0.944

Table 5-7. Alternative TRAM II - Future Diesel Tax Rates Results			
Maximum Biannual Adjustment Rate = 2.2%			
Fiscal Year	**Tax Rate**	**Fiscal Year**	**Tax Rate**
FY 2,024	$ 0.30	FY 2,049	$ 0.39
FY 2,025	$ 0.30	FY 2,050	$ 0.40
FY 2,026	$ 0.31	FY 2,051	$ 0.40
FY 2,027	$ 0.31	FY 2,052	$ 0.41
FY 2,028	$ 0.31	FY 2,053	$ 0.41
FY 2,029	$ 0.31	FY 2,054	$ 0.42
FY 2,030	$ 0.32	FY 2,055	$ 0.42
FY 2,031	$ 0.32	FY 2,056	$ 0.43
FY 2,032	$ 0.33	FY 2,057	$ 0.43
FY 2,033	$ 0.33	FY 2,058	$ 0.44
FY 2,034	$ 0.34	FY 2,059	$ 0.44
FY 2,035	$ 0.34	FY 2,060	$ 0.45
FY 2,036	$ 0.34	FY 2,061	$ 0.45
FY 2,037	$ 0.34	FY 2,062	$ 0.46
FY 2,038	$ 0.35	FY 2,063	$ 0.46

Table 5-7. Alternative TRAM II - Future Diesel Tax Rates Results			
Maximum Biannual Adjustment Rate = 2.2%			
Fiscal Year	**Tax Rate**	**Fiscal Year**	**Tax Rate**
FY 2,039	$ 0.35	FY 2,064	$ 0.47
FY 2,040	$ 0.36	FY 2,065	$ 0.47
FY 2,041	$ 0.36	FY 2,066	$ 0.48
FY 2,042	$ 0.37	FY 2,067	$ 0.48
FY 2,043	$ 0.37	FY 2,068	$ 0.49
FY 2,044	$ 0.37	FY 2,069	$ 0.49
FY 2,045	$ 0.37	FY 2,070	$ 0.50
FY 2,046	$ 0.38	FY 2,071	$ 0.50
FY 2,047	$ 0.38	FY 2,072	$ 0.51
FY 2,048	$ 0.39	FY 2,073	$ 0.51

GTPI values for Alternative TRAM II, shown in Table 5-8 can also be considered similar to those from the first alternative. The greatest expected GTPI difference between both TRAM alternatives would occur at year 2033, with an annual Alternative II GTPI value just sixty cents ($0.60) greater than its corresponding value for the first alternative.

Table 5-8. Gasoline Tax Payment Increase - GTPI, Alternative TRAM II Results

Fiscal Year	GTPI Alternative II	Difference	GTPI Alternative II
FY 2,024	$ -	FY 2,049	$ 7.73
FY 2,025	$ 4.46	FY 2,050	$ 7.73
FY 2,026	$ 4.46	FY 2,051	$ 8.32
FY 2,027	$ 4.46	FY 2,052	$ 8.32
FY 2,028	$ 4.46	FY 2,053	$ 8.62
FY 2,029	$ 4.75	FY 2,054	$ 8.62
FY 2,030	$ 4.75	FY 2,055	$ 8.91
FY 2,031	$ 5.05	FY 2,056	$ 8.91
FY 2,032	$ 5.05	FY 2,057	$ 9.51
FY 2,033	$ 5.35	FY 2,058	$ 9.51
FY 2,034	$ 5.35	FY 2,059	$ 10.10
FY 2,035	$ 5.65	FY 2,060	$ 10.10

Table 5-8. Gasoline Tax Payment Increase - GTPI, Alternative TRAM II Results

Fiscal Year	GTPI Alternative II	Difference	GTPI Alternative II
FY 2,036	$ 5.65	FY 2,061	$ 10.40
FY 2,037	$ 5.94	FY 2,062	$ 10.40
FY 2,038	$ 5.94	FY 2,063	$ 10.99
FY 2,039	$ 6.24	FY 2,064	$ 10.99
FY 2,040	$ 6.24	FY 2,065	$ 11.59
FY 2,041	$ 6.54	FY 2,066	$ 11.59
FY 2,042	$ 6.54	FY 2,067	$ 12.18
FY 2,043	$ 6.83	FY 2,068	$ 12.18
FY 2,044	$ 6.83	FY 2,069	$ 12.78
FY 2,045	$ 7.13	FY 2,070	$ 12.78
FY 2,046	$ 7.13	FY 2,071	$ 13.37
FY 2,047	$ 7.43	FY 2,072	$ 13.37
FY 2,048	$ 7.43	FY 2,073	$ 13.93

As done for Alternative TRAM I in the previous section, the impact of the second alternative TRAM was further assessed by calculating of annual impact (AI) values for the different occupational groups, in the form of percentages of their corresponding biannual median wage values. Table 5-9 shows the annual AI values for the five selected occupational groups, but those values were calculated for all 23 taxpayer groups. Under this alternative TRAM, taxpayers will fall the financial every two years when the rate adjustments are performed. Therefore, AI values in Table 5-9 are calculated using the biannual rate adjustment and its corresponding two-year income.

Table 5-9. Annual Impact of Gasoline Tax Rate Increase (AI) – Alternative TRAM II

Fiscal Year	Annual Gasoline Tax Increase	00-0000	11-0000	17-0000	47-0000	53-0000
FY 2,024						
FY 2,025	$ -					
FY 2,026	$ 8.91	0.013%	0.005%	0.005%	0.012%	0.015%
FY 2,027	$ -					
FY 2,028	$ 8.91	0.013%	0.005%	0.005%	0.011%	0.015%
FY 2,029	$ -					
FY 2,030	$ 9.51	0.014%	0.006%	0.006%	0.012%	0.016%
FY 2,031	$ -					
FY 2,032	$ 10.10	0.014%	0.006%	0.006%	0.013%	0.017%
FY 2,033	$ -					
FY 2,034	$ 10.70	0.015%	0.006%	0.006%	0.013%	0.018%
FY 2,035	$ -					
FY 2,036	$ 11.29	0.016%	0.006%	0.006%	0.014%	0.019%
FY 2,037	$ -					
FY 2,038	$ 11.89	0.017%	0.007%	0.007%	0.015%	0.020%
FY 2,039	$ -					
FY 2,040	$ 12.48	0.017%	0.007%	0.007%	0.015%	0.021%
FY 2,041	$ -					
FY 2,042	$ 13.07	0.018%	0.007%	0.007%	0.016%	0.022%
FY 2,043	$ -					
FY 2,044	$ 13.67	0.019%	0.008%	0.007%	0.017%	0.023%
FY 2,045	$ -					
FY 2,046	$ 14.26	0.020%	0.008%	0.008%	0.017%	0.024%
FY 2,047	$ -					
FY 2,048	$ 14.86	0.020%	0.008%	0.008%	0.018%	0.025%
FY 2,049	$ -					
FY 2,050	$ 15.45	0.021%	0.008%	0.008%	0.018%	0.026%
FY 2,051	$ -					
FY 2,052	$ 16.64	0.022%	0.009%	0.009%	0.020%	0.028%
FY 2,053	$ -					
FY 2,054	$ 17.23	0.023%	0.009%	0.009%	0.020%	0.029%
FY 2,055	$ -					
FY 2,056	$ 17.83	0.024%	0.009%	0.009%	0.021%	0.030%
FY 2,057	$ -					

Table 5-9. Annual Impact of Gasoline Tax Rate Increase (AI) – Alternative TRAM II

Fiscal Year	Annual Gasoline Tax Increase	00-0000	11-0000	17-0000	47-0000	53-0000
FY 2,058	$ 19.02	0.025%	0.010%	0.009%	0.022%	0.032%
FY 2,059	$ -					
FY 2,060	$ 20.21	0.027%	0.011%	0.010%	0.023%	0.034%
FY 2,061	$ -					
FY 2,062	$ 20.80	0.027%	0.011%	0.010%	0.024%	0.035%
FY 2,063	$ -					
FY 2,064	$ 21.99	0.029%	0.011%	0.010%	0.025%	0.037%
FY 2,065	$ -					
FY 2,066	$ 23.18	0.030%	0.012%	0.011%	0.026%	0.039%
FY 2,067	$ -					
FY 2,068	$ 24.37	0.031%	0.012%	0.011%	0.027%	0.041%
FY 2,069	$ -					
FY 2,070	$ 25.55	0.033%	0.013%	0.012%	0.028%	0.043%
FY 2,071	$ -					
FY 2,072	$ 26.74	0.034%	0.013%	0.012%	0.029%	0.045%
FY 2,073	$ -					

As expected, AI values in Table 5-9 are similar to those from Alternative TRAM I with the difference that under this TRAM, taxpayers would be financially impacted every two years. AI values also tend to be greater for greater forecasting time horizons, yielding the greatest values at year 2073. The highest AI value among the five selected occupational also corresponds to year 2073 for Transportation and Material Moving Occupations (Code 53-0000) (AI2073; Alt. I = 0.044%; and AI2073; Alt. II = 0.045%). Similarly, the highest overall AI value among all 23 occupational groups corresponds to AI for Food Preparation and Service Related Occupations (Code 35-0000) at year 2073, and it is also similar to its corresponding value in Alternate TRAM I (AI2073; Alt. I = 0.062%; and AI2073; Alt. II = 0.064%).

Table 5-10. AI Values for each Occupational Group at 2073

CODE	DESCRIPTION	AI_{2073}
00-0000	All Occupations	0.034%
11-0000	Management Occupations	0.013%
13-0000	Business and Financial Operations Occupations	0.021%
15-0000	Computer and Mathematical Occupations	0.017%
17-0000	Architecture and Engineering Occupations	0.012%
19-0000	Life, Physical, and Social Science Occupations	0.024%
21-0000	Community and Social Service Occupations	0.021%
23-0000	Legal Occupations	0.031%
25-0000	Education, Training, and Library Occupations	0.033%
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	0.032%
29-0000	Healthcare Practitioners and Technical Occupations	0.021%
31-0000	Healthcare Support Occupations	0.054%
33-0000	Protective Service Occupations	0.042%
35-0000	Food Preparation and Serving Related Occupations	0.064%
37-0000	Building and Grounds Cleaning and Maintenance Occupations	0.047%
39-0000	Personal Care and Service Occupations	0.045%
41-0000	Sales and Related Occupations	0.059%
43-0000	Office and Administrative Support Occupations	0.036%
45-0000	Farming, Fishing, and Forestry Occupations	0.042%
47-0000	Construction and Extraction Occupations	0.029%
49-0000	Installation, Maintenance, and Repair Occupations	0.027%
51-0000	Production Occupations	0.045%
53-0000	Transportation and Material Moving Occupations	0.045%

CHAPTER SIX:
CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

The study presented throughout this thesis was aimed at conducting a comprehensive assessment of the fuel tax rate adjustment methodology (TRAM) launched in Alabama in March 2019 through the enactment of the Rebuild Alabama Act. By the moment of its implementation, gasoline and diesel tax rates had remained unchanged sin 1993, at 18 and 19 cents per gallon, respectively.

The Rebuild Alabama Act stated a two-phase implementation process for the new TRAM. The first phase, and the most aggressive one, consisted of three consecutive annual fuel tax rate adjustments. It started with a six-cent increase in October 2019, followed by two-cents additional tax rate increments, one and two years later. By October 2021, gasoline and diesel tax rates increased by 10 cents, bringing them to 28 and 29 cents per gallon.

The second TRAM implementation phase provides for additional, but smaller tax rate adjustments on a biannual basis (every two years) according to observed fluctuations in the National Highway Construction Cost Index (NHCCI), which is published and maintained by the Federal Highway Administration (FHWA). To limit the impact of significant NHCCI changes on Alabama’s taxpayers, the Rebuild Alabama Act established a maximum one-cent adjustment for any recalculation period.

There is no doubt that abandoning the static fuel tax rate system would have a positive impact on the ability of ALDOT to growth and maintain Alabama’s public transportation network. However, there were still uncertainties regarding the actual performance and effectiveness of the new TRAM, as well as about its potential impact on the financial capacity of taxpayers. Moreover, this TRAM was planned and implemented without knowing that the devastating COVID-19 pandemic could hit the United States just months after enactment of the Rebuild Alabama Act. To the best knowledge of the author, this thesis is the first formal effort to assess the performance of the recently implemented TRAM on the post-pandemic world.

A three-part research methodology was designed and followed to assess the actual performance of the TRAM one year before and four years after its implementation (FY 2018 to FY 2023), forecast and assess performance trends along the next 20 years (FY 2024 to 2043), and proposed alternative and more effective and sustainable alternative TRAMS. The following are the three parts of het proposed research methodology with their respective research questions:

- Part I: Current Performance Assessment (FY 2018 – FY 2023)

  - How has the current TRAM impacted Alabama Department of Transportation (ALDOT's) financial capacity to expand and maintain Alabama's Transportation Infrastructure?

  - How has the current TRAM financially impacted taxpayers since its implementation?

- Part II: Future Performance Assessment (FY 2018 – FY 2023)

  - How will the current TRAM affect ALDOT's financial capacity to expand and maintain Alabama Transportation Infrastructure if it continues to be applied over the next 20 years?

  - How will the current TRAM financially impact taxpayers if it continues to be applied over the next 20 years?

- Part III: Alternative TRAMs

  - Could Alabama benefit from different type of TRAM? Or, are there any aspects of the current TRAM that could be implemented?

  - How will any potential alternative TRAM impact the financial capacity of taxpayers?

6.2 CONCLUSIONS AND FINDINGS

This section summarizes all major conclusions and findings as they relate and help answering to the research questions stated above.

How has the current TRAM impacted ALDOT's financial capacity to expand and maintain Alabama's Transportation Infrastructure?

To answer this question, it was first necessary to create a Construction Cost Index using relevant historical bid data provided by the ALDOT. This index, referred to in this thesis as ALDOT_CCI, is assumed to represent ALDOT's transportation construction market. It revealed a continues increase in transportation construction prices between FY 2018 and FY 2023, with considerable increase of 21.5% in FY 2022, which could be explained by the COVID-19 pandemic.

It was now important to determine if the three consecutive annual adjustments during the initial implementation of the new TRAM, which were planned for a pre-pandemic world, were able to cope with the higher than usual inflation trends triggered by COVI-19. Indices were also developed to track changes in annual gasoline and diesel tax revenues (GTRI and DTRI, respectively) over the same period of time. Those two indices showed similar behaviors from FY 2018 and FY 2023, with an average growing rate greater than the one for ALDOT_CCI. It led to the conclusion that ALDOT's funding gap narrowed after the implementation of the new TRAM, improving ALDOT's financial capacity and its ability to maintain Alabama's transportation infrastructure. This is a remarkable conclusion since the TRAM was able to reduce the funding gap regardless of the economic impacts of the pandemic and the reduced fuel consumption levels that resulted from the COVID-19 mandated lockdowns. It could imply that policy makers planned for an even greater funding gap reduction, which was not achieved due to the pandemic.

After a rapid growth, gasoline and diesel tax revenue indices flatten during the last year assessed to answer this research question (FY 2023) and after the first TRAM implementation phase concluded. This happened because the NHCCI-based biannual tax rate adjustment schedule started and no adjustments were scheduled for FY 2023. This, and the fact that maximum biannual adjustments are limited to one (1) cent, indicated that future performance of the TRAM might not be as positive as the one observed in the first part of this study. This observation was confirmed during the second part of the study.

How has the current TRAM financially impacted taxpayers since its implementation?

This question was answered through a systematic comparative analysis between Taxpayer Financial Capacity Indices (TFCIs) developed for 23 different taxpayer groups and an additional index developed to track changes in gasoline tax rates (GTRaI). Each taxpayer group represents an occupational category used by the Bureau of Labor Statistics (BLS). Thus, all individuals within a given group are expected to have similar occupations or work in the same field or industry.

A comparison between each TFCI and the GTRaI showed a marked difference between the rapid increase in fuel tax rates and the slower growth in taxpayer financial capacity; this means that fuel tax rates are growing faster than the financial capacity of taxpayers, which actually decreased between 2019 and 2023 for most of the occupational groups considered in this study. Almost 70% of those groups (16 out of 23) showed a reduction in their financial capacity over that four-year period.

Findings from the previous research question and from this one suggest that the new TRAM was effective in generating additional revenue for ALDOT during its initial implementation, but at a cost for taxpayers. This is not an unexpected result since it was clear that the additional revenue would be coming directly from taxpayers. Before its implementation, policy maker estimated the financial impact of the first TRAM implementation phase (10-cent rate increase over three years) on taxpayers. It was estimated to be about $4.58 per month for each driver, or the equivalent to "a cup of coffee" (Rebuild Alabama Act, 2019). This value, which was considered inconsequential by the proponents of the Rebuild Alabama Act, was confirmed later in the study.

How will the current TRAM affect ALDOT's financial capacity to expand and maintain Alabama's Transportation Infrastructure if it continues to be applied over the next 20 years?

This question was answered through a series of comparative analysis among the 20-year risk-based forecast of the ADLOT_CCI, GTRI, and DTRI (FY 2024 to FY 2043). These forecasted values show a considerable change in the trend evaluated during the first part of the study. The ALDOT_CCI, which represents changes in ALDOT's financial needs, now showed a greater growth rate than gasoline and diesel tax revenues. This created a scenario that will erase any financial benefits obtained by ALDOT during the initial TRAM implementation phase. Based on forecasted median values, the funding gap reduction associated with the 10-cent gasoline and diesel tax rate increases will be reversed by fiscal years 2027 and 2039, respectively.

The risk-based forecasts consist of the projected median plus confidence intervals to account for forecasting uncertainty. Confidence intervals were set at 50%, 80%, and 95%. Probabilistic comparisons between risk-based estimates were conducted via Monte Carlo simulation through 10,000 iterations. Outputs from those probabilistic comparative analysis showed that ALDOT's funding gap associated gasoline tax revenues will most likely increasingly growth along the entire 20-year forecasting time horizon. There is no scenario within the 95% confidence boundaries that represent a funding gap in 2043 equal to greater than the funding gap experienced by ALDOT when the new TRAM was implemented (at 2019).

The forecast of the funding gap associated with diesel tax revenues is less critical. There is an over 40% chance that the diesel related funding gap will be narrower in 2043 than it was in 2019. However, this observation becomes less promising when considering that, on average, gasoline tax revenues are about 2.8 greater that diesel tax revenues.

In summary, research efforts aimed at answering this question allow to conclude, with a high degree of certainty, that the continuation of the current TRAM without any changes, would result in a progressive, rapid increase of ALDOT's funding gap.

How will the current TRAM financially impact taxpayers if it continues to be applied over the next 20 years?

Efforts to answer this question comprised 23 probabilistic comparative analyses. Each of the 23 TFCIs was forecasted in a risk-based manner and probabilistic compared against a risk-based forecast of the GTRaI. Results from these analyses showed that, on average across all occupational groups, the gap between TFCIs and the GTRaI created during the initial implementation of the new TRAM (which intentionally worsen taxpayers' financial capacity) remained relatively constant along the 20-year forecasting period.

This relatively constant gap seems to explain the strategic purpose behind each of the two TRAM implementation phases. First, the TRAM rapidly increased the taxation burden on Alabama's taxpayers by 10 cents over three years. This aggressive adjustment was intended to reduce the funding gap affecting ALDOT's ability to maintain Alabama's transportation infrastructure. Subsequently, the second phase of the TRAM that makes fuel tax rate adjustments base on NHCCI fluctuations, attempts to sustain the new taxation burden imposed on Alabama drivers during phase one, preventing it from growing or shrinking. The one-cent rate cap adjustment adopted during the second phase seems to contribute to maintaining the constant taxation burden. Without that cap, fuel tax rates would be expected to grow faster than the financial capacity of taxpayers.

However, based on results and observations associated with the previous questions, it is possible to conclude a long-term implementation of this taxpayer-oriented philosophy will likely lead to continuously increasing funding gap, preventing ALDOT from effectively maintaining the public transportation infrastructure in Alabama.

Could Alabama benefit from different type of TRAM? Or, are there any aspects of the current TRAM that could be implemented?

The following two alternative TRAMs were designed taking into consideration the results and findings produced throughout this study. The proposed TRAMs are aimed at offering better sustainability in terms of ALDOT's ability to maintain its financial capacity. In other words, unlike the taxpayer-focus of the current TRAM, the TRAMS described below prioritize ALDOT's financial capacity. This approach is based on the premise that although the funding gap normally affecting ALDOT's operations is significant, it could be partially addressed with the help of taxpayers through marginal fuel tax rate increases.

- Alternative TRAM I: Fixed annual percentage tax adjustment rates of +2.4% and +1.1% are used to increase the gasoline and diesel tax rates every year, respectively. These fixed rates have been determined to align tax rate adjustments with expected ALDOT_CCI fluctuations.
- Alternative TRAM II: This alternative modifies the tax rate adjustment cap for the current NHCCI-based TRAM. The new rate adjustment caps are 5.0% and 2.2% for

gasoline and diesel tax rate adjustments, respectively. The rate adjustment cap is set as a fixed percentage value rather than a fixed number of cents, making the TRAM more sustainable. It is also set to allow for greater tax rate adjustments in an attempt to match the higher transportation construction inflation levels measured by ALDOT_CCI. This alternative still maintains the biannual rate adjustment schedule of the current TRAM.

It should be noted that both alternatives were designed to align with ALDOT_CCI fluctuations. Therefore, they are expected to yield similar tax rates, causing similar financial impacts on taxpayers. The main difference is that Alternative TRAM II still relies on the NHCCI like the current TRAM. This could make its implementation smoother and easier to accept by taxpayers. However, it should be noted that Alternative TRAM II carries greater levels of uncertainty. The accuracy of the forecasted performance for that alternative depends on both the independent accuracies of the forecasted outputs for both ALDOT_CCI and the NHCCI. On the other hand, Alternative TRAM I is only affected by ALDOT_CCI inherent uncertainty.

How will any potential alternative TRAM impact the financial capacity of taxpayers?

While Chapter 4 found and discussed some limitations of the current taxpayer-driven TRAM to cope with growing financial needs of Alabama's public transportation infrastructure, Chapter 5 proposes a change in the TRAM fundamental objectives, establishing as the top priority the ability to prevent ALDOT's funding gap from continuing growing. More specifically the proposed alternatives were designed to maintain a funding gap proportionally equivalent to the one experienced by ALDOT at FY 2019. All of this while monitoring the impact of the infrastructure-driven TRAM on the taxpayers through the AI values presented in this section.

This thesis does not pretend to produce a conclusive statement regardless of the significance of the potential impacts of the proposed TRAMs on Alabama's taxpayers. It aims to provide policy makers with sufficient data and information to make well-informed, evidence-based decisions. However, the relatively low GTPI and AI low values associated with the two proposed alternatives may suggest that a TRAM driven by infrastructure needs rather than by taxpayers' financial capabilities could be a feasible option. Although further research is needed to better understand this issue, the results of this study indicate that the traditional severe financial stress placed on ALDOT could be potentially addressed by distributing that burden among fuel taxpayers in the form of marginal or inconsequential tax rate adjustments.

6.3 RECOMMENDATIONS FOR FUTURE RESEARCH

Future research should focus on exploring alternative funding mechanisms, such as public-private partnerships and usage-based fees, to diversify revenue sources for transportation funding. Assessing the impact of technological advancements, such as electric vehicles and autonomous transportation, on fuel tax revenues and infrastructure needs is also critical. Longitudinal studies should be conducted to monitor the long-term effects of implemented tax rate adjustments and refine methodologies based on observed outcomes.

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APPENDICES

Appendix A: Selected ALDOT's Pay Items

Appendix B: Graphs for selected Pay Items

Appendix C: Index Hierarchical Structure by Levels

Appendix D: Pay Item Level Indices

Appendix E: Taxpayers' Financial Capacity Index - TFCI

Appendix F: TFCI Vs Fuel Tax Rate Index

Appendix G: TFCI Analysis

Appendix H: 20-year of Gasoline & Diesel Consumption Forecasts

APPENDIX A: Selected ALDOT's Pay Items

Table 7-1. Selected ALDOT's Pay Items

N°	ITEM ID	ITEM DESCRIPTION	EQUATION	R²
1	206C000	Removing Concrete Sidewalk	y = 67.229x^(-0.187)	0.1591
2	206C001	Removing Concrete Pavement	y = 327.55x^(-0.46)	0.6971
3	206C002	Removing Concrete Slope Paving	y = 76.578x^(-0.296)	0.2866
4	206C003	Removing Concrete Flumes	y = 45.992x^(-0.245)	0.1946
5	206C010	Removing Concrete Driveway	y = 160.18x^(-0.345)	0.2177
6	206D000	Removing Pipe	y = 42.8x^(-0.156)	0.0619
7	206D001	Removing Guardrail	y = 15.84x^(-0.184)	0.125
8	206D002	Removing Curb	y = 55.422x^(-0.268)	0.1803
9	206D003	Removing Curb and Gutter	y = 44.437x^(-0.187)	0.1792
10	206D005	Removing Gutter	y = 37.015x^(-0.17)	0.1532
11	206D011	Removing Fence	y = 70.999x^(-0.47)	0.3118
12	210A000	Unclassified Excavation	y = 75.236x^(-0.189)	0.2499
13	210D001	Borrow Excavation (Loose Truck bed Measurement)	y = 108.44x^(-0.196)	0.3595
14	210D011	Borrow Excavation (A4 Or Better)	y = 161.27x^(-0.254)	0.5781
15	210D021	Borrow Excavation (Loose Truck bed Measurement) (A4 or Better)	y = 68.772x^(-0.147)	0.162
16	212A000	Machine Grading Shoulders	y = 274.45x-0.302	0.3491

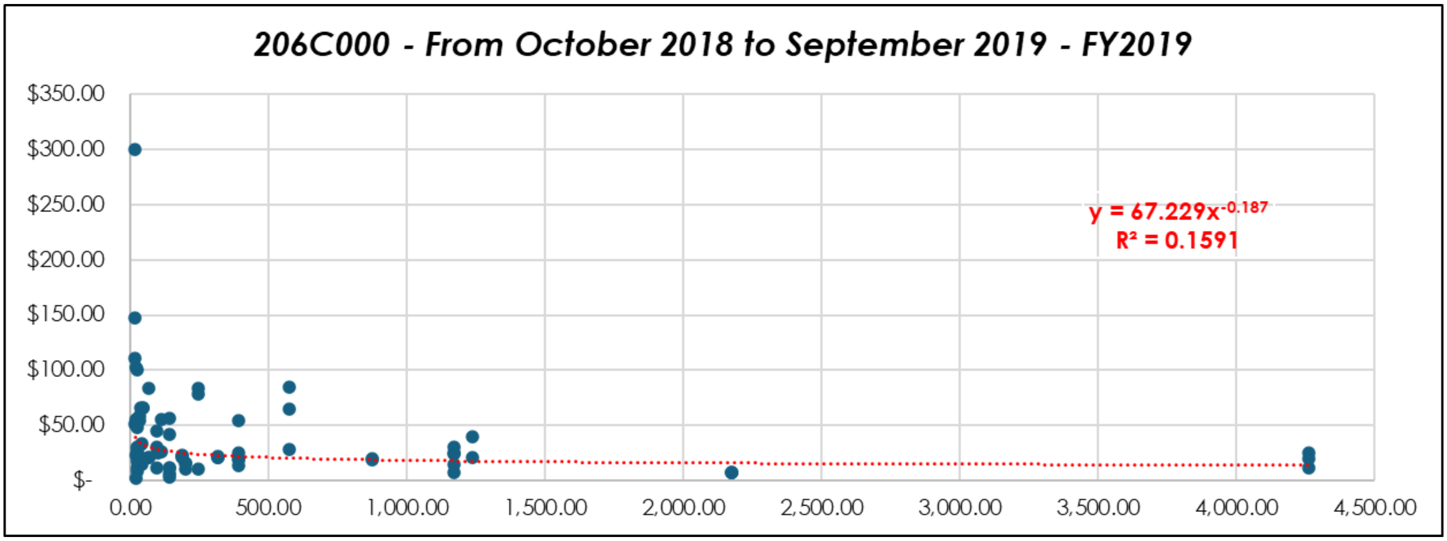
Table 7-1. Selected ALDOT's Pay Items

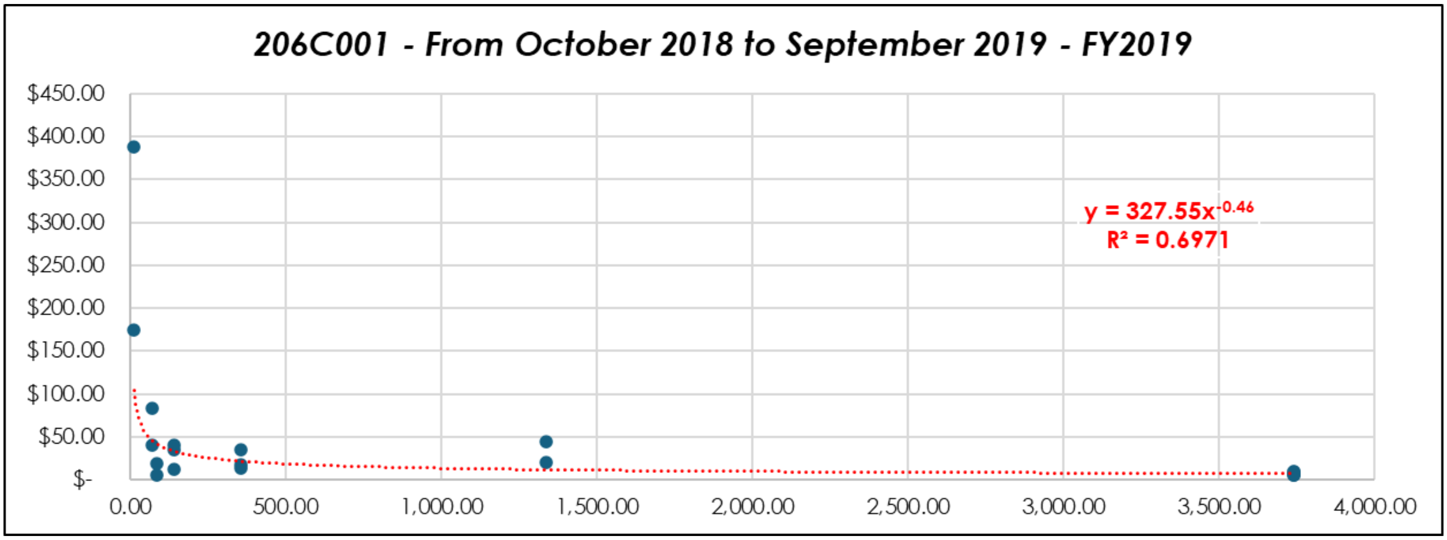
N°	ITEM ID	ITEM DESCRIPTION	EQUATION	R^2
17	214A000	Structure Excavation	y = 79.018x^(-0.243)	0.0934
18	214B001	Foundation Backfill, Commercial	y = 89.52x^(-0.079)	0.1018
19	230A000	Roadbed Processing	y = 2952.1x^(-0.605)	0.0905
20	301A012	Crushed Aggregate Base Course, Type B, Plant Mixed, 6" Compacted Thickness	y = 51.611x^(-0.155)	0.5126
21	305B077	Crushed Aggregate, Section 825, For Miscellaneous Use	y = 96.996x^(-0.117)	0.2914
22	305B078	Crushed Aggregate, Section 825, Type B, For Miscellaneous Use	y = 106.42x^(-0.187)	0.3479
23	401A000	Bituminous Treatment A	y = 14.085x^(-0.253)	0.093
24	401B100	Bituminous Treatment E (With Polymer Additive)	y = 221.15x^(-0.434)	0.8785
25	401B108	Bituminous Treatment G (With Polymer Additive)	y = 20.137x^(-0.224)	0.2186
26	405A000	Tack Coat	y = 18.095x^(-0.198)	0.2116
27	408A051	Planning Existing Pavement (Approximately 0.00" Thru 1.0" Thick)	y = 106.64x^(-0.391)	0.71
28	408A052	Planning Existing Pavement (Approximately 1.10" Thru 2.0" Thick)	y = 72.414x^(-0.351)	0.5691
29	408A053	Planning Existing Pavement (Approximately 2.10" Thru 3.0" Thick)	y = 112.88x^(-0.354)	0.6429
30	408A054	Planning Existing Pavement (Approximately 3.10" Thru 4.0" Thick)	y = 92.339x^(-0.33)	0.5091
31	408B000	Micro-Milling Existing Pavement (Approximately 0.00" Thru 1.00" Thick)	y = 62.643x^(-0.334)	0.7335
32	408B001	Micro-Milling Existing Pavement (Approximately 1.10" Thru 2.00" Thick)	y = 32.262x^(-0.258)	0.4588
33	424A340	Superpave Bituminous Concrete Wearing Surface Layer, 1/2" Maximum Aggregate Size Mix, ESAL Range A/B	y = 400.65x^(-0.181)	0.6573
34	424A360	Superpave Bituminous Concrete Wearing Surface Layer, 1/2" Maximum Aggregate Size Mix, ESAL Range C/D	y = 342.13x^(-0.153)	0.3878
35	424A369	Superpave Bituminous Concrete Wearing Surface Layer, Widening, 1/2" Maximum Aggregate Size Mix, ESAL Range C/D	y = 380.24x^(-0.173)	0.3354
36	424B650	Superpave Bituminous Concrete Upper Binder Layer, 3/4" Maximum Aggregate Size Mix, ESAL Range C/D	y = 350.17x^(-0.168)	0.7511
37	430B043	Aggregate Surfacing (1" Down, Crusher Run)	y = 111.15x^(-0.146)	0.2719
38	502A000	Steel Reinforcement	y = 15.243x^(-0.229)	0.4575
39	508A000	Structural Steel	y = 31.8x^(-0.212)	0.276
40	510A007	Bridge Substructure Concrete	y = 1418.2x^(-0.099)	0.0621

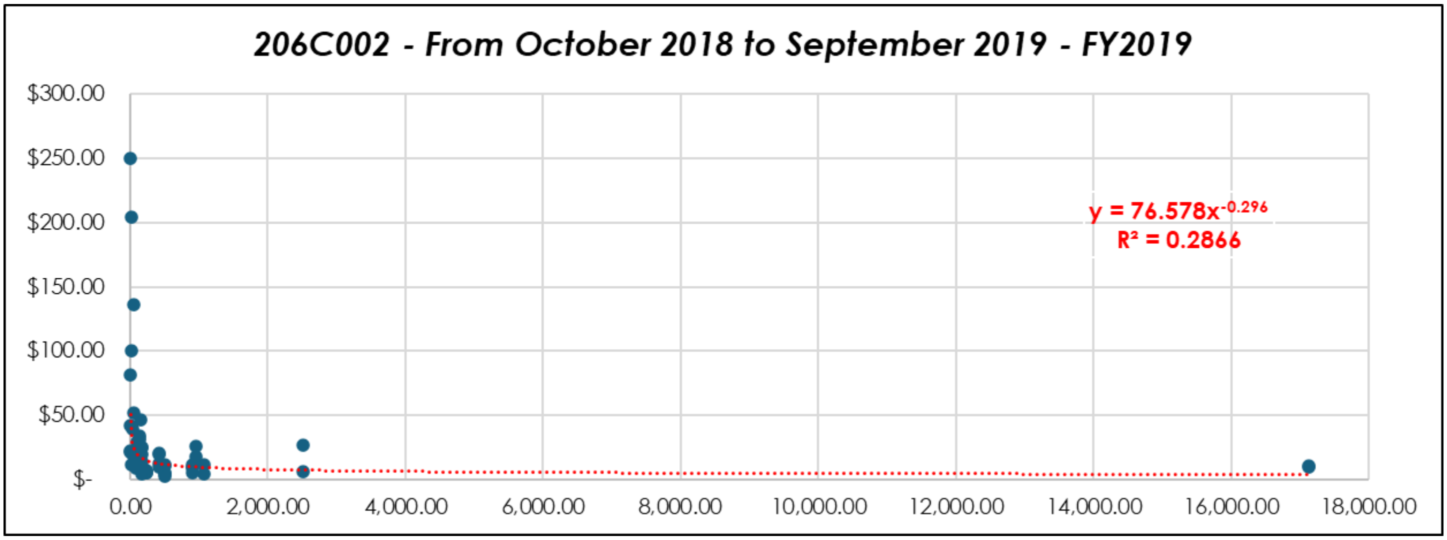
Table 7-1. Selected ALDOT's Pay Items

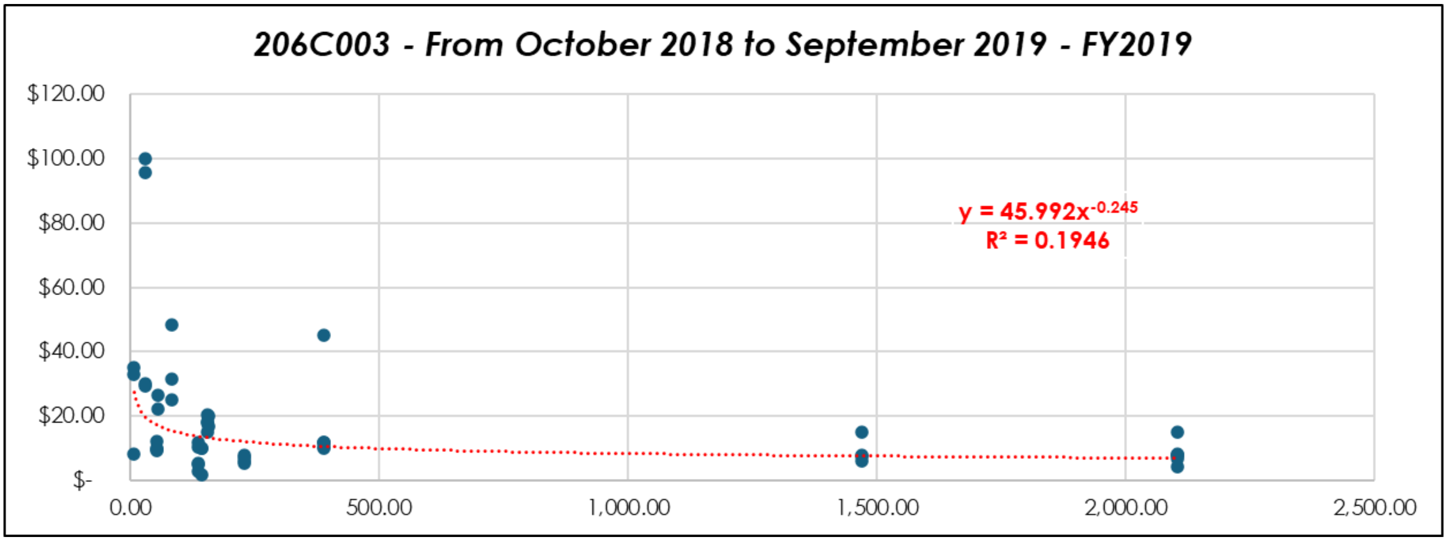
N°	ITEM ID	ITEM DESCRIPTION	EQUATION	R^2
41	510E000	Grooving Concrete Bridge Decks	y = 530.89x^(-0.643)	0.7358
42	524A010	Culvert Concrete	y = 2653.7x^(-0.188)	0.4228
43	524B011	Culvert Concrete Extension (Cast in Place)	y = 10247x^(-0.456)	0.7008
44	610D003	Filter Blanket, Geotextile	y = 6.5936x^(-0.088)	0.0669
45	618A000	Concrete Sidewalk, 4" Thick	y = 509.19x^(-0.259)	0.399
46	630A001	Steel Beam Guardrail, Class A, Type 2	y = 76.951x^(-0.151)	0.2118
47	650A000	Topsoil	y = 97.739x^(-0.22)	0.2632
48	652C000	Mowing	y = 328.81x^(-0.37)	0.337
49	654A001	Solid Sodding (Bermuda)	y = 12.471x^(-0.114)	0.3895
50	665B001	Temporary Mulching	y = 506.79x^(-0.21)	0.1495
51	665I000	Temporary Riprap, Class 2	y = 96.375x^(-0.089)	0.1048
52	665J002	Silt Fence	y = 7.9379x^(-0.107)	0.1471
53	665O001	Silt Fence Removal	y = 7.4229x^(-0.289)	0.2262
54	701A227	Solid White, Class 2, Type A Traffic Stripe (5" Wide)	y = 4107.4x^(-0.094)	0.3285
55	701A230	Solid Yellow, Class 2, Type A Traffic Stripe (5" Wide)	y = 4071x^(-0.097)	0.3186
56	701C000	Broken Temporary Traffic Stripe	y = 981.74x^(-0.044)	0.1099
57	701C001	Solid Temporary Traffic Stripe	y = 1312.8x^(-0.101)	0.3246
58	703A002	Traffic Control Markings, Class 2, Type A	y = 12.164x^(-0.114)	0.0661
59	703D001	Temporary Traffic Control Markings	y = 5.8231x^(-0.158)	0.1526
60	740B000	Construction Signs	y = 16.86x^(-0.082)	0.0363

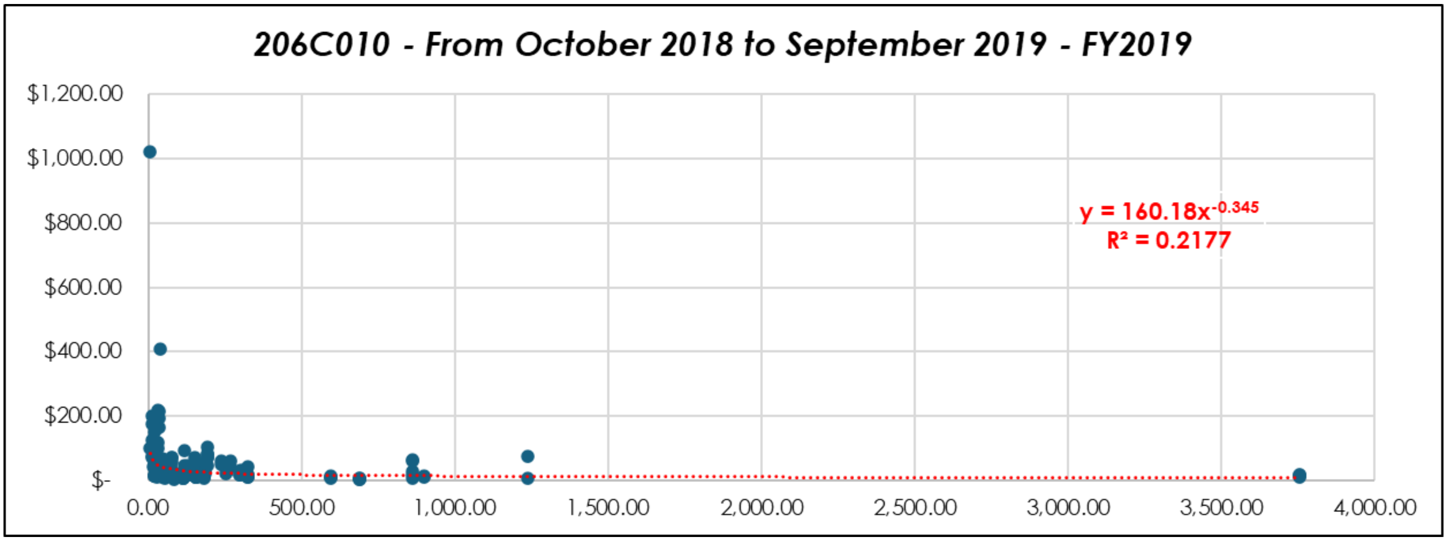
APPENDIX B: Graphs for selected Pay Items

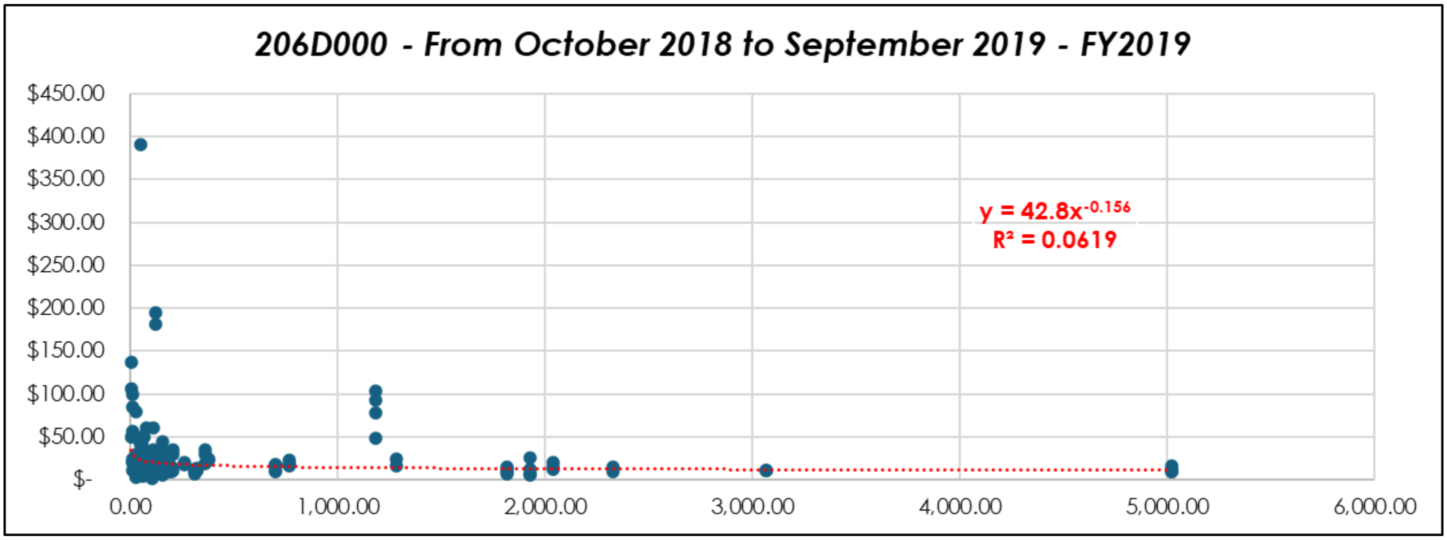


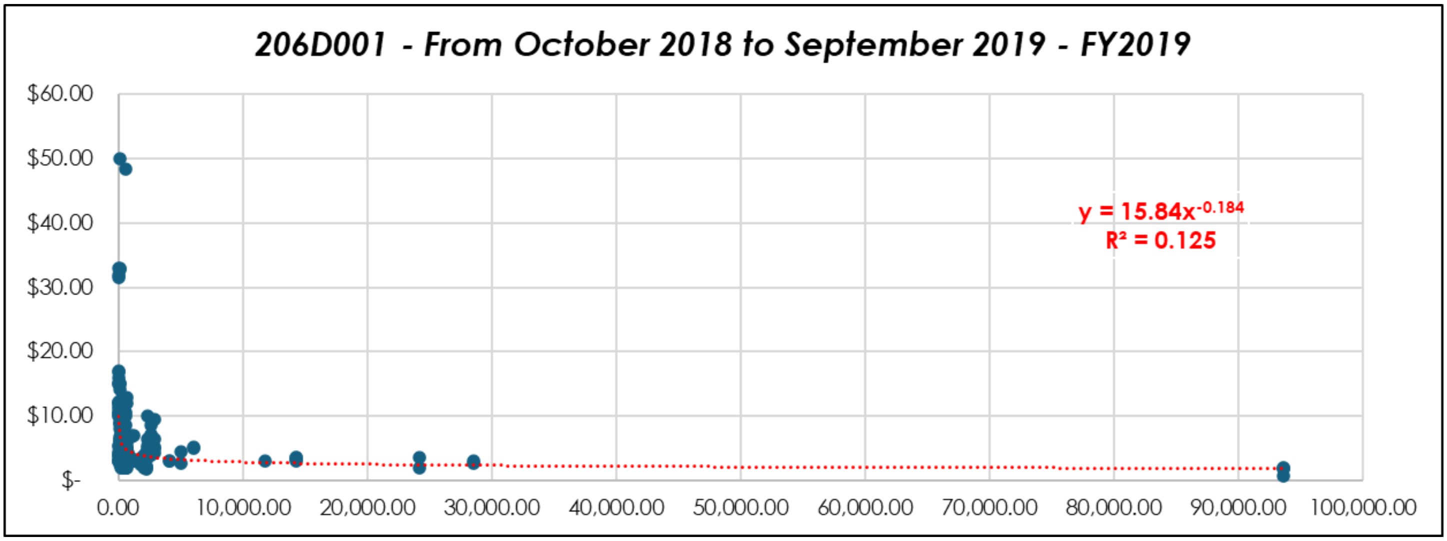


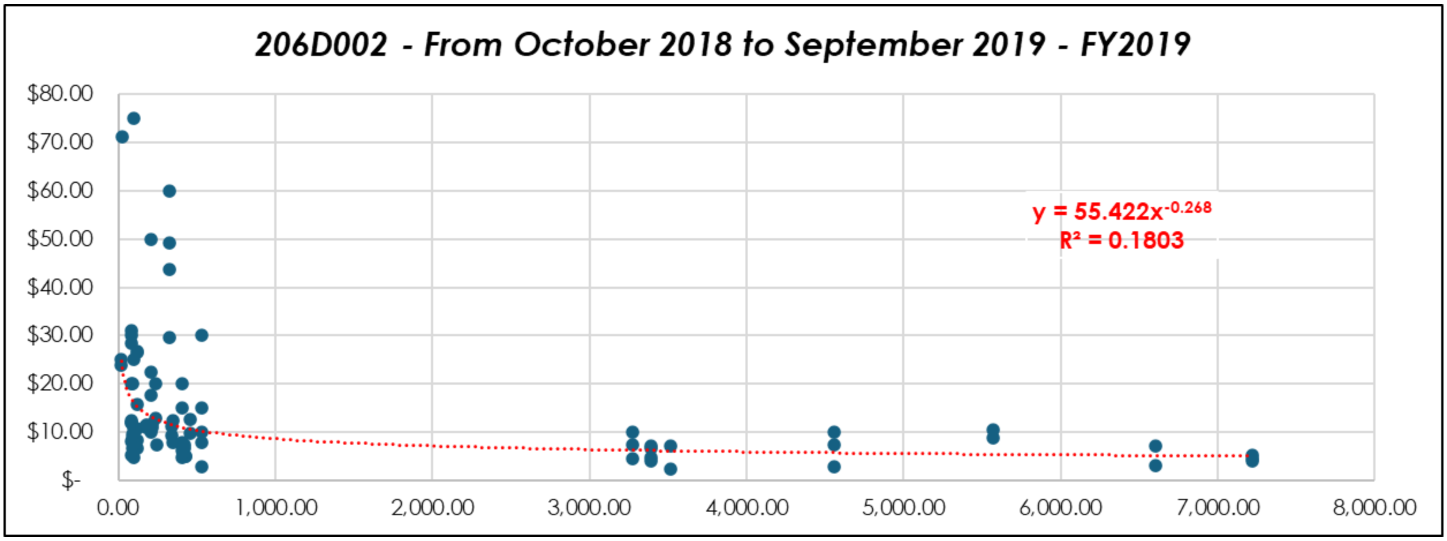

206C002 - From October 2018 to September 2019 - FY2019
$300.00
$250.00
$200.00
$150.00
$100.00
$50.00
$-
0.00
2,000.00
4,000.00
6,000.00
8,000.00
10,000.00
12,000.00
14,000.00
16,000.00
18,000.00
y = 76.578x^-0.296
R² = 0.2866

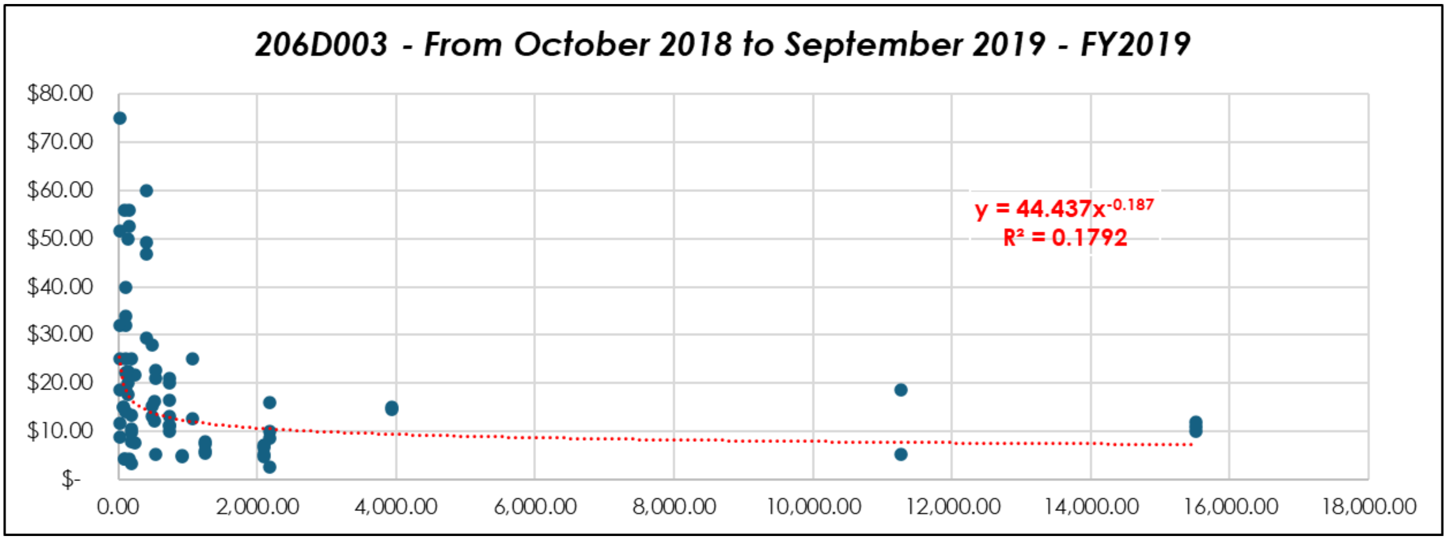

206C003 - From October 2018 to September 2019 - FY2019
$120.00
$100.00
$80.00
$60.00
$40.00
$20.00
$-
0.00
500.00
1,000.00
1,500.00
2,000.00
2,500.00
y = 45.992x^-0.245
R² = 0.1946


206C010 - From October 2018 to September 2019 - FY2019
$1,200.00
$1,000.00
$800.00
$600.00
$400.00
$200.00
$-
0.00
500.00
1,000.00
1,500.00
2,000.00
2,500.00
3,000.00
3,500.00
4,000.00
y = 160.18x^-0.345
R² = 0.2177


206D000 - From October 2018 to September 2019 - FY2019
$450.00
$400.00
$350.00
$300.00
$250.00
$200.00
$150.00
$100.00
$50.00
$-
0.00
1,000.00
2,000.00
3,000.00
4,000.00
5,000.00
6,000.00
y = 42.8x^-0.156
R² = 0.0619


206D001 - From October 2018 to September 2019 - FY2019
$60.00
$50.00
$40.00
$30.00
$20.00
$10.00
$-
0.00
10,000.00
20,000.00
30,000.00
40,000.00
50,000.00
60,000.00
70,000.00
80,000.00
90,000.00
100,000.00
y = 15.84x^-0.184
R² = 0.125


206D002 - From October 2018 to September 2019 - FY2019
$80.00
$70.00
$60.00
$50.00
$40.00
$30.00
$20.00
$10.00
$-
0.00
1,000.00
2,000.00
3,000.00
4,000.00
5,000.00
6,000.00
7,000.00
8,000.00
y = 55.422x^-0.268
R² = 0.1803


206D003 - From October 2018 to September 2019 - FY2019
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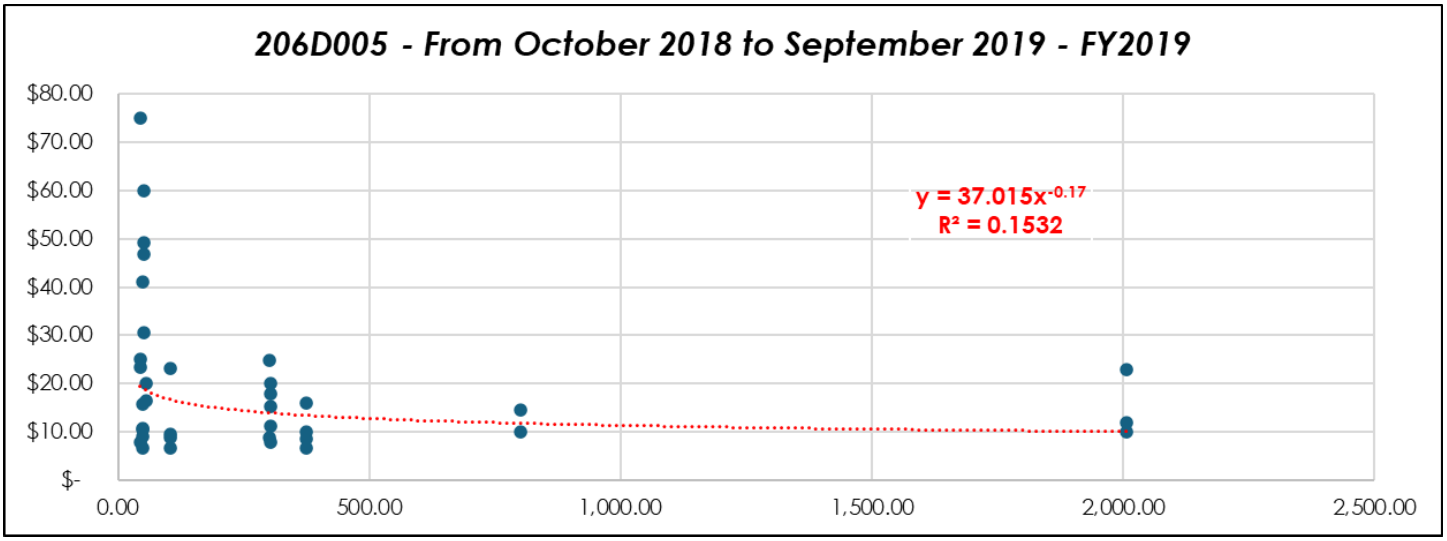
$50.00
$40.00
$30.00
$20.00
$10.00
$-
0.00
2,000.00
4,000.00
6,000.00
8,000.00
10,000.00
12,000.00
14,000.00
16,000.00
18,000.00
y = 44.437x-0.187
R² = 0.1792


206D005 - From October 2018 to September 2019 - FY2019
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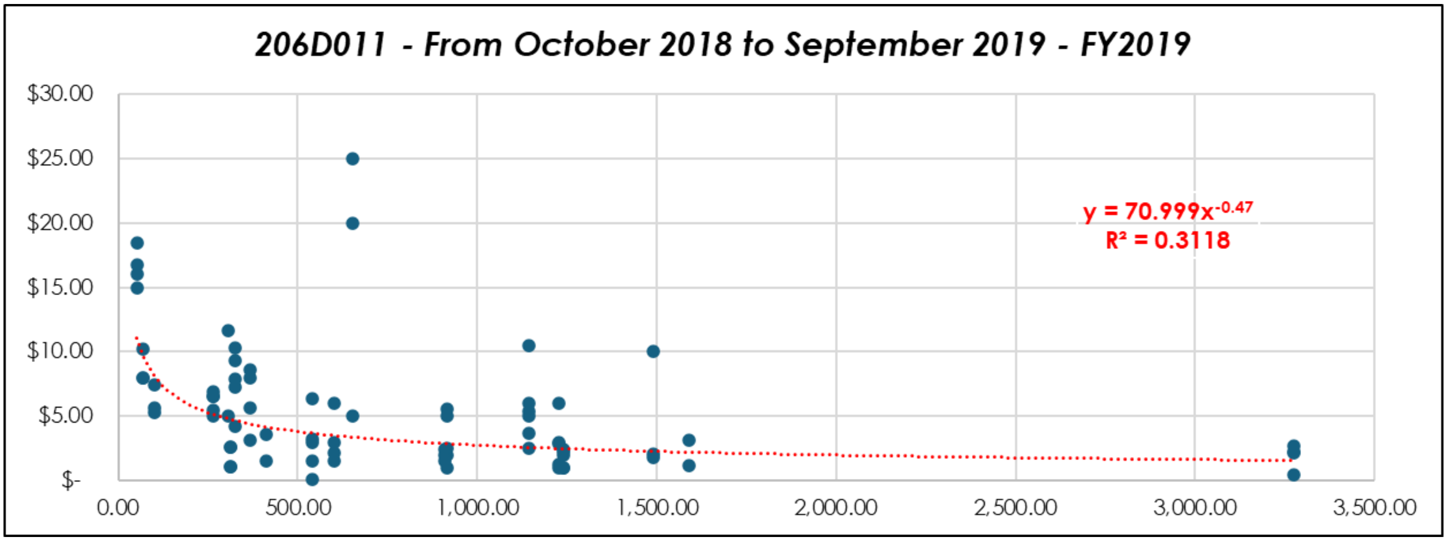
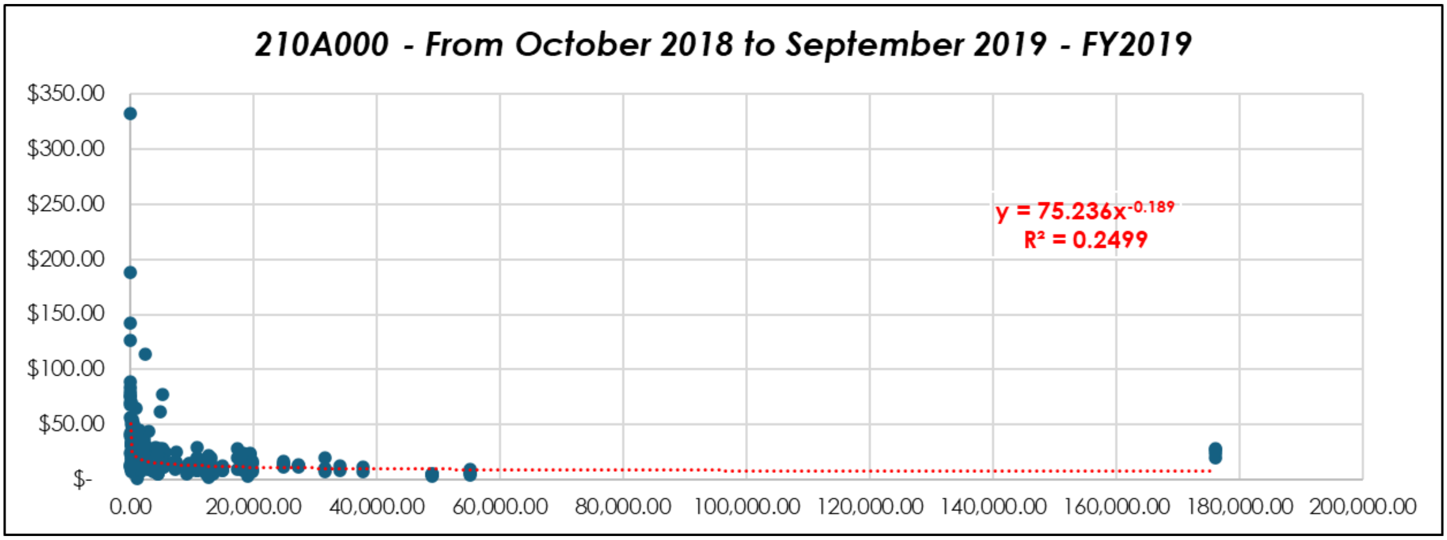
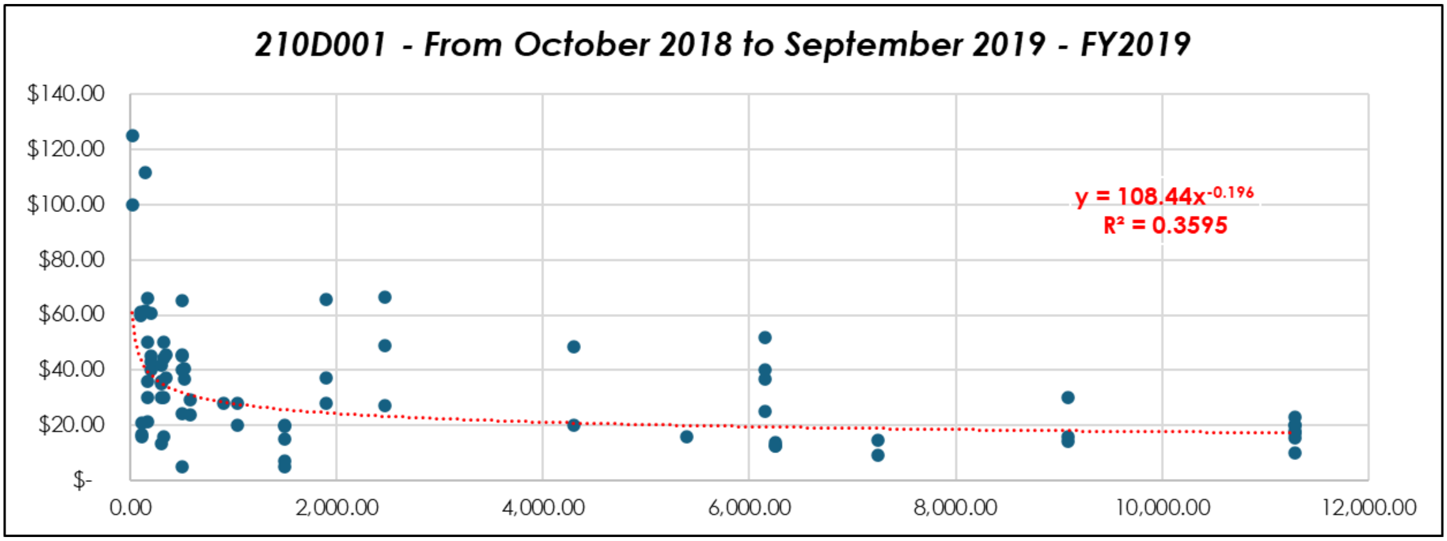
$50.00
$40.00
$30.00
$20.00
$10.00
$-
0.00
500.00
1,000.00
1,500.00
2,000.00
2,500.00
y = 37.015x-0.17
R² = 0.1532


206D011 - From October 2018 to September 2019 - FY2019
$30.00
$25.00
$20.00
$15.00
$10.00
$5.00
$-
0.00
500.00
1,000.00
1,500.00
2,000.00
2,500.00
3,000.00
3,500.00
y = 70.999x-0.47
R² = 0.3118


210A000 - From October 2018 to September 2019 - FY2019
$350.00
$300.00
$250.00
$200.00
$150.00
$100.00
$50.00
$-
0.00
20,000.00
40,000.00
60,000.00
80,000.00
100,000.00
120,000.00
140,000.00
160,000.00
180,000.00
200,000.00
y = 75.236x^-0.189
R² = 0.2499


210D001 - From October 2018 to September 2019 - FY2019
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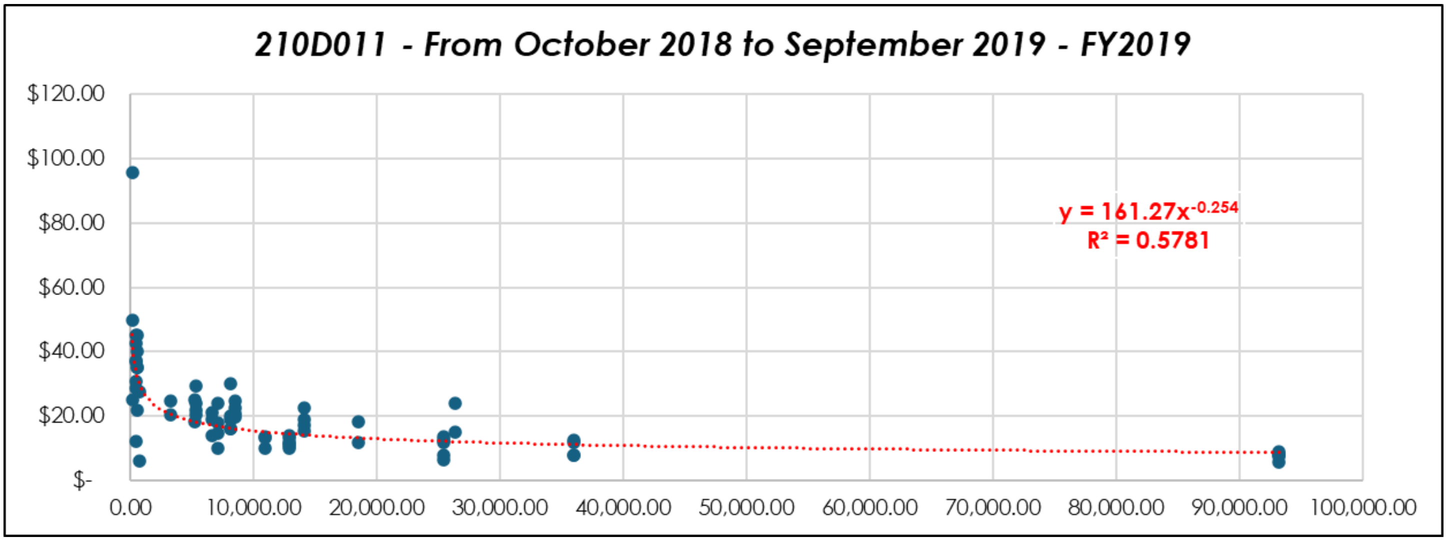
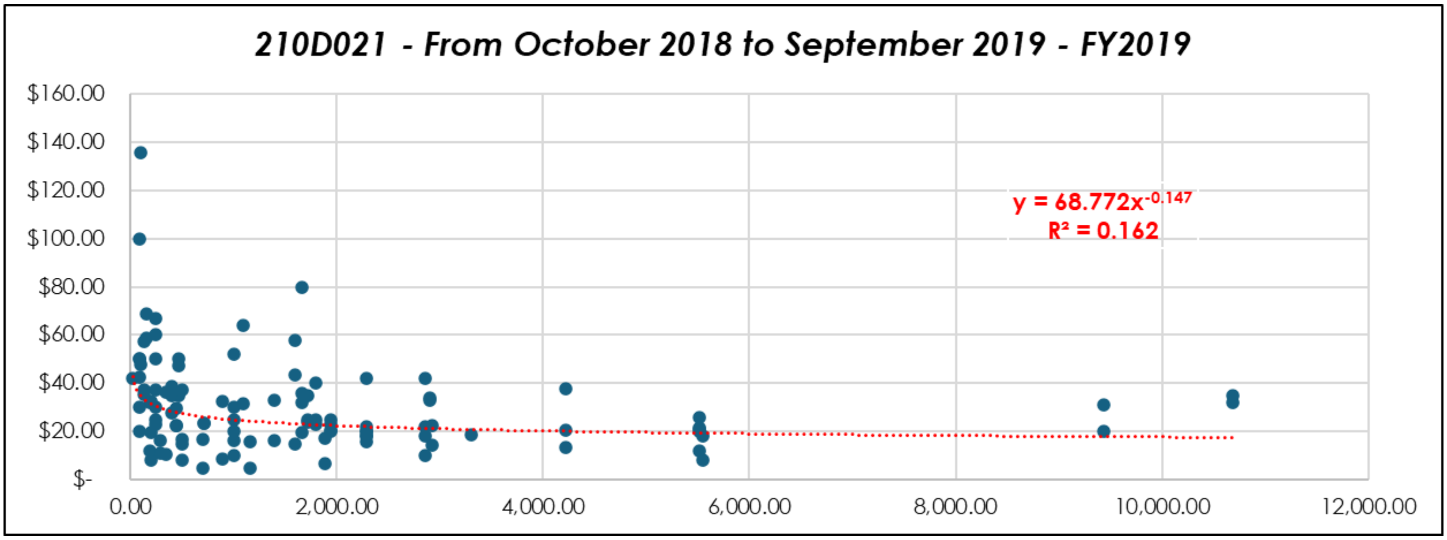
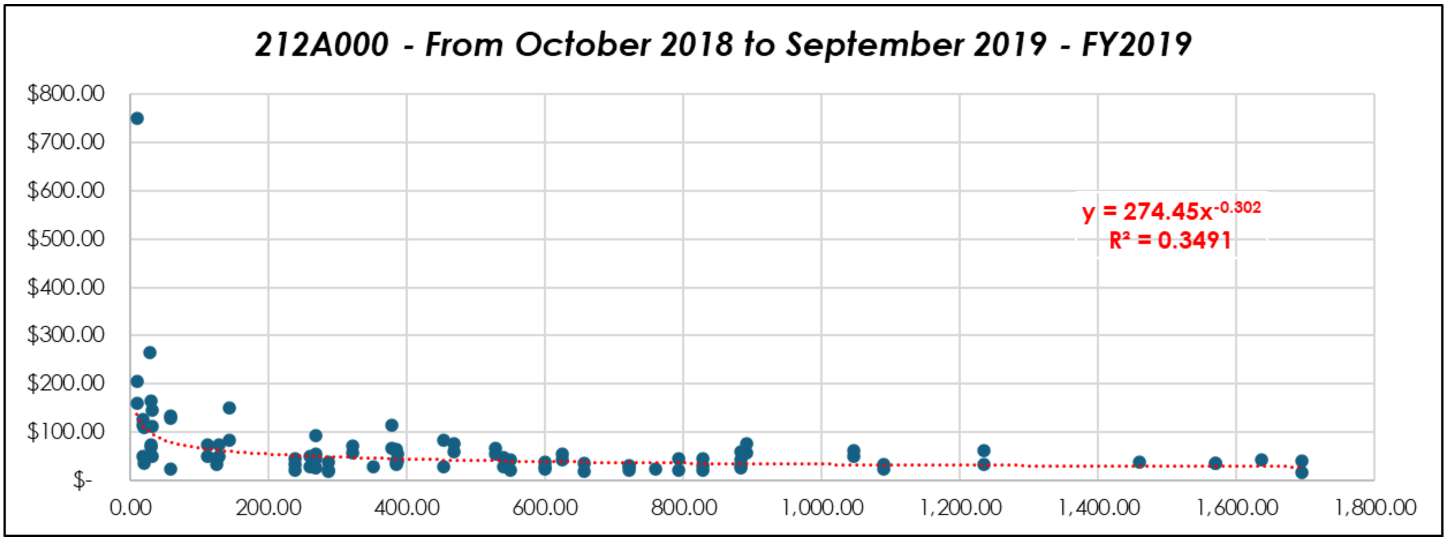
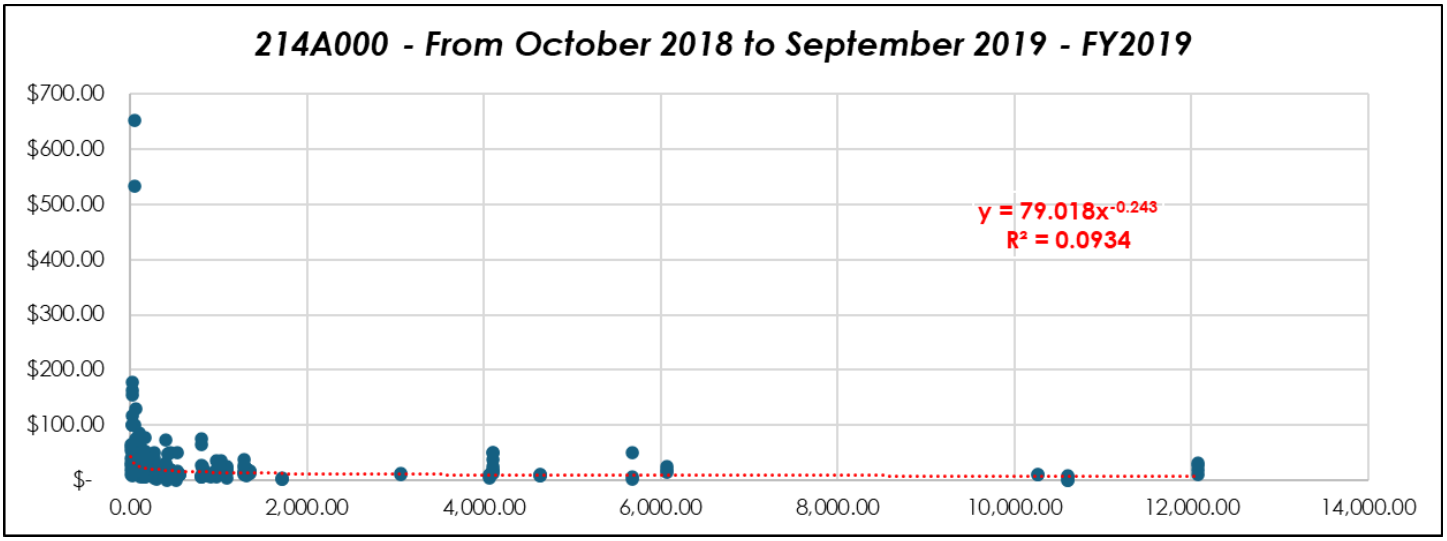
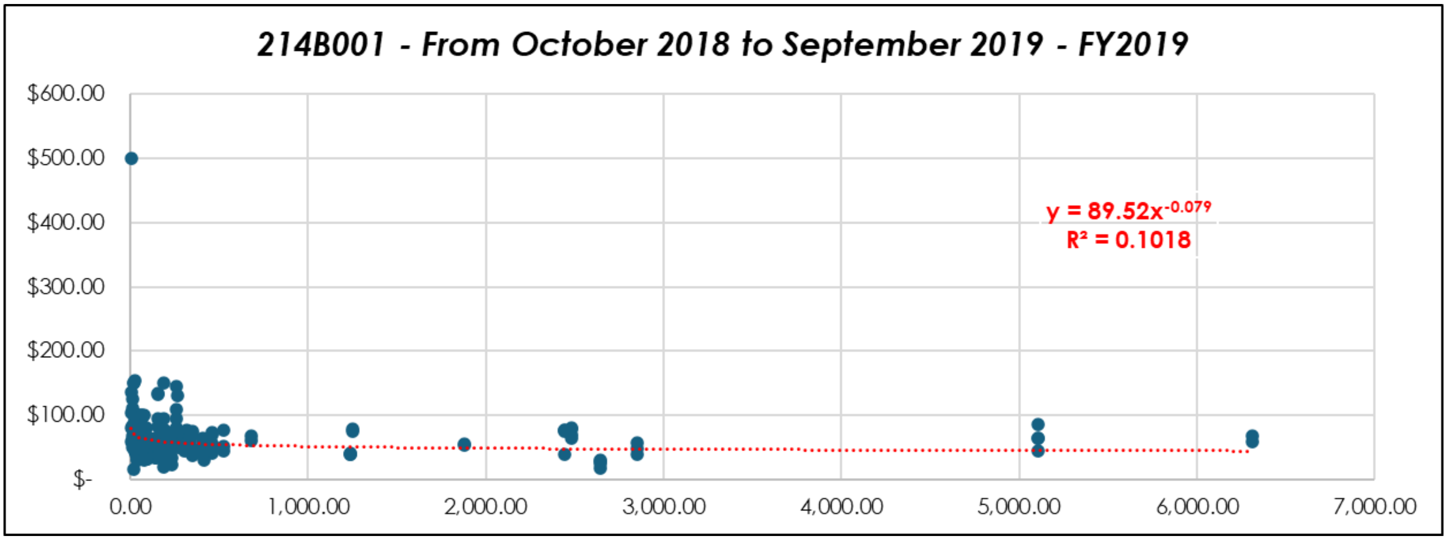
$120.00
$100.00
$80.00
$60.00
$40.00
$20.00
$-
0.00
2,000.00
4,000.00
6,000.00
8,000.00
10,000.00
12,000.00
y = 108.44x^-0.196
R² = 0.3595

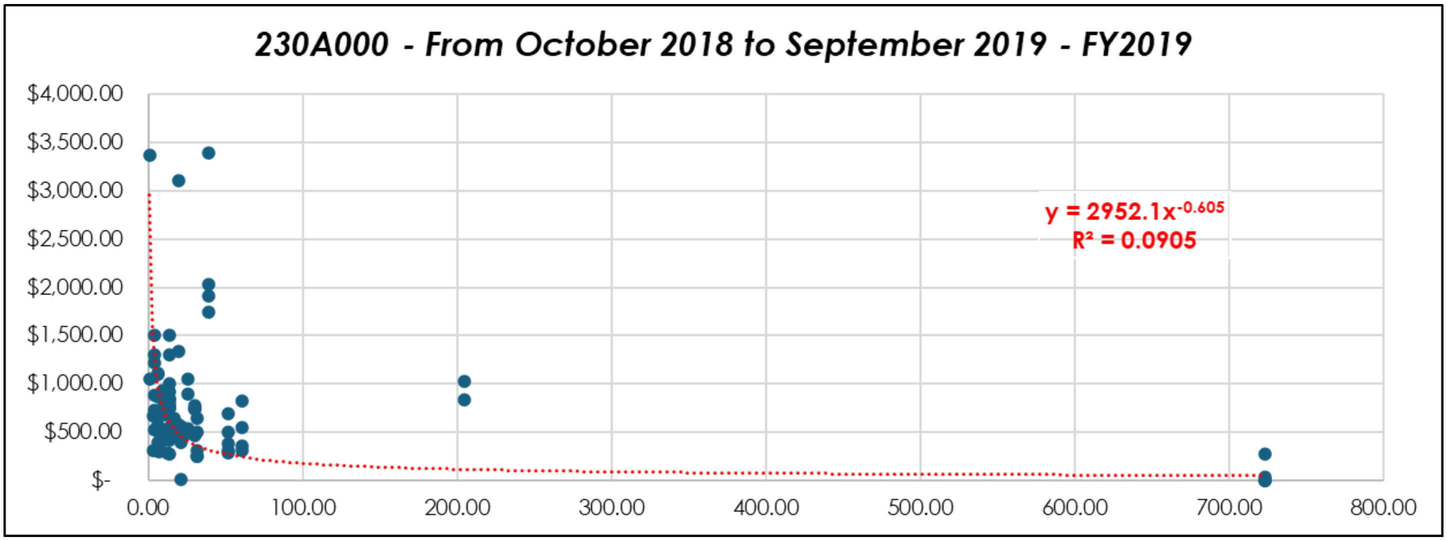

210D011 - From October 2018 to September 2019 - FY2019
$120.00
$100.00
$80.00
$60.00
$40.00
$20.00
$-
0.00
10,000.00
20,000.00
30,000.00
40,000.00
50,000.00
60,000.00
70,000.00
80,000.00
90,000.00
100,000.00
y = 161.27x^-0.254
R² = 0.5781


210D021 - From October 2018 to September 2019 - FY2019
$160.00
$140.00
$120.00
$100.00
$80.00
$60.00
$40.00
$20.00
$-
0.00
2,000.00
4,000.00
6,000.00
8,000.00
10,000.00
12,000.00
y = 68.772x^-0.147
R² = 0.162


212A000 - From October 2018 to September 2019 - FY2019
$800.00
$700.00
$600.00
$500.00
$400.00
$300.00
$200.00
$100.00
$-
0.00
200.00
400.00
600.00
800.00
1,000.00
1,200.00
1,400.00
1,600.00
1,800.00
y = 274.45x^-0.302
R² = 0.3491


214A000 - From October 2018 to September 2019 - FY2019
$700.00
$600.00
$500.00
$400.00
$300.00
$200.00
$100.00
$-
0.00
2,000.00
4,000.00
6,000.00
8,000.00
10,000.00
12,000.00
14,000.00
y = 79.018x^-0.243
R² = 0.0934


214B001 - From October 2018 to September 2019 - FY2019
$600.00
$500.00
$400.00
$300.00
$200.00
$100.00
$-
0.00
1,000.00
2,000.00
3,000.00
4,000.00
5,000.00
6,000.00
7,000.00
y = 89.52x^-0.079
R² = 0.1018


230A000 - From October 2018 to September 2019 - FY2019
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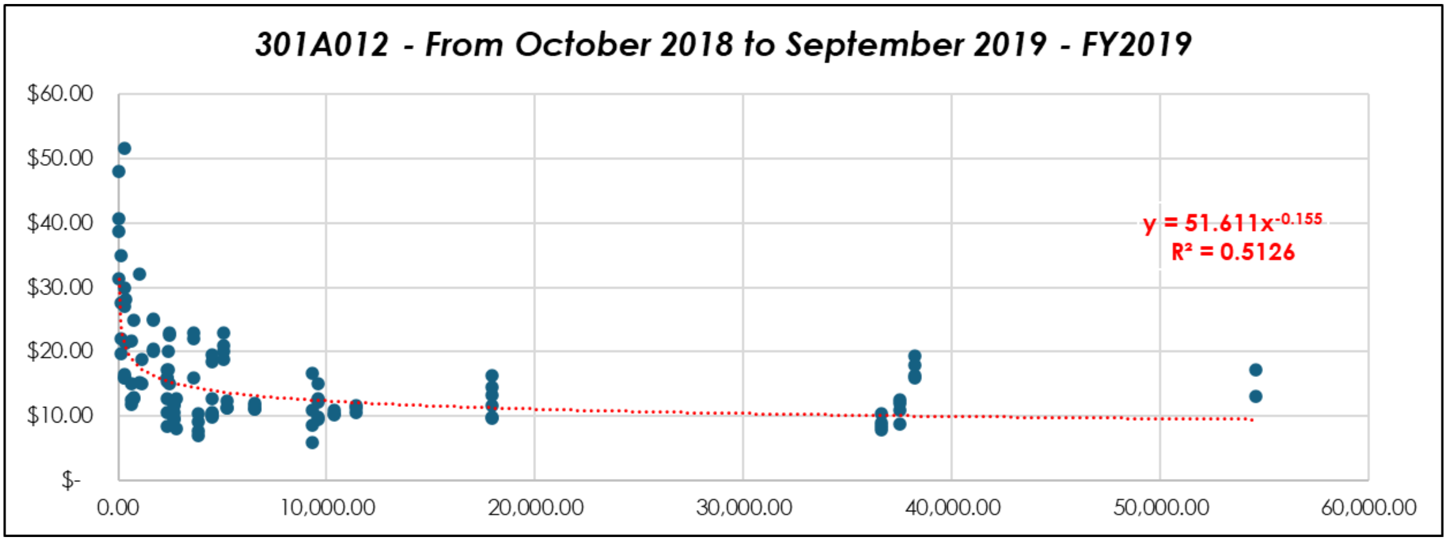
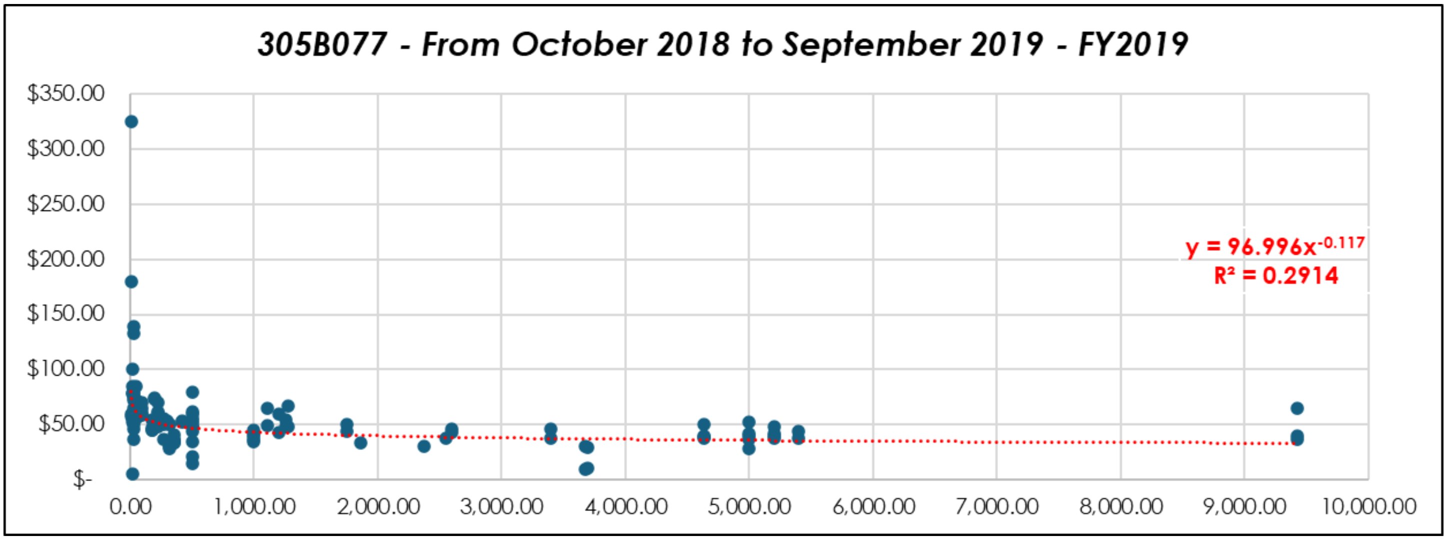
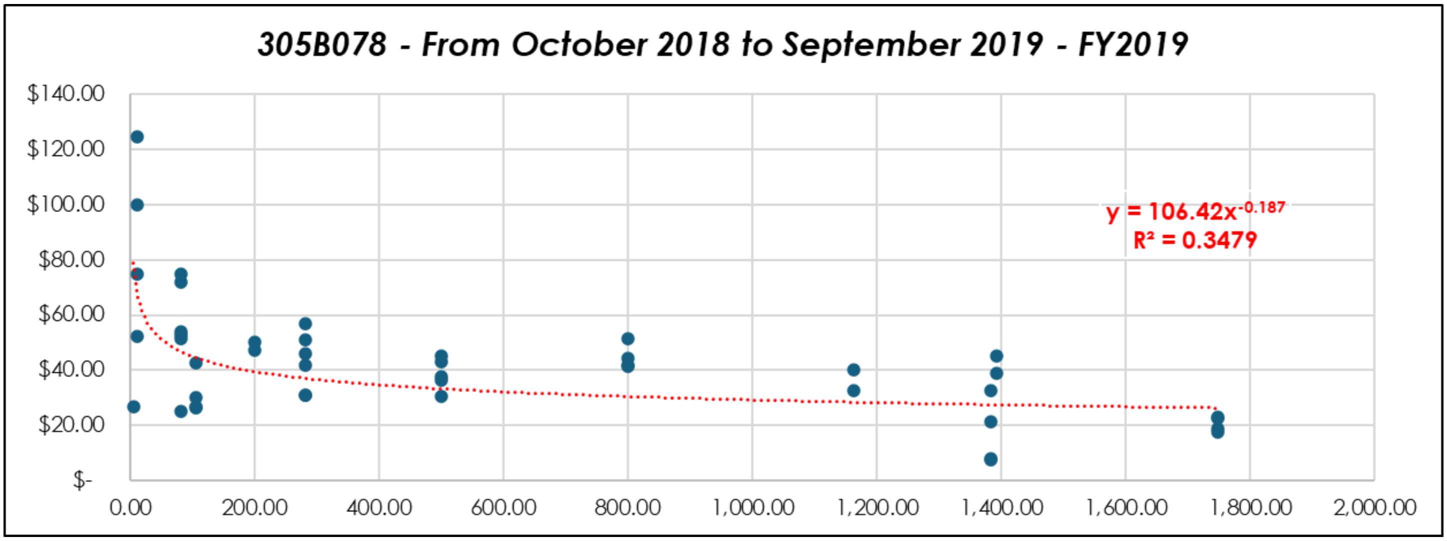
$3,500.00
$3,000.00
$2,500.00
$2,000.00
$1,500.00
$1,000.00
$500.00
$-
0.00
100.00
200.00
300.00
400.00
500.00
600.00
700.00
800.00
y = 2952.1x^-0.605
R² = 0.0905


301A012 - From October 2018 to September 2019 - FY2019
$60.00
$50.00
$40.00
$30.00
$20.00
$10.00
$-
0.00
10,000.00
20,000.00
30,000.00
40,000.00
50,000.00
60,000.00
y = 51.611x^-0.155
R² = 0.5126


305B077 - From October 2018 to September 2019 - FY2019
$350.00
$300.00
$250.00
$200.00
$150.00
$100.00
$50.00
$-
0.00
1,000.00
2,000.00
3,000.00
4,000.00
5,000.00
6,000.00
7,000.00
8,000.00
9,000.00
10,000.00
$y = 96.996x^{-0.117}$
$R^2 = 0.2914$


305B078 - From October 2018 to September 2019 - FY2019
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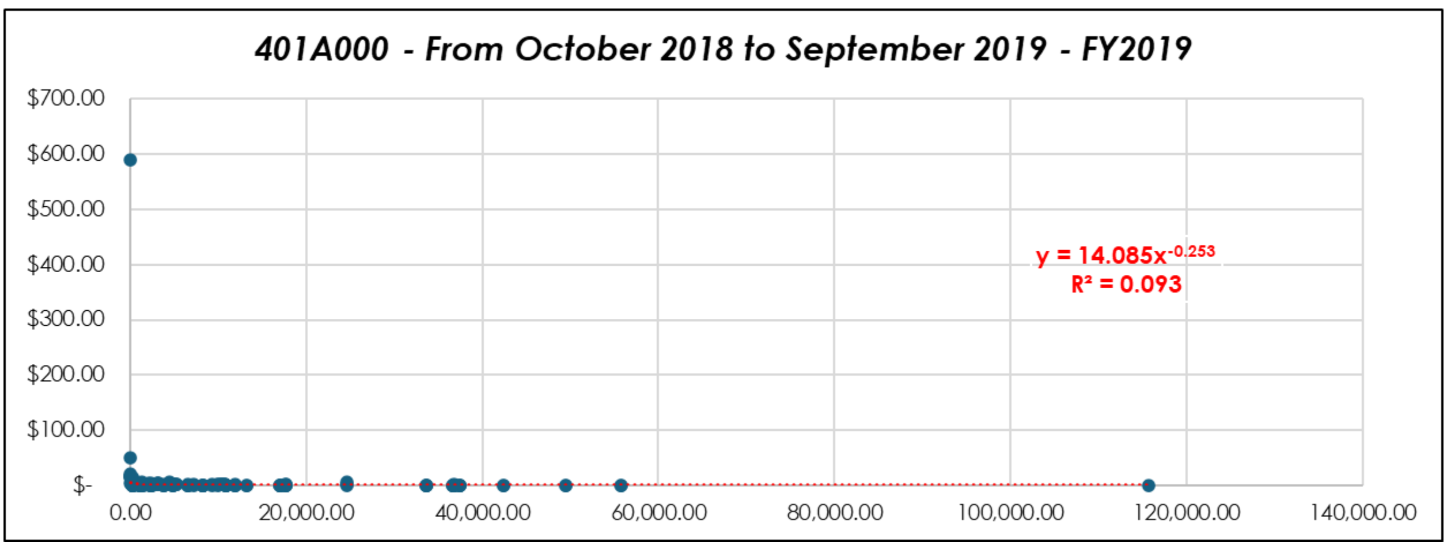
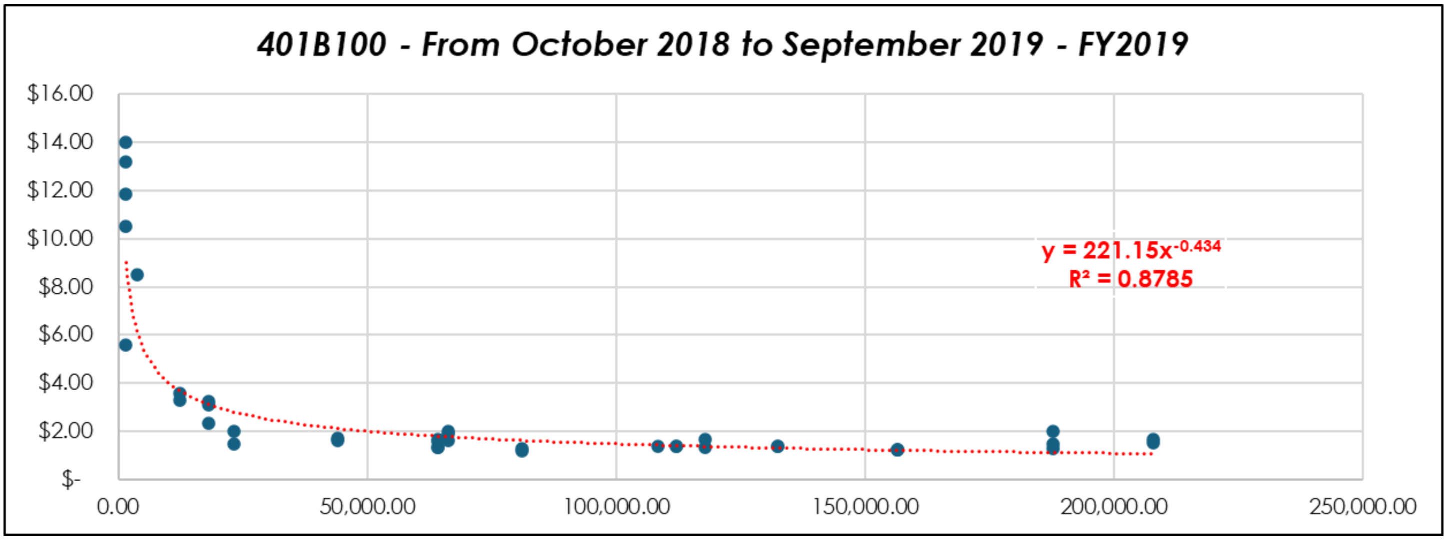
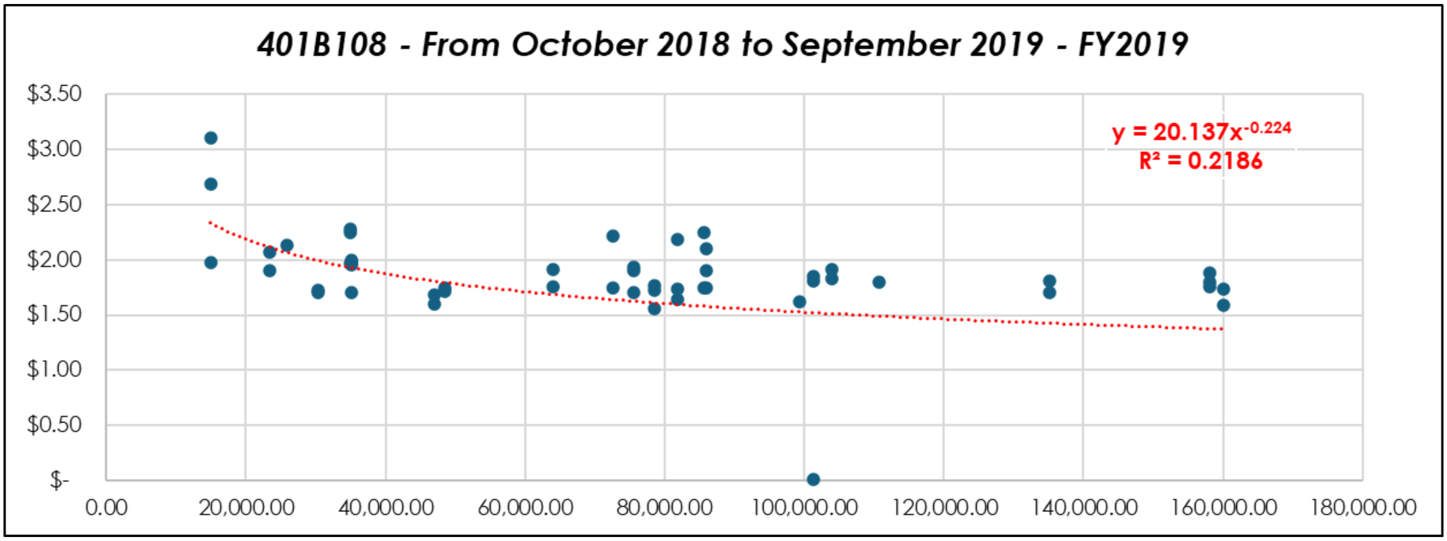
$120.00
$100.00
$80.00
$60.00
$40.00
$20.00
$-
0.00
200.00
400.00
600.00
800.00
1,000.00
1,200.00
1,400.00
1,600.00
1,800.00
2,000.00
$y = 106.42x^{-0.187}$
$R^2 = 0.3479$


401A000 - From October 2018 to September 2019 - FY2019
$700.00
$600.00
$500.00
$400.00
$300.00
$200.00
$100.00
$-
0.00
20,000.00
40,000.00
60,000.00
80,000.00
100,000.00
120,000.00
140,000.00
$y = 14.085x^{-0.253}$
$R^2 = 0.093$


401B100 - From October 2018 to September 2019 - FY2019
$16.00
$14.00
$12.00
$10.00
$8.00
$6.00
$4.00
$2.00
$-
0.00
50,000.00
100,000.00
150,000.00
200,000.00
250,000.00
y = 221.15x^-0.434
R² = 0.8785


401B108 - From October 2018 to September 2019 - FY2019
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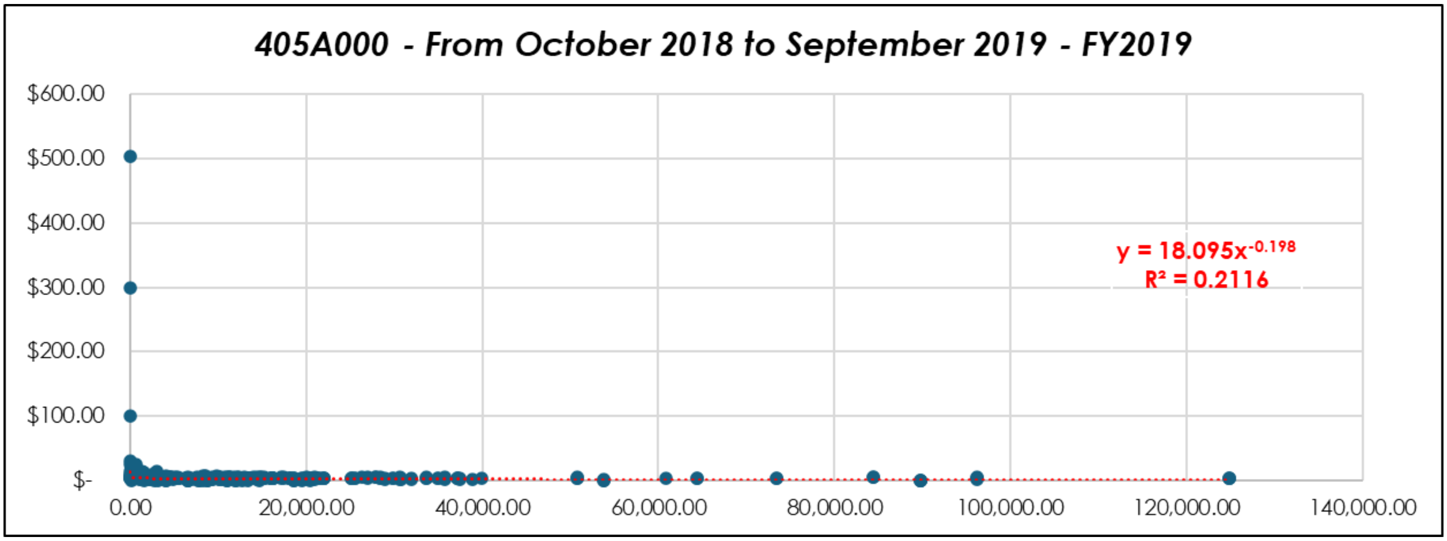
$2.50
$2.00
$1.50
$1.00
$0.50
$-
0.00
20,000.00
40,000.00
60,000.00
80,000.00
100,000.00
120,000.00
140,000.00
160,000.00
180,000.00
y = 20.137x^-0.224
R² = 0.2186


405A000 - From October 2018 to September 2019 - FY2019
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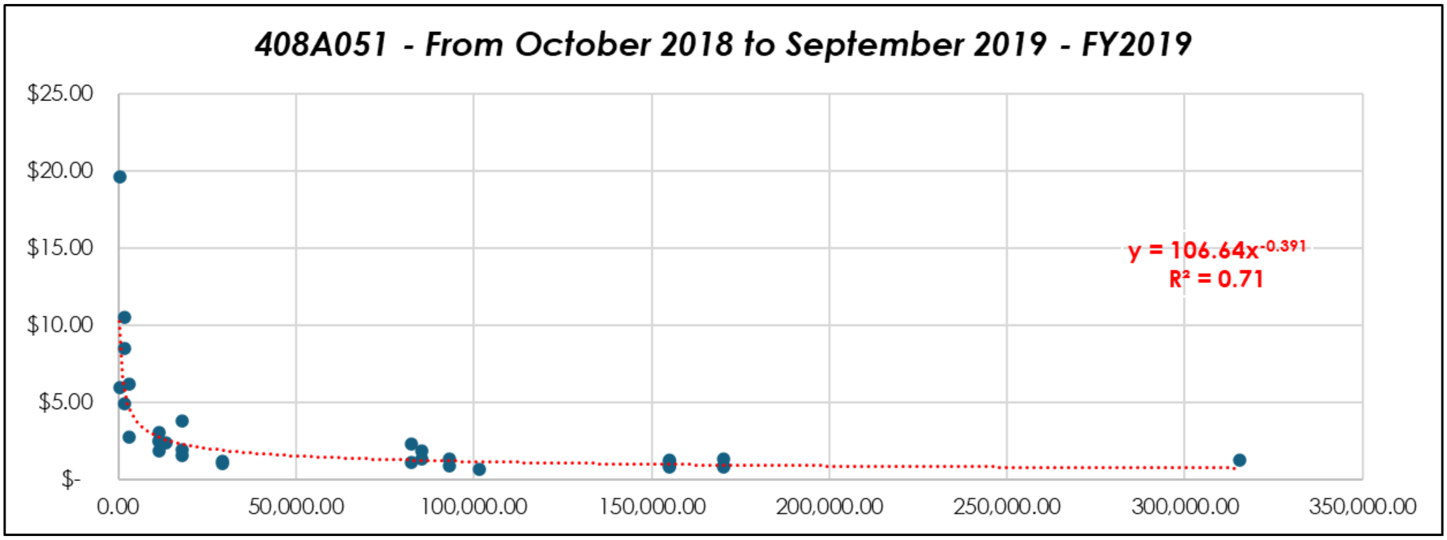
$500.00
$400.00
$300.00
$200.00
$100.00
$-
0.00
20,000.00
40,000.00
60,000.00
80,000.00
100,000.00
120,000.00
140,000.00
y = 18.095x^-0.198
R² = 0.2116


408A051 - From October 2018 to September 2019 - FY2019
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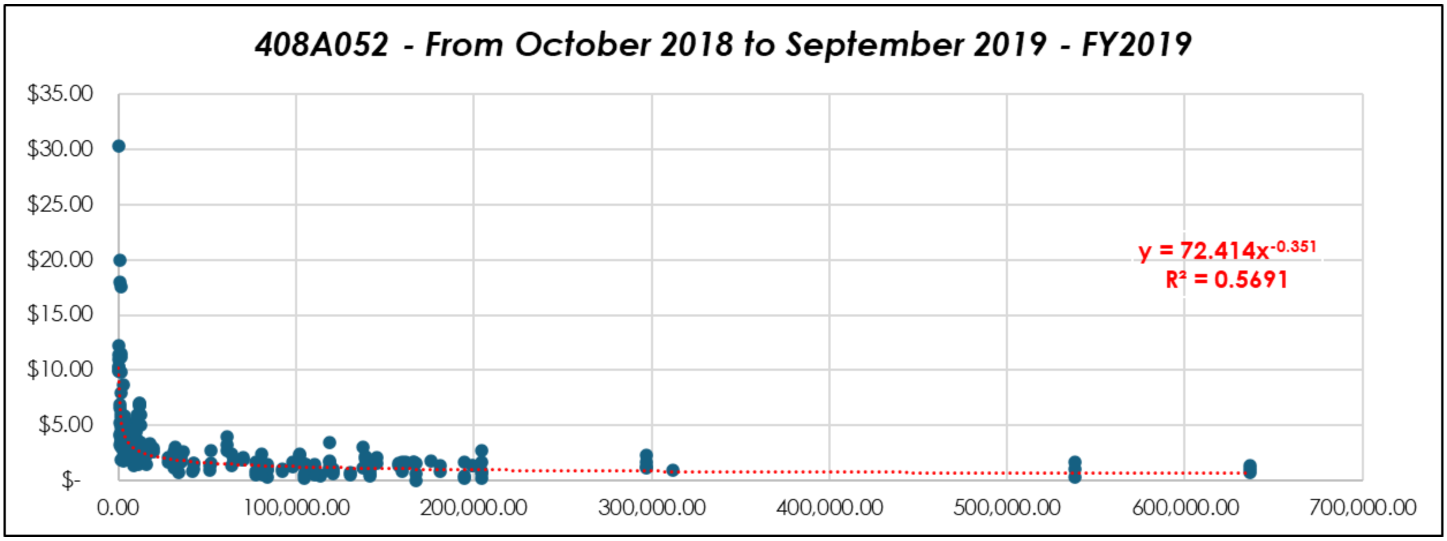
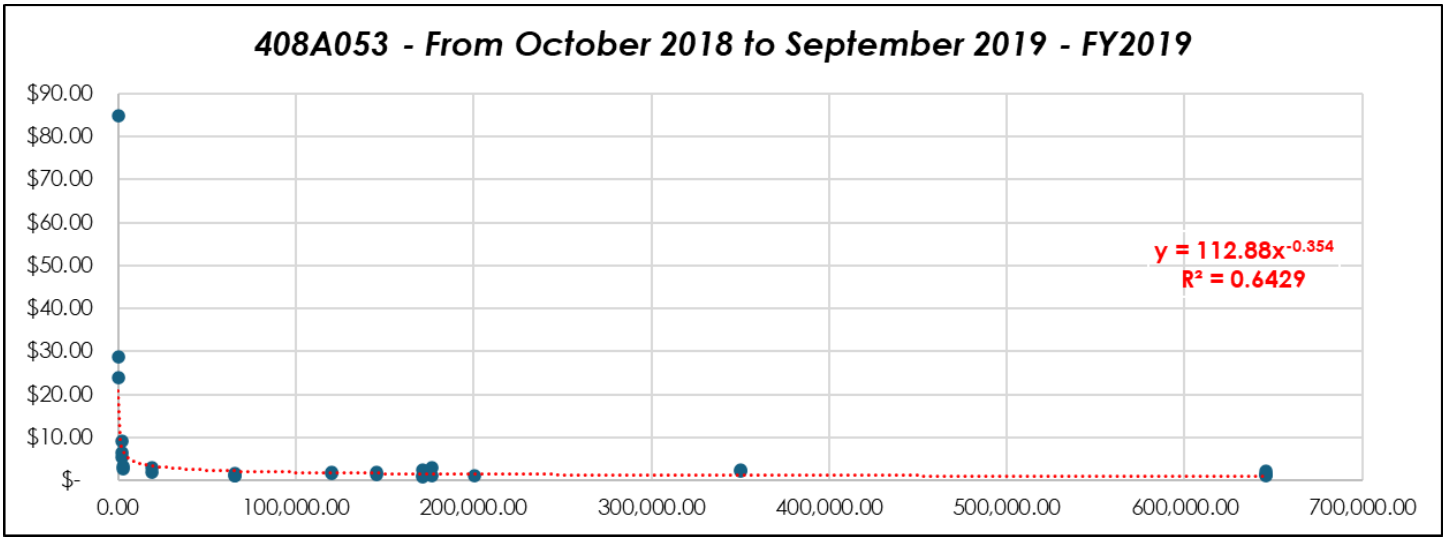
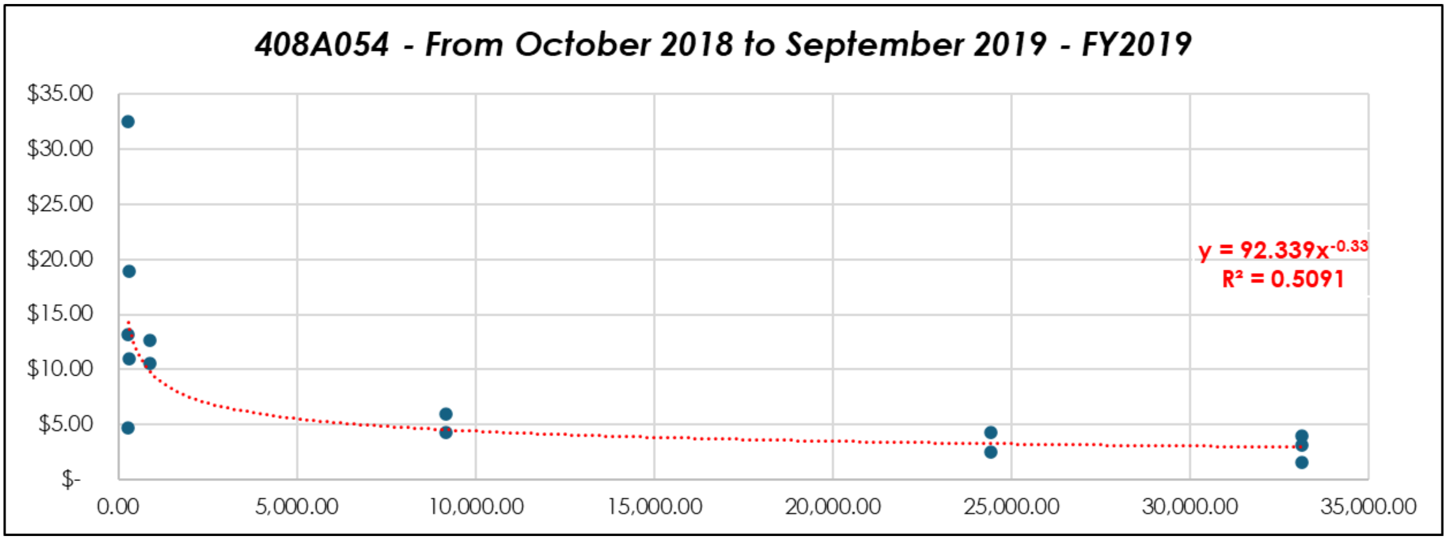
$20.00
$15.00
$10.00
$5.00
$-
0.00
50,000.00
100,000.00
150,000.00
200,000.00
250,000.00
300,000.00
350,000.00
y = 106.64x^-0.391
R² = 0.71


408A052 - From October 2018 to September 2019 - FY2019
$35.00
$30.00
$25.00
$20.00
$15.00
$10.00
$5.00
$-
0.00
100,000.00
200,000.00
300,000.00
400,000.00
500,000.00
600,000.00
700,000.00
y = 72.414x^-0.351
R² = 0.5691


408A053 - From October 2018 to September 2019 - FY2019
$90.00
$80.00
$70.00
$60.00
$50.00
$40.00
$30.00
$20.00
$10.00
$-
0.00
100,000.00
200,000.00
300,000.00
400,000.00
500,000.00
600,000.00
700,000.00
y = 112.88x^-0.354
R² = 0.6429


408A054 - From October 2018 to September 2019 - FY2019
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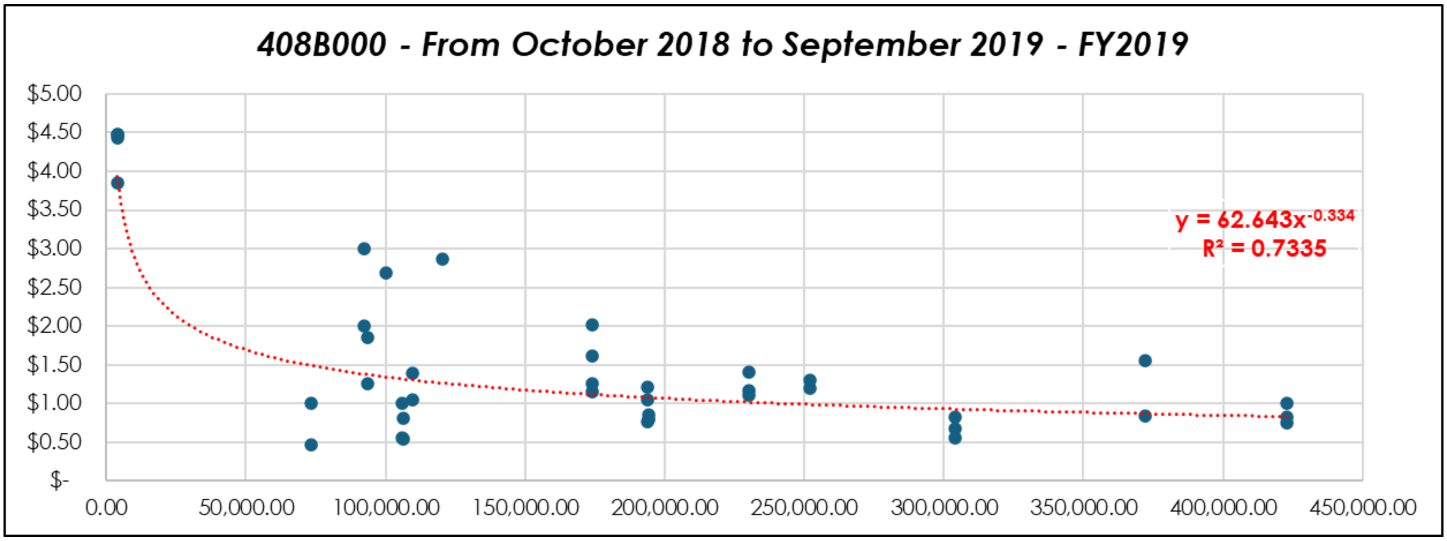
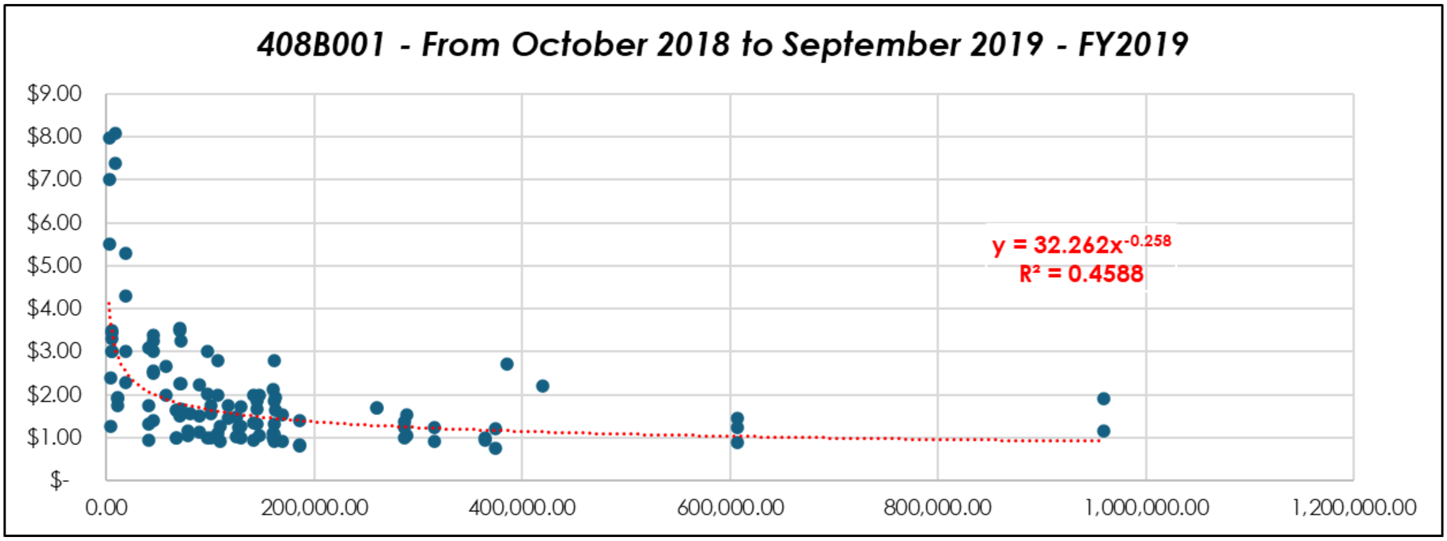
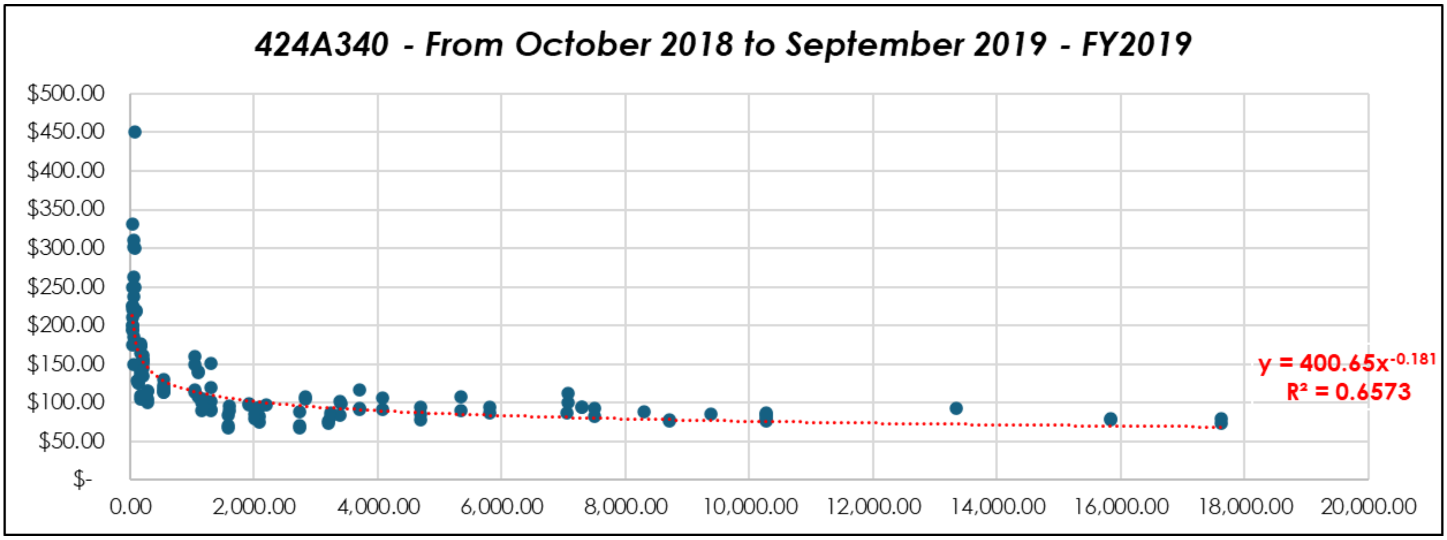
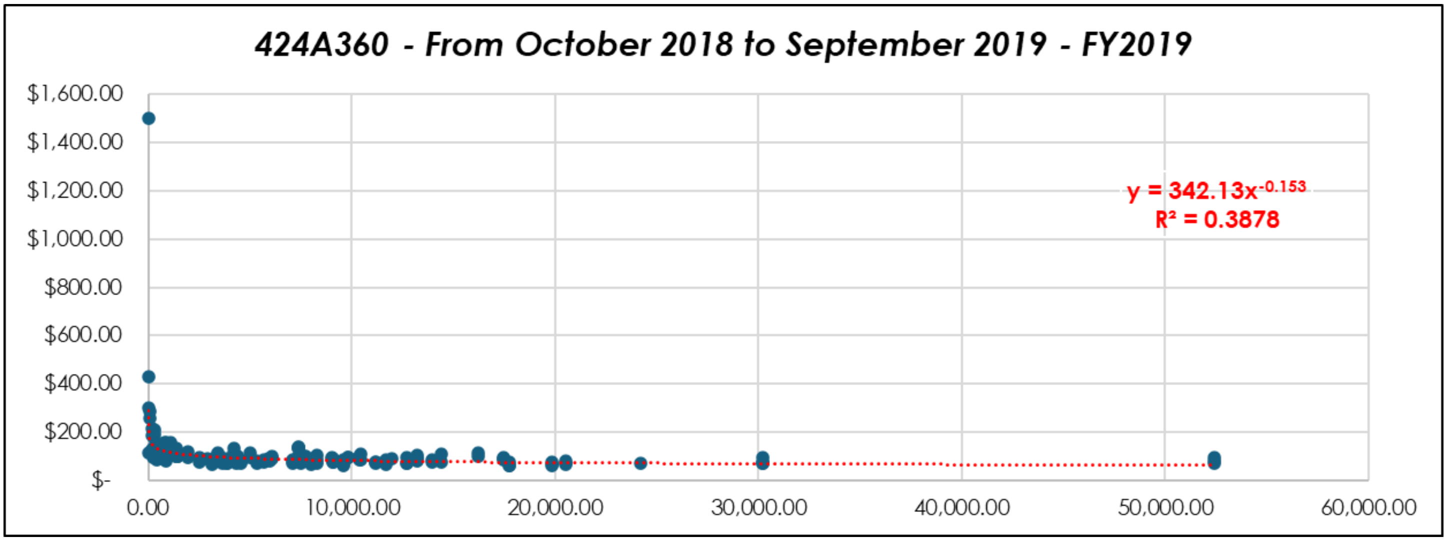
$30.00
$25.00
$20.00
$15.00
$10.00
$5.00
$-
0.00
5,000.00
10,000.00
15,000.00
20,000.00
25,000.00
30,000.00
35,000.00
y = 92.339x-0.33
R² = 0.5091


408B000 - From October 2018 to September 2019 - FY2019
$5.00
$4.50
$4.00
$3.50
$3.00
$2.50
$2.00
$1.50
$1.00
$0.50
$-
0.00
50,000.00
100,000.00
150,000.00
200,000.00
250,000.00
300,000.00
350,000.00
400,000.00
450,000.00
y = 62.643x-0.334
R² = 0.7335


408B001 - From October 2018 to September 2019 - FY2019
$9.00
$8.00
$7.00
$6.00
$5.00
$4.00
$3.00
$2.00
$1.00
$-
0.00
200,000.00
400,000.00
600,000.00
800,000.00
1,000,000.00
1,200,000.00
y = 32.262x-0.258
R² = 0.4588


424A340 - From October 2018 to September 2019 - FY2019
$500.00
$450.00
$400.00
$350.00
$300.00
$250.00
$200.00
$150.00
$100.00
$50.00
$-
0.00
2,000.00
4,000.00
6,000.00
8,000.00
10,000.00
12,000.00
14,000.00
16,000.00
18,000.00
20,000.00
y = 400.65x^-0.181
R² = 0.6573


424A360 - From October 2018 to September 2019 - FY2019
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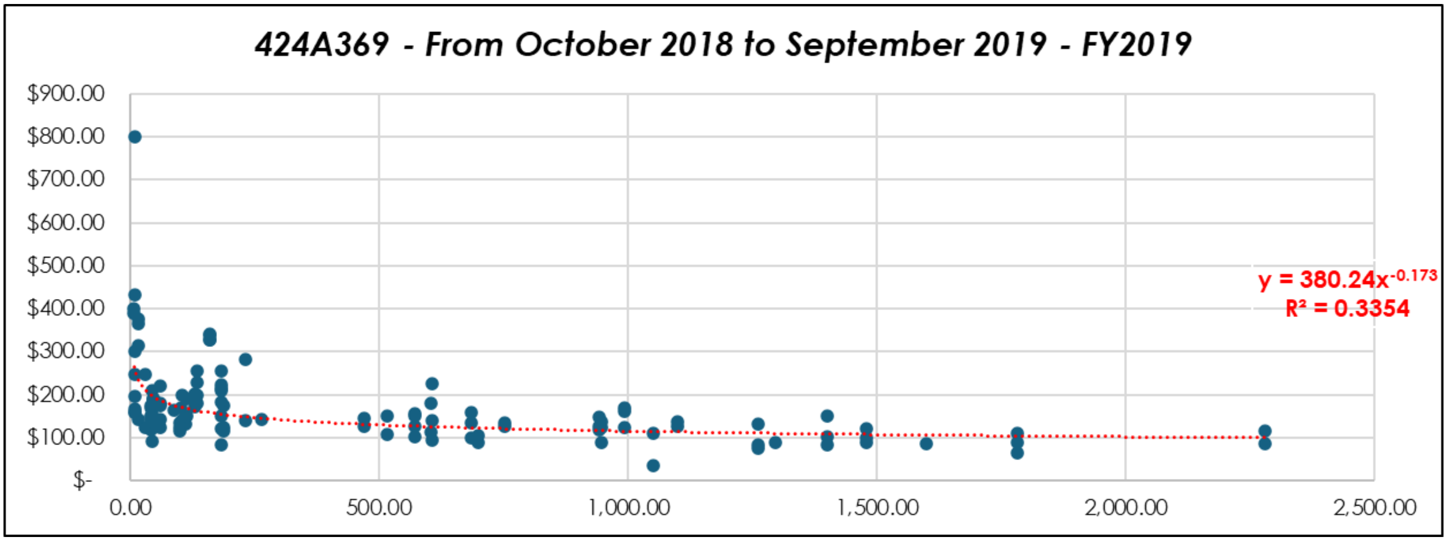
$1,400.00
$1,200.00
$1,000.00
$800.00
$600.00
$400.00
$200.00
$-
0.00
10,000.00
20,000.00
30,000.00
40,000.00
50,000.00
60,000.00
y = 342.13x^-0.153
R² = 0.3878


424A369 - From October 2018 to September 2019 - FY2019
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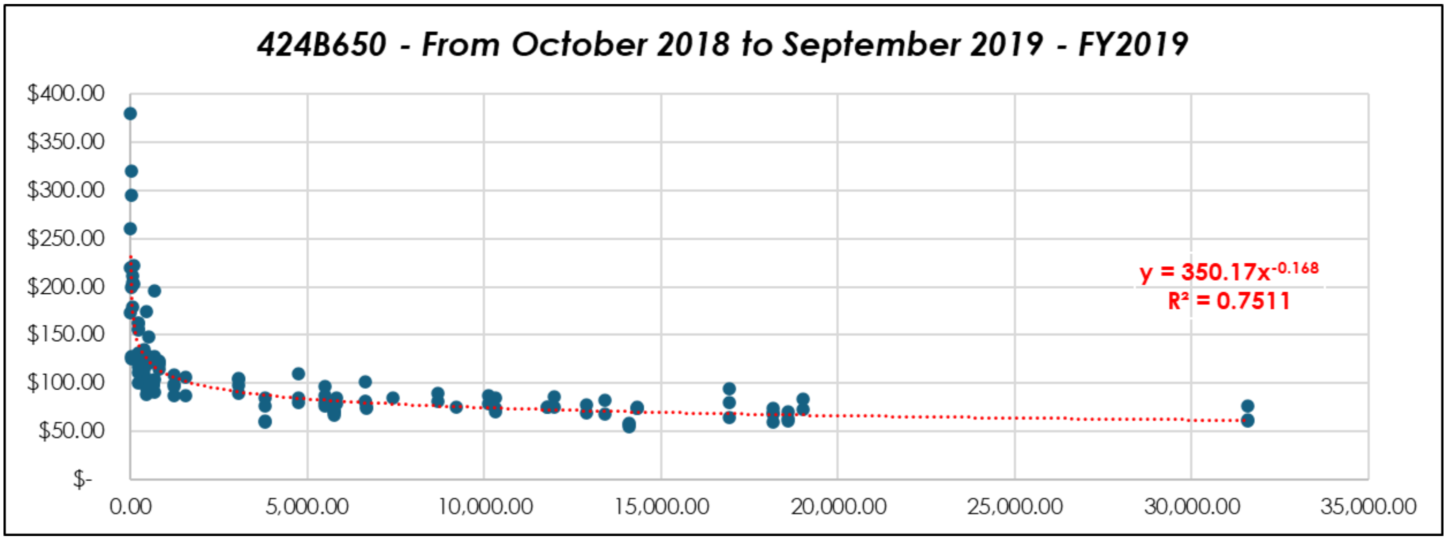
$800.00
$700.00
$600.00
$500.00
$400.00
$300.00
$200.00
$100.00
$-
0.00
500.00
1,000.00
1,500.00
2,000.00
2,500.00
y = 380.24x^-0.173
R² = 0.3354


424B650 - From October 2018 to September 2019 - FY2019
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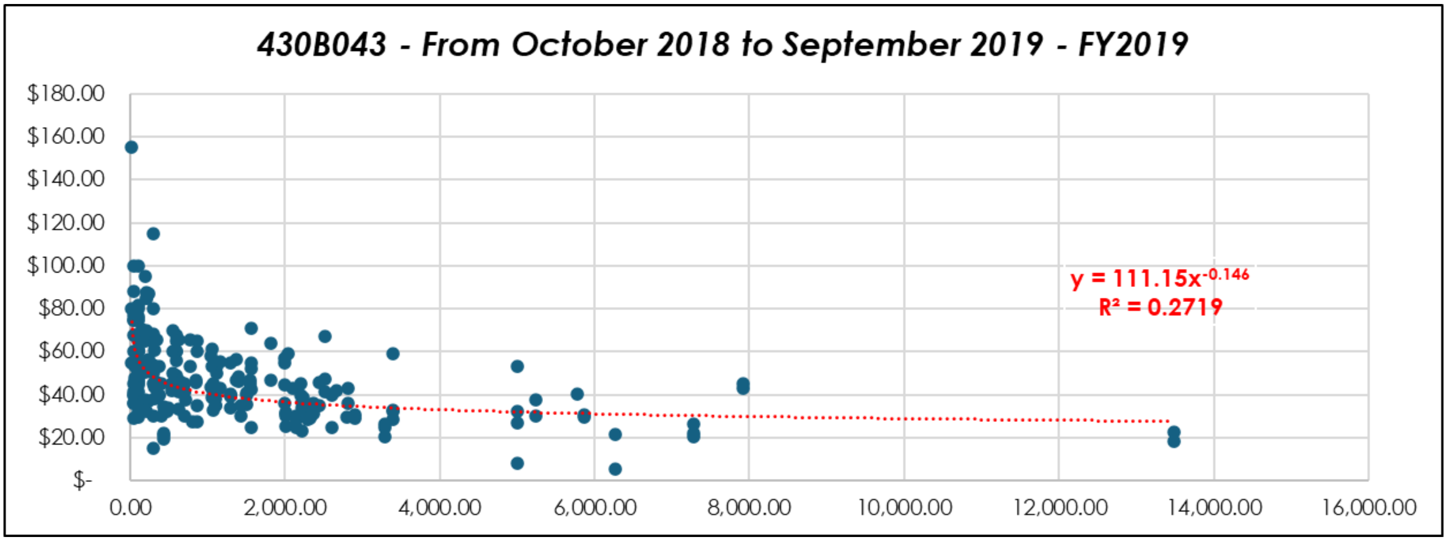
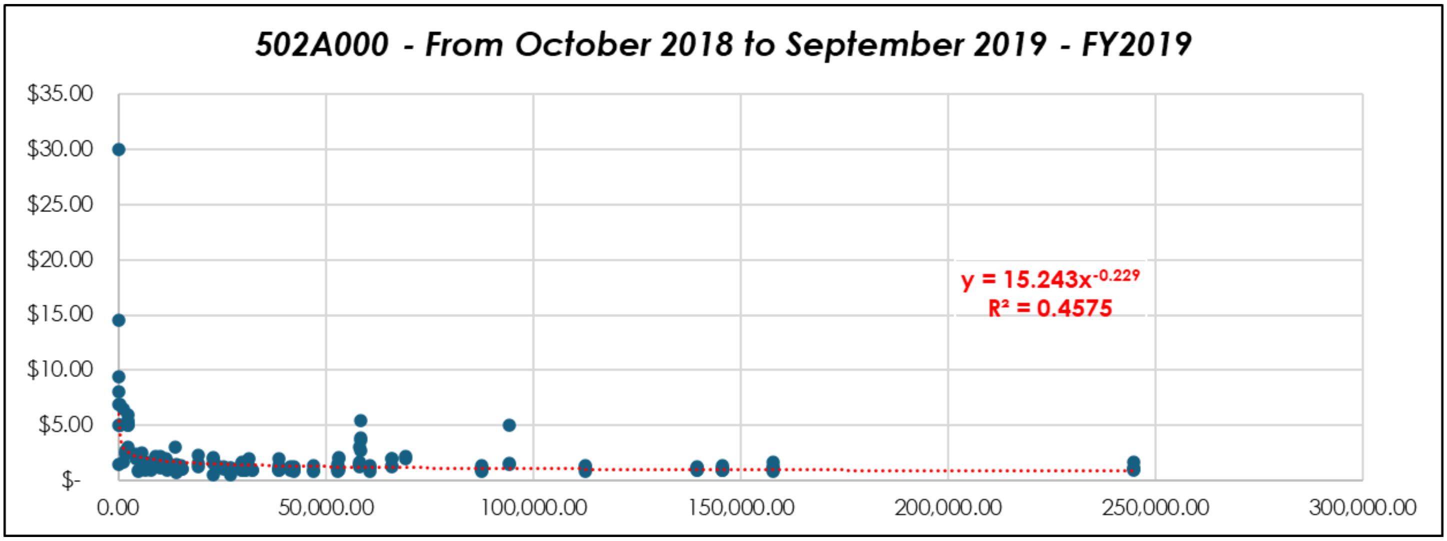
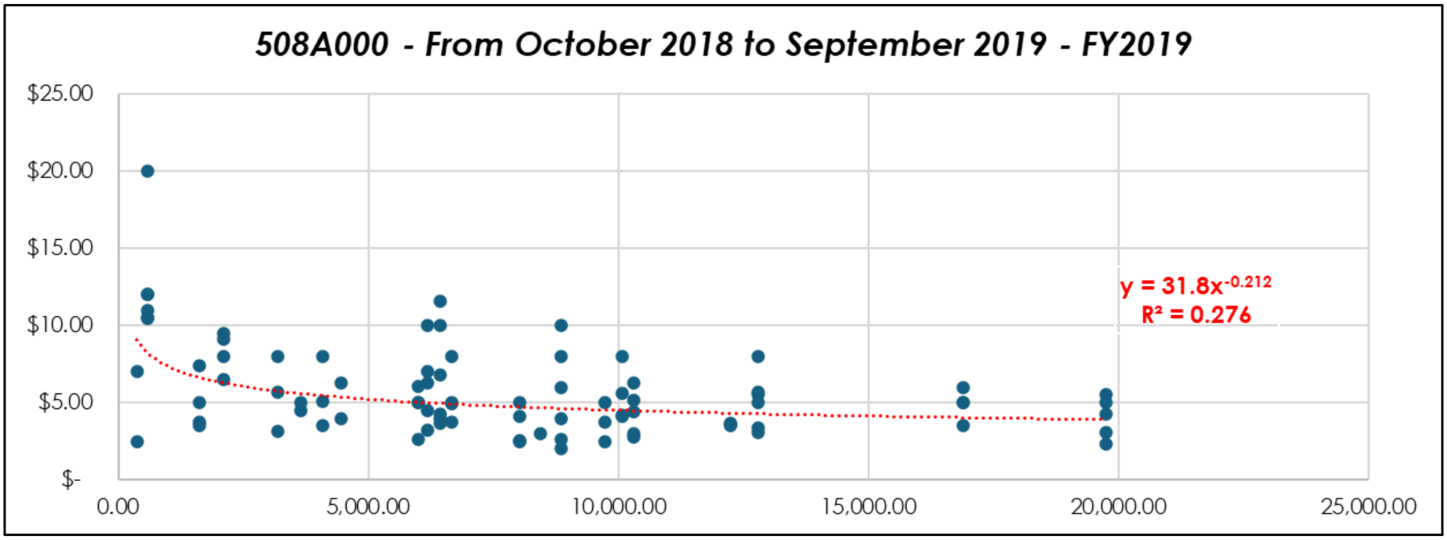
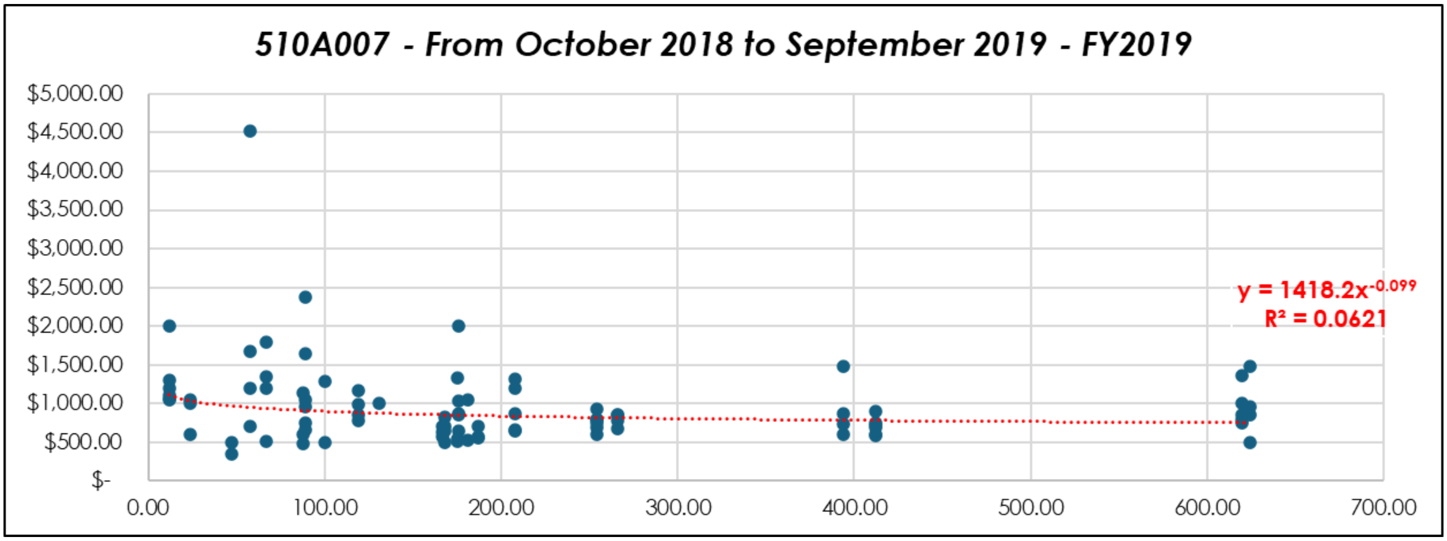
$350.00
$300.00
$250.00
$200.00
$150.00
$100.00
$50.00
$-
0.00
5,000.00
10,000.00
15,000.00
20,000.00
25,000.00
30,000.00
35,000.00
y = 350.17x-0.168
R² = 0.7511


430B043 - From October 2018 to September 2019 - FY2019
$180.00
$160.00
$140.00
$120.00
$100.00
$80.00
$60.00
$40.00
$20.00
$-
0.00
2,000.00
4,000.00
6,000.00
8,000.00
10,000.00
12,000.00
14,000.00
16,000.00
y = 111.15x-0.146
R² = 0.2719


502A000 - From October 2018 to September 2019 - FY2019
$35.00
$30.00
$25.00
$20.00
$15.00
$10.00
$5.00
$-
0.00
50,000.00
100,000.00
150,000.00
200,000.00
250,000.00
300,000.00
y = 15.243x-0.229
R² = 0.4575


508A000 - From October 2018 to September 2019 - FY2019
$25.00
$20.00
$15.00
$10.00
$5.00
$-
0.00
5,000.00
10,000.00
15,000.00
20,000.00
25,000.00
y = 31.8x-0.212
R² = 0.276


510A007 - From October 2018 to September 2019 - FY2019
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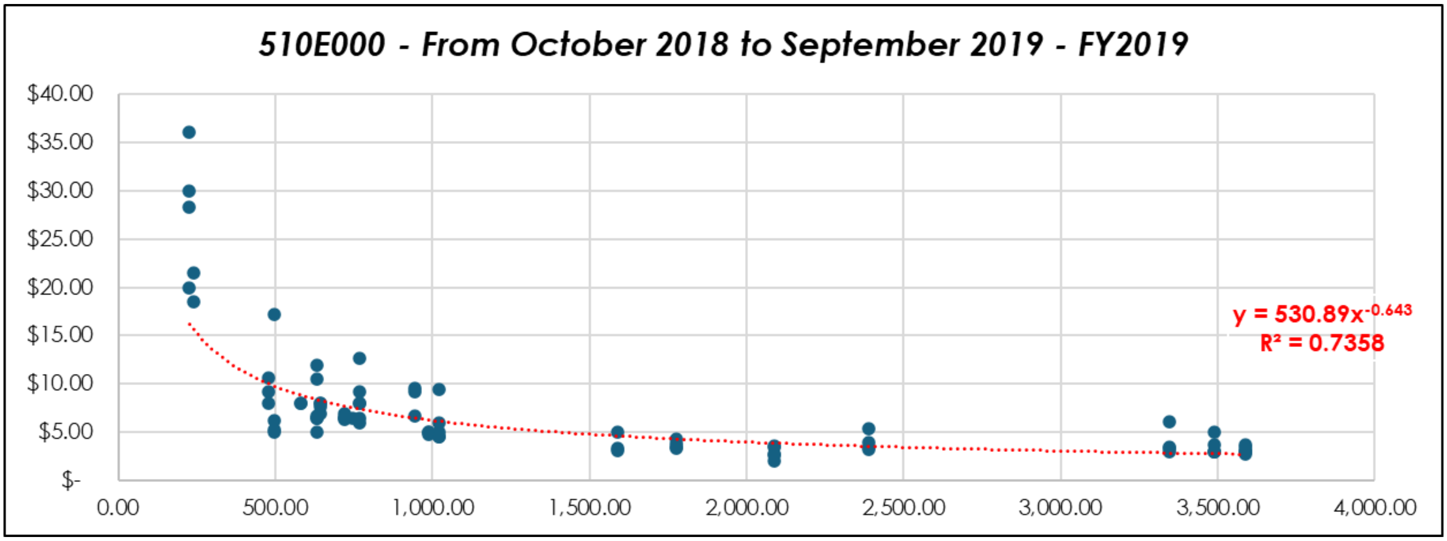
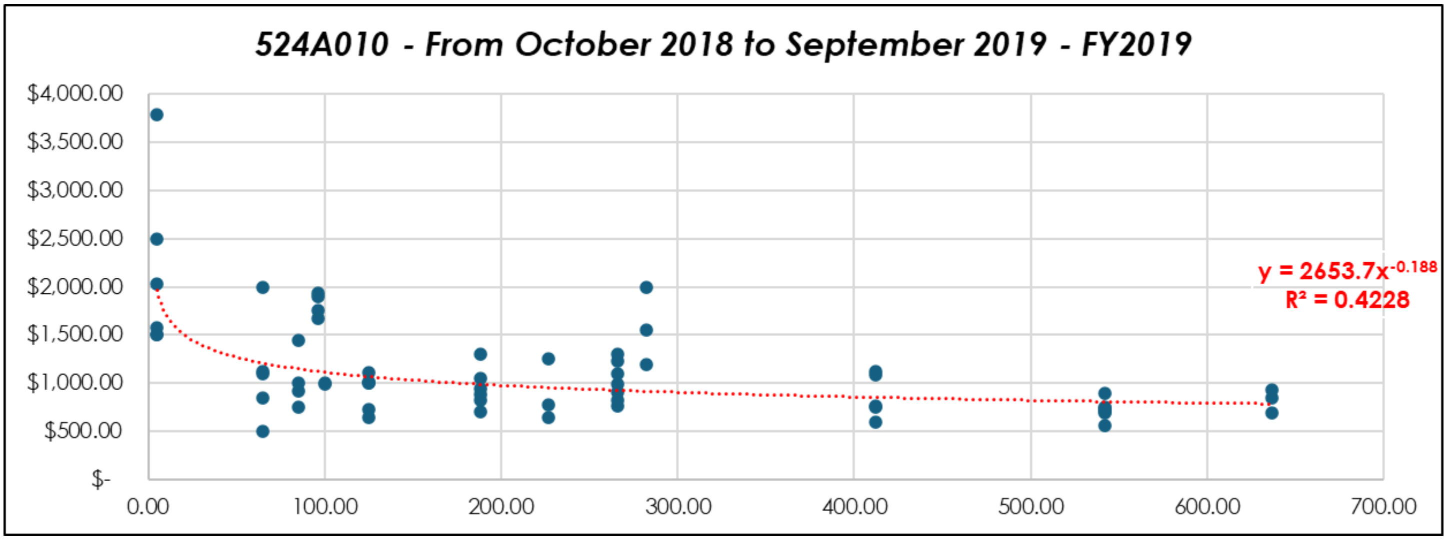
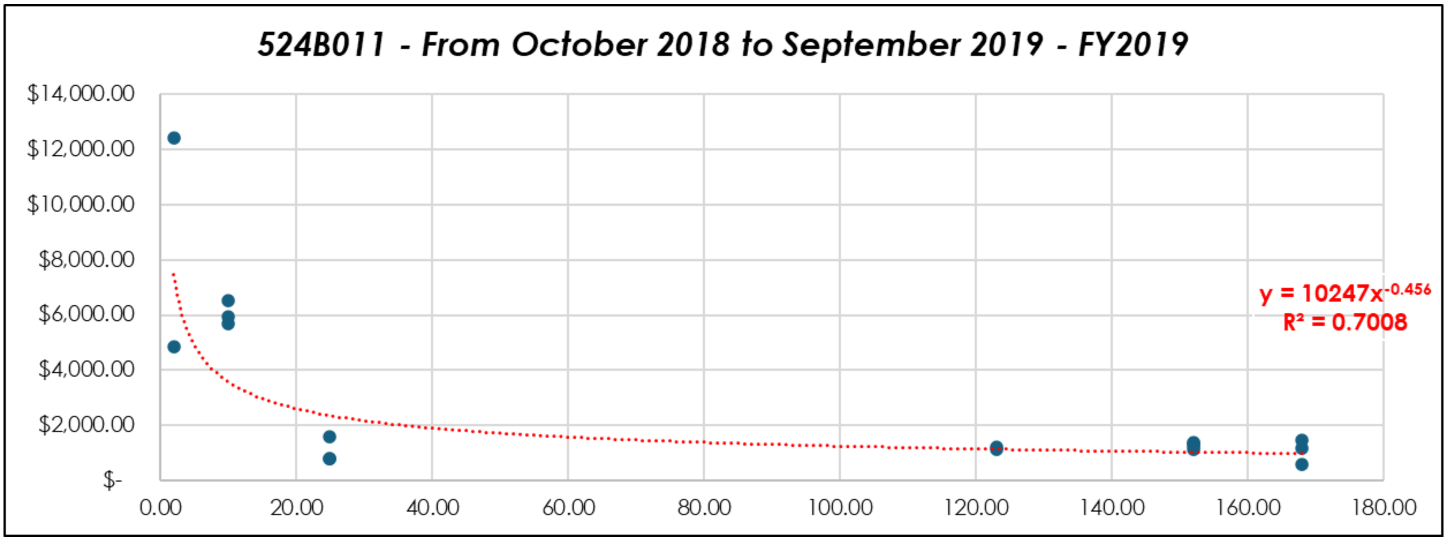
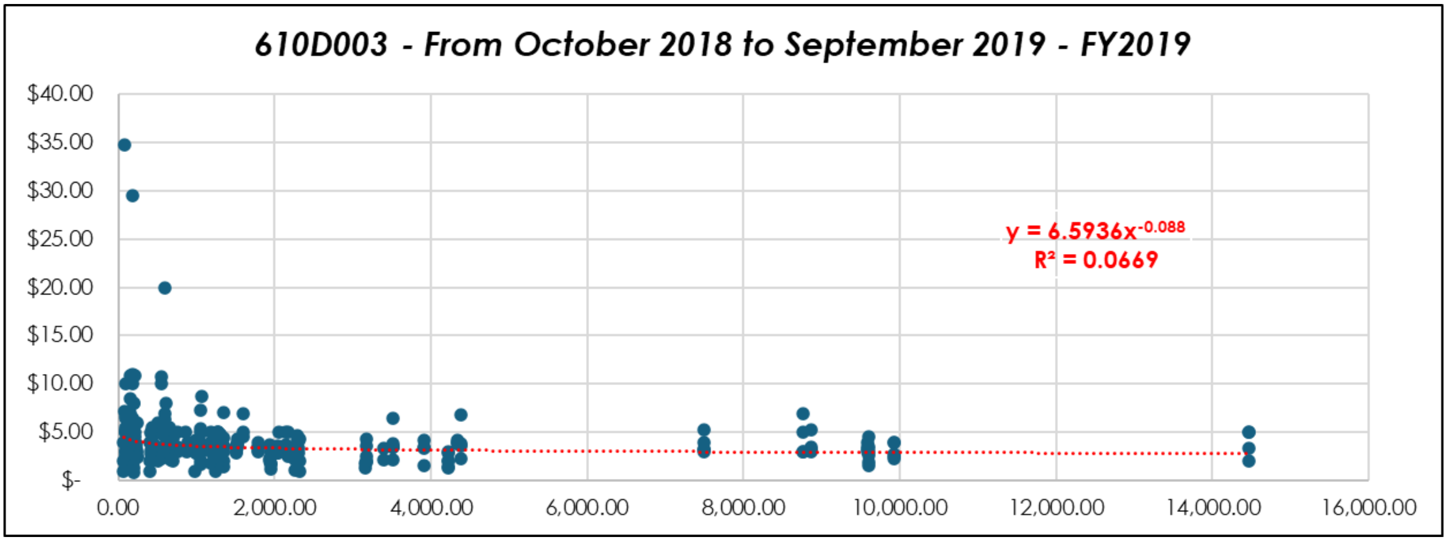
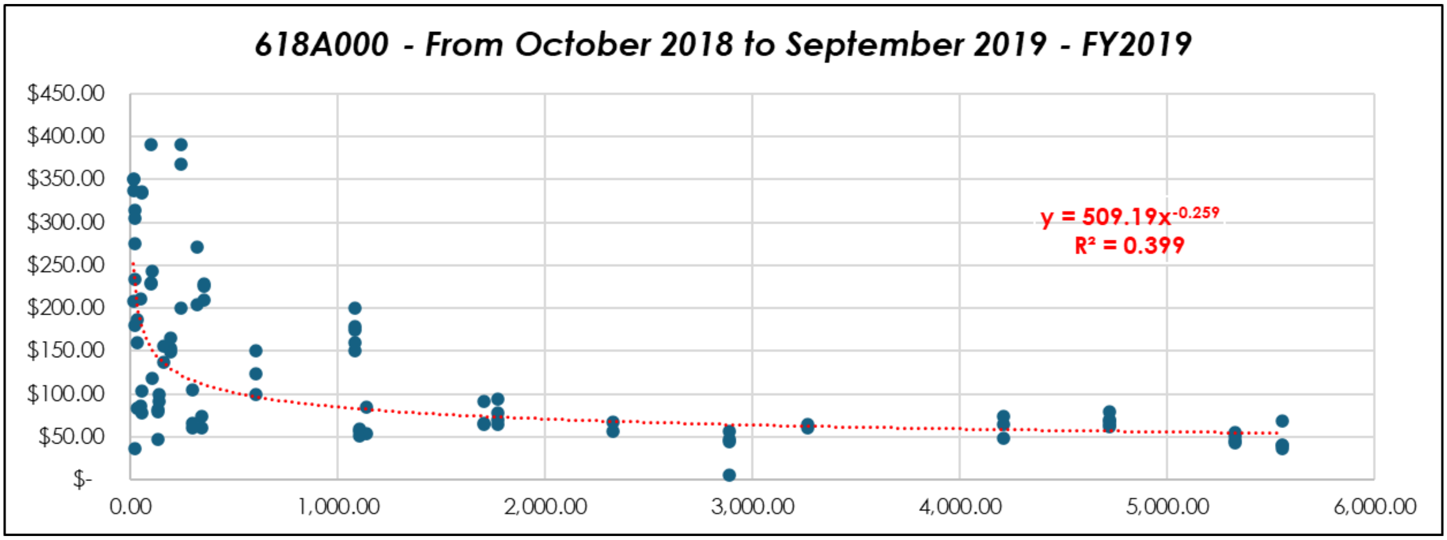
$4,000.00
$3,500.00
$3,000.00
$2,500.00
$2,000.00
$1,500.00
$1,000.00
$500.00
$-
0.00
100.00
200.00
300.00
400.00
500.00
600.00
700.00
y = 1418.2x-0.099
R² = 0.0621

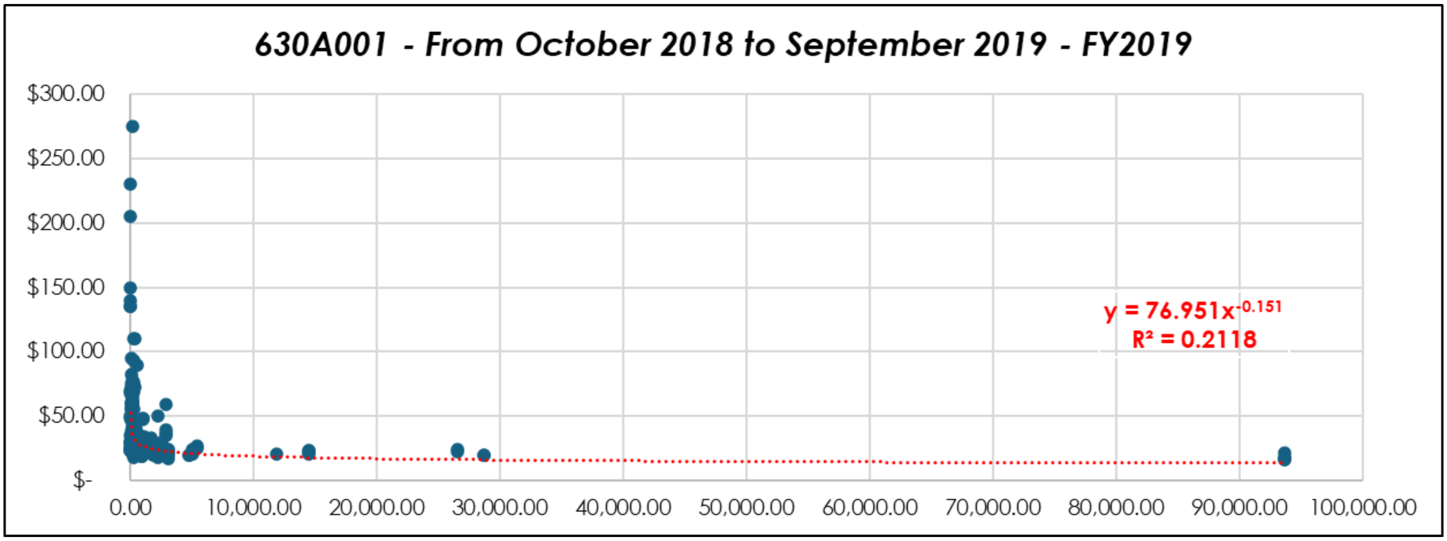

510E000 - From October 2018 to September 2019 - FY2019
$40.00
$35.00
$30.00
$25.00
$20.00
$15.00
$10.00
$5.00
$-
0.00
500.00
1,000.00
1,500.00
2,000.00
2,500.00
3,000.00
3,500.00
4,000.00
y = 530.89x-0.643
R² = 0.7358

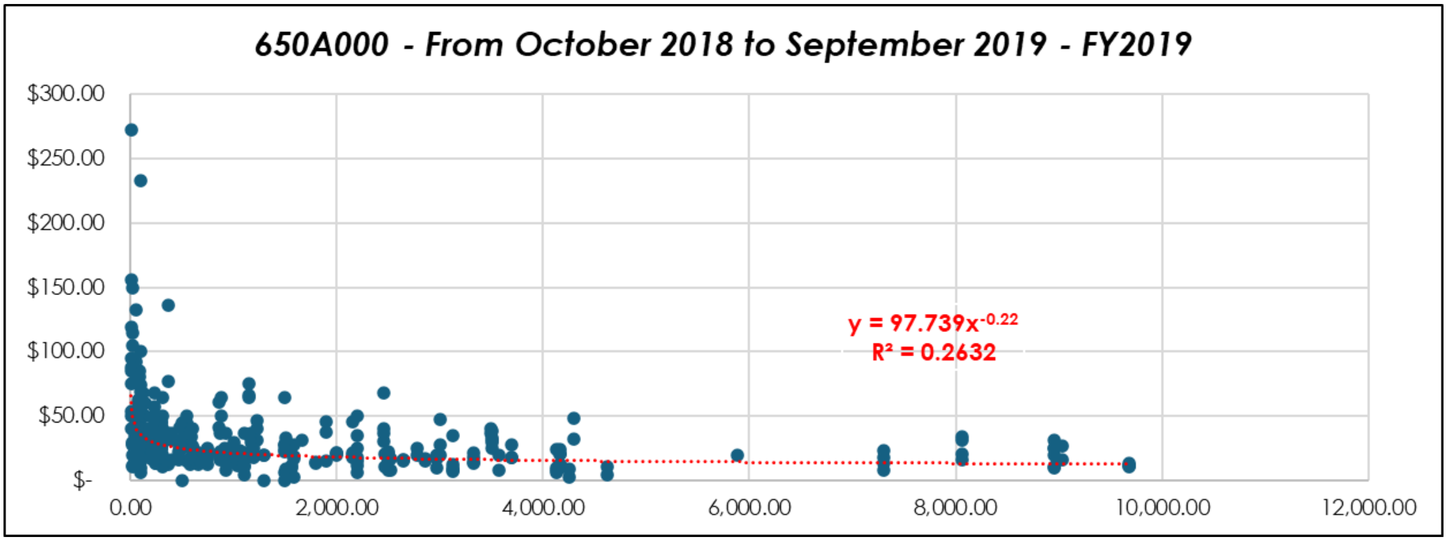

524A010 - From October 2018 to September 2019 - FY2019
$4,000.00
$3,500.00
$3,000.00
$2,500.00
$2,000.00
$1,500.00
$1,000.00
$500.00
$-
0.00
100.00
200.00
300.00
400.00
500.00
600.00
700.00
y = 2653.7x-0.188
R² = 0.4228

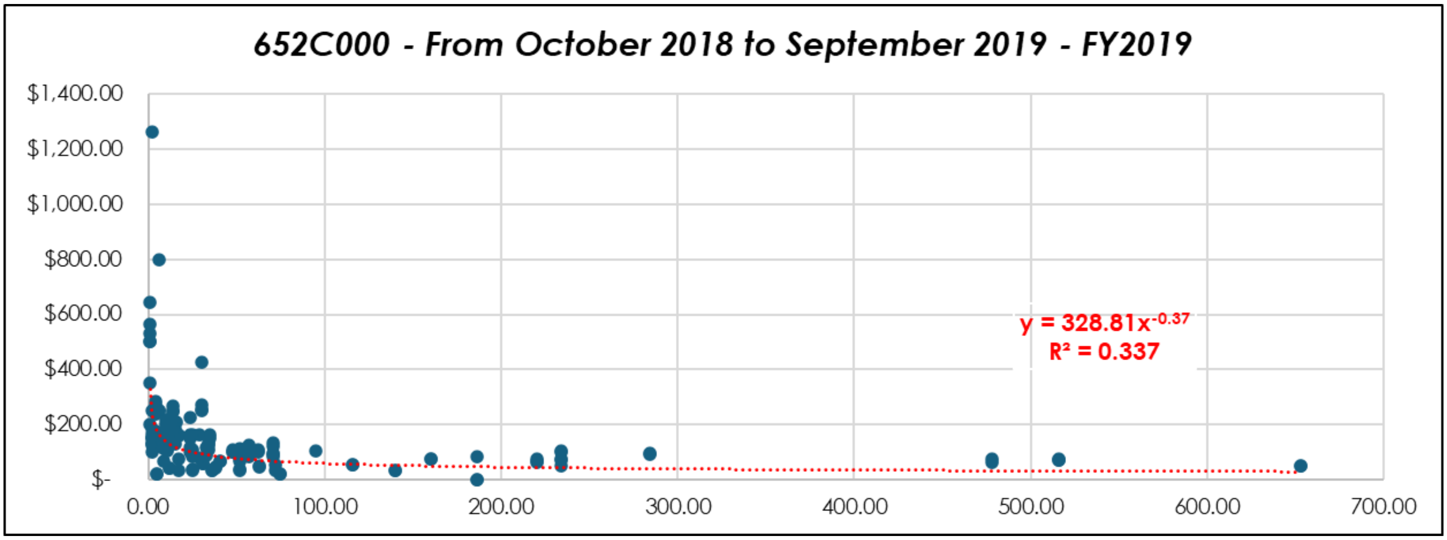

524B011 - From October 2018 to September 2019 - FY2019
$14,000.00
$12,000.00
$10,000.00
$8,000.00
$6,000.00
$4,000.00
$2,000.00
$-
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
y = 10247x-0.456
R² = 0.7008

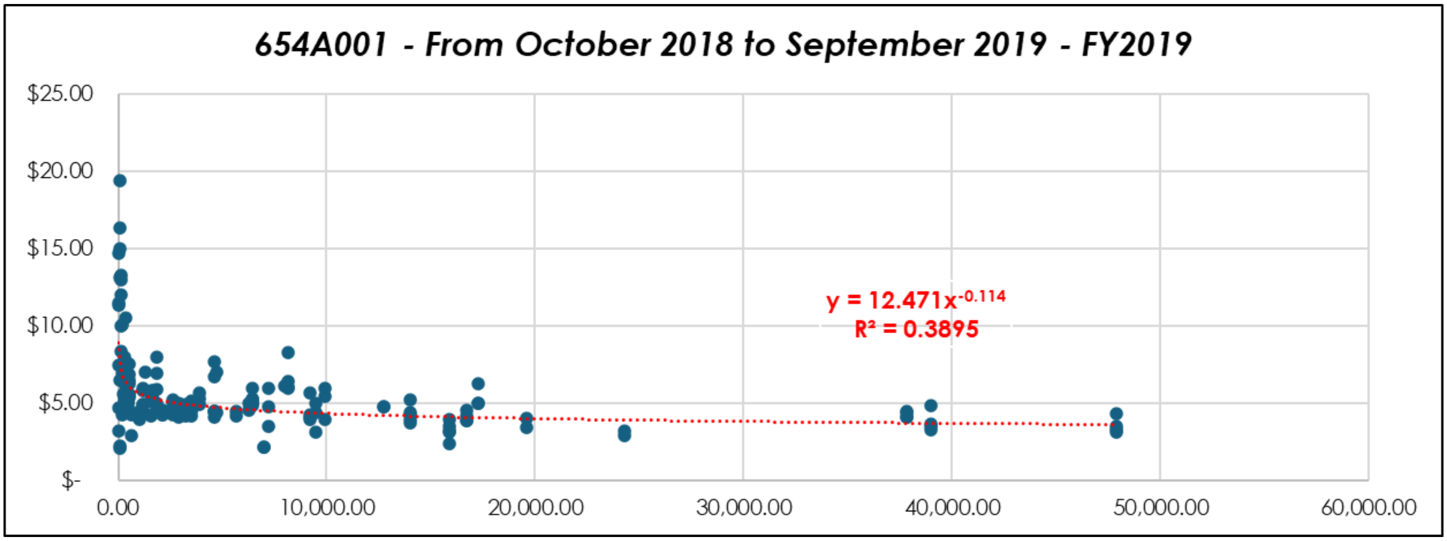

610D003 - From October 2018 to September 2019 - FY2019
$40.00
$35.00
$30.00
$25.00
$20.00
$15.00
$10.00
$5.00
$-
0.00
2,000.00
4,000.00
6,000.00
8,000.00
10,000.00
12,000.00
14,000.00
16,000.00
y = 6.5936x-0.088
R² = 0.0669

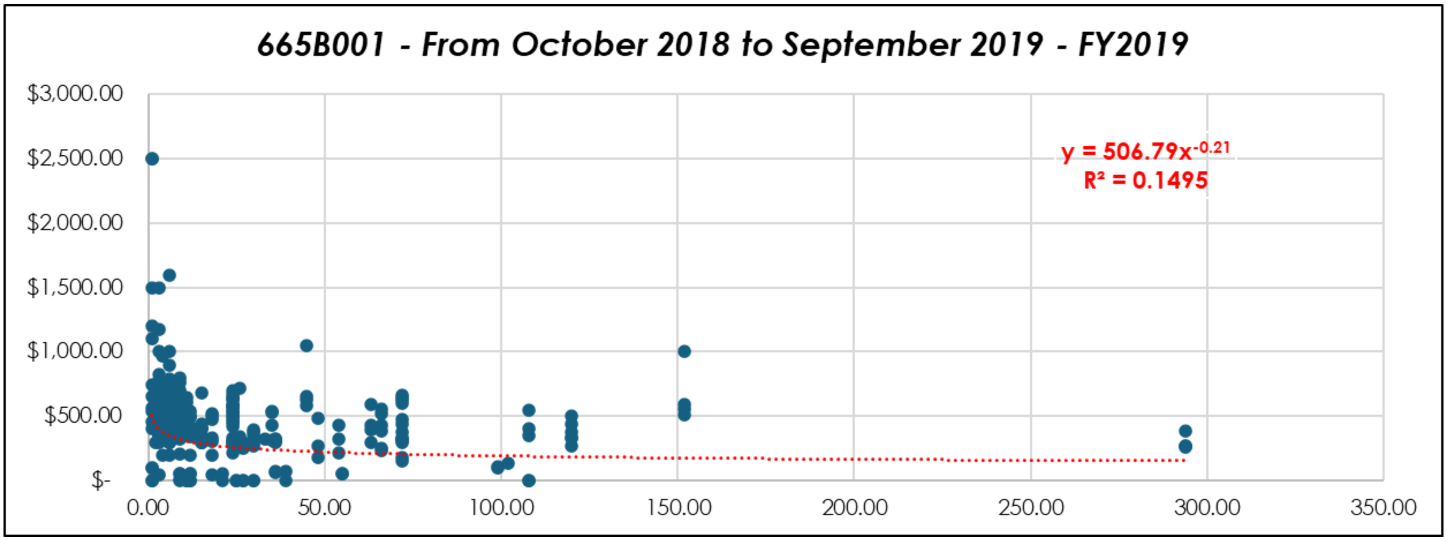

618A000 - From October 2018 to September 2019 - FY2019
$450.00
$400.00
$350.00
$300.00
$250.00
$200.00
$150.00
$100.00
$50.00
$-
0.00
1,000.00
2,000.00
3,000.00
4,000.00
5,000.00
6,000.00
y = 509.19x-0.259
R² = 0.399

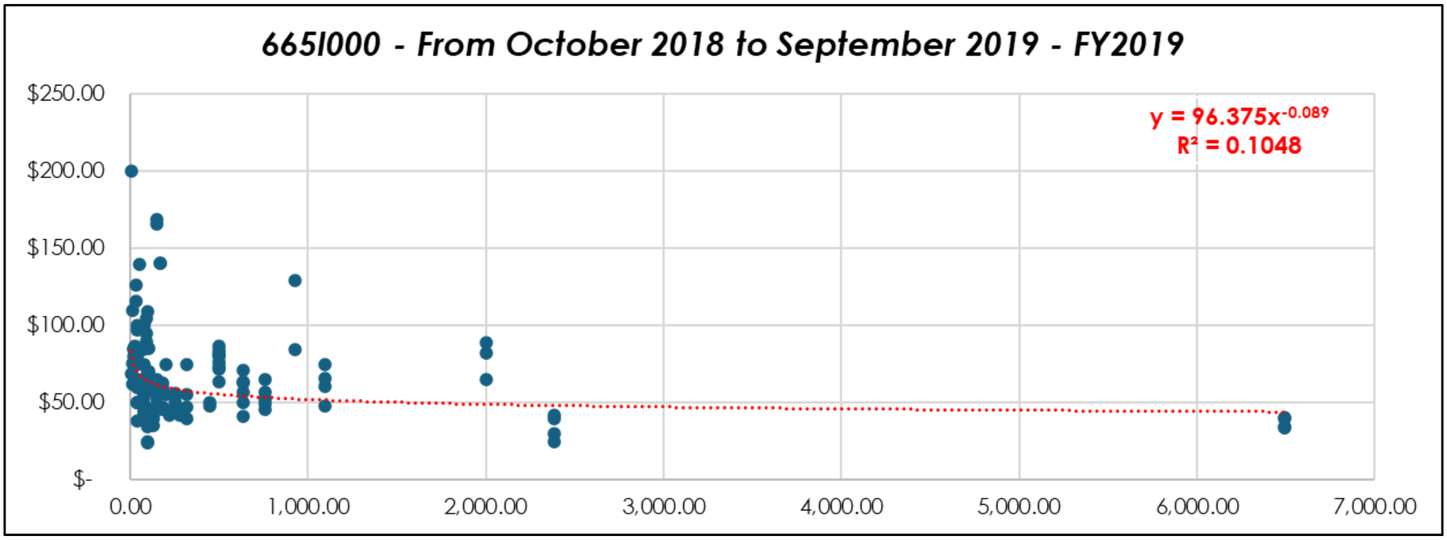

630A001 - From October 2018 to September 2019 - FY2019
$300.00
$250.00
$200.00
$150.00
$100.00
$50.00
$-
0.00
10,000.00
20,000.00
30,000.00
40,000.00
50,000.00
60,000.00
70,000.00
80,000.00
90,000.00
100,000.00
y = 76.951x-0.151
R² = 0.2118

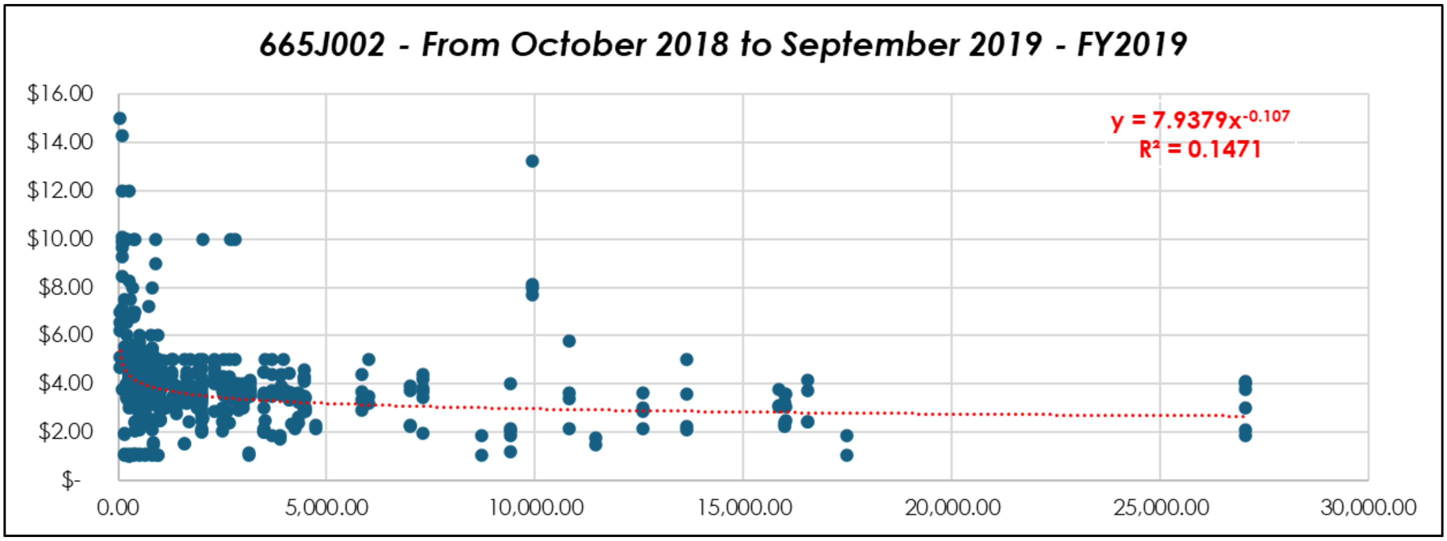

650A000 - From October 2018 to September 2019 - FY2019
$300.00
$250.00
$200.00
$150.00
$100.00
$50.00
$-
0.00
2,000.00
4,000.00
6,000.00
8,000.00
10,000.00
12,000.00
y = 97.739x-0.22
R² = 0.2632

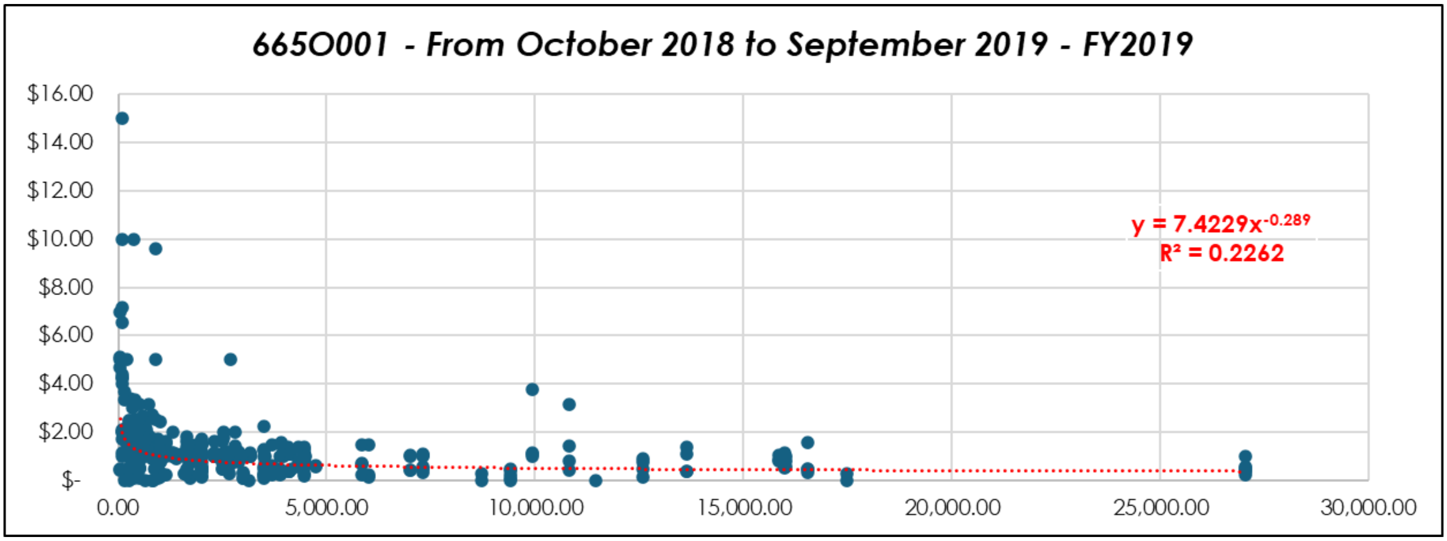

652C000 - From October 2018 to September 2019 - FY2019
$1,400.00
$1,200.00
$1,000.00
$800.00
$600.00
$400.00
$200.00
$-
0.00
100.00
200.00
300.00
400.00
500.00
600.00
700.00
y = 328.81x-0.37
R² = 0.337

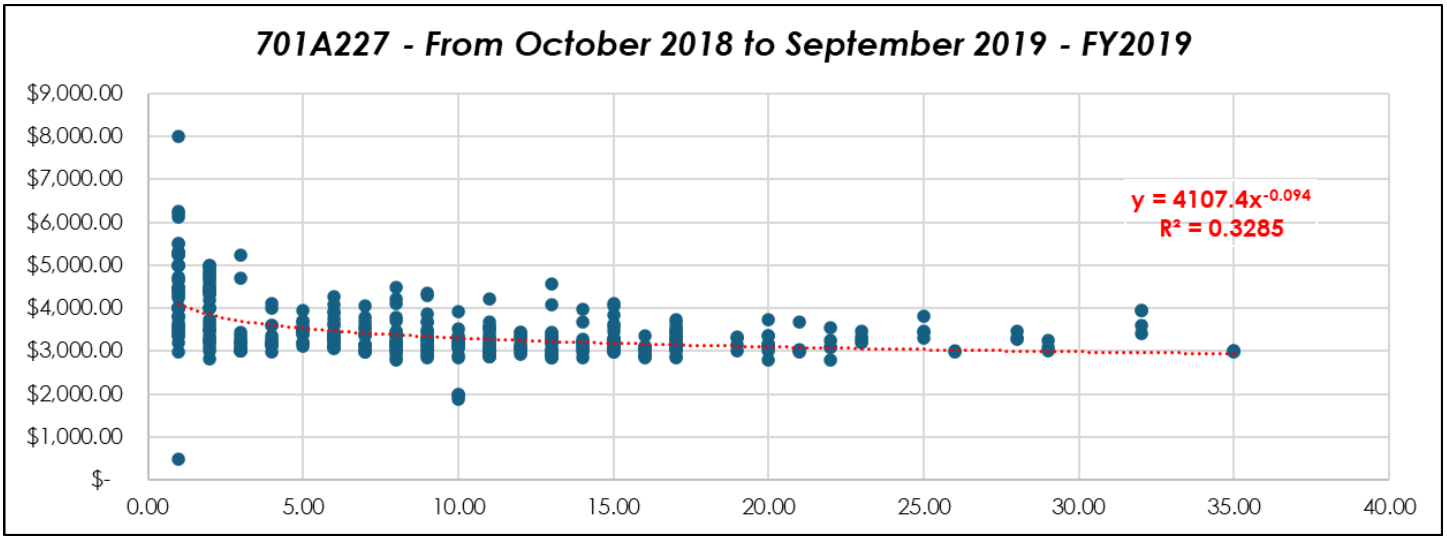

654A001 - From October 2018 to September 2019 - FY2019
$25.00
$20.00
$15.00
$10.00
$5.00
$-
0.00
10,000.00
20,000.00
30,000.00
40,000.00
50,000.00
60,000.00
y = 12.471x-0.114
R² = 0.3895

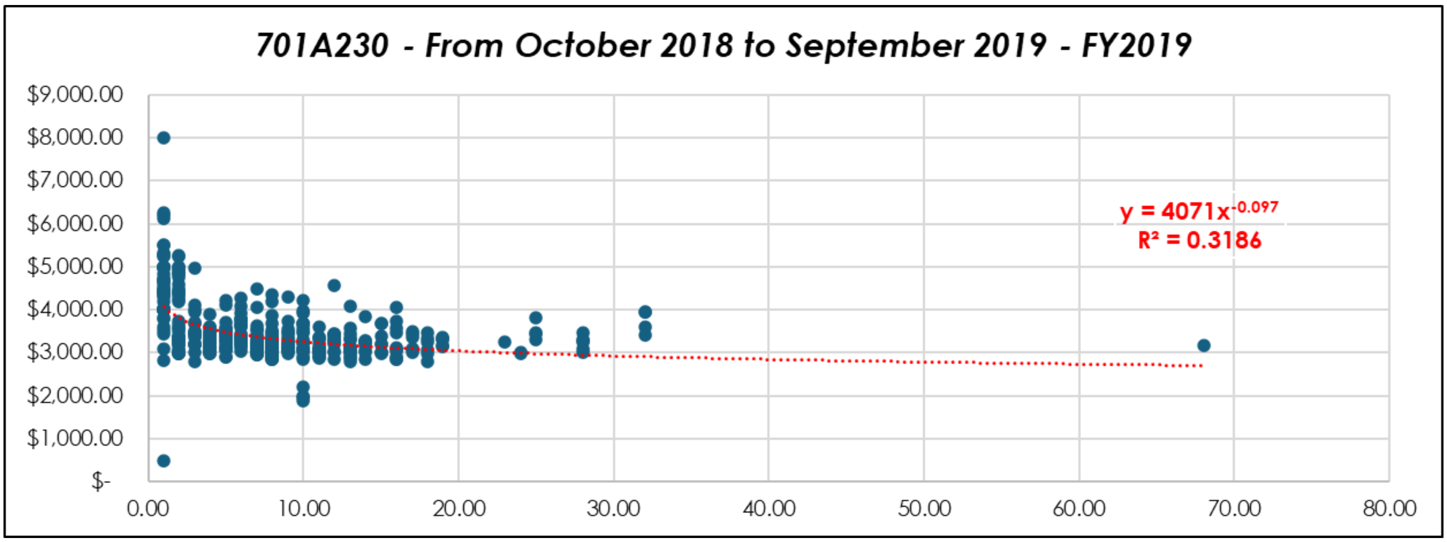

665B001 - From October 2018 to September 2019 - FY2019
$3,000.00
$2,500.00
$2,000.00
$1,500.00
$1,000.00
$500.00
$-
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
y = 506.79x-0.21
R² = 0.1495

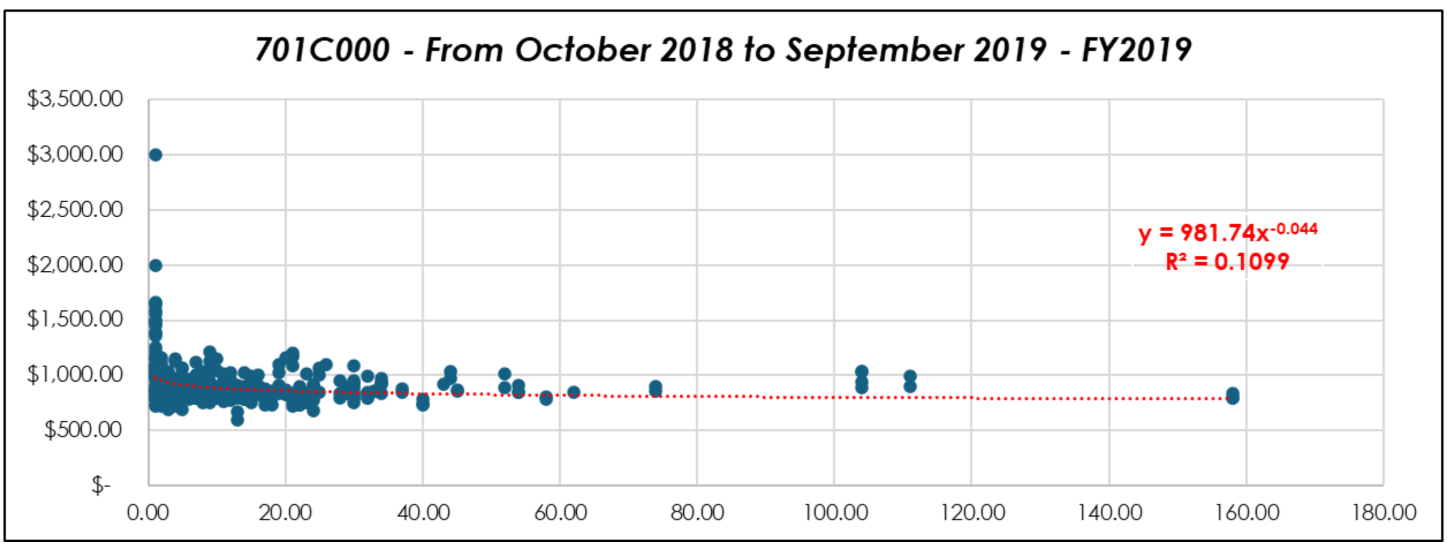

665I000 - From October 2018 to September 2019 - FY2019
y = 96.375x-0.089
R² = 0.1048
$250.00
$200.00
$150.00
$100.00
$50.00
$-
0.00
1,000.00
2,000.00
3,000.00
4,000.00
5,000.00
6,000.00
7,000.00

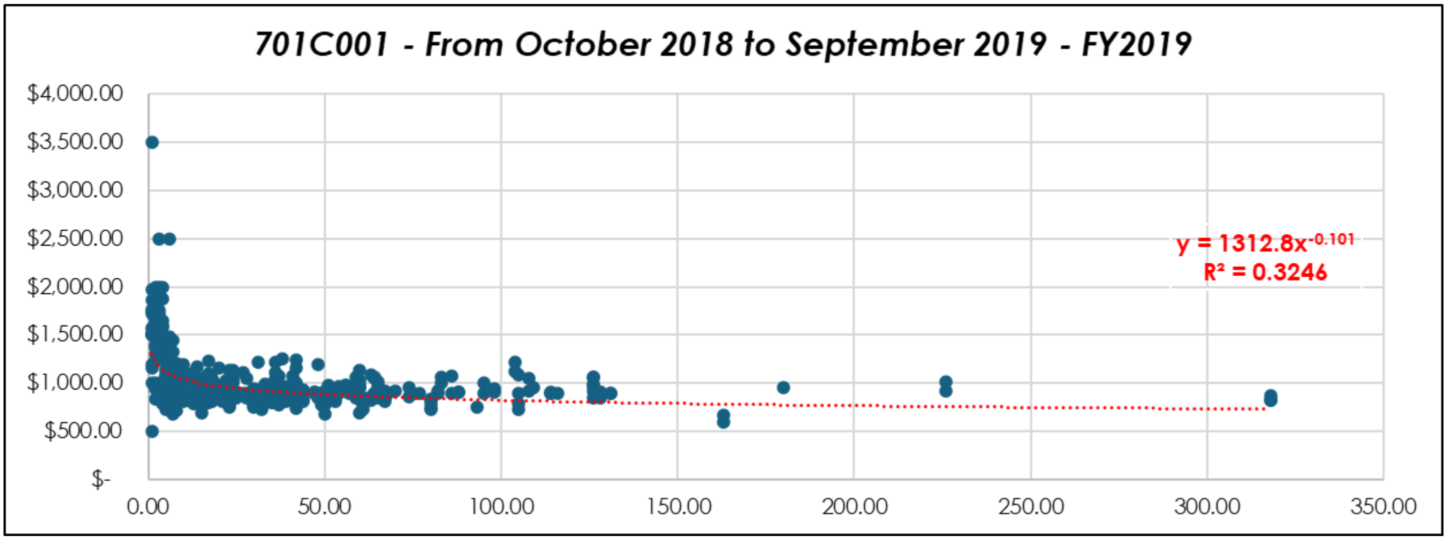

665J002 - From October 2018 to September 2019 - FY2019
y = 7.9379x-0.107
R² = 0.1471
$16.00
$14.00
$12.00
$10.00
$8.00
$6.00
$4.00
$2.00
$-
0.00
5,000.00
10,000.00
15,000.00
20,000.00
25,000.00
30,000.00


665O001 - From October 2018 to September 2019 - FY2019
y = 7.4229x-0.289
R² = 0.2262
$16.00
$14.00
$12.00
$10.00
$8.00
$6.00
$4.00
$2.00
$-
0.00
5,000.00
10,000.00
15,000.00
20,000.00
25,000.00
30,000.00

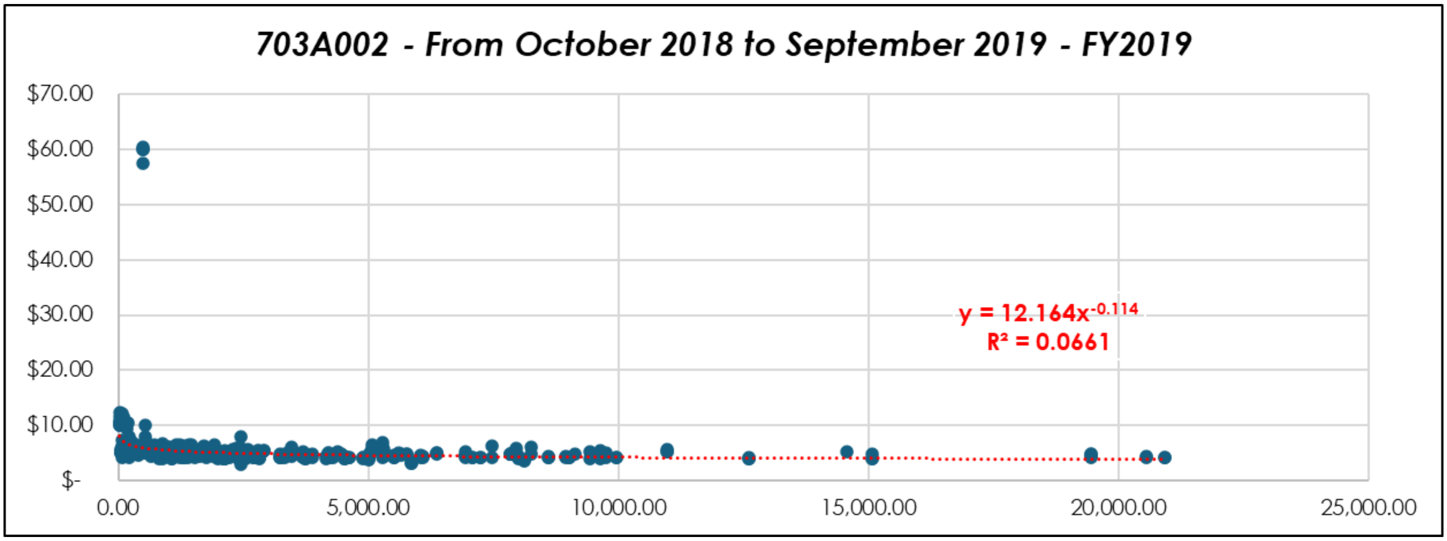

701A227 - From October 2018 to September 2019 - FY2019
$9,000.00
$8,000.00
$7,000.00
$6,000.00
$5,000.00
$4,000.00
$3,000.00
$2,000.00
$1,000.00
$-
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
y = 4107.4x-0.094
R² = 0.3285


701A230 - From October 2018 to September 2019 - FY2019
$9,000.00
$8,000.00
$7,000.00
$6,000.00
$5,000.00
$4,000.00
$3,000.00
$2,000.00
$1,000.00
$-
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
y = 4071x-0.097
R² = 0.3186

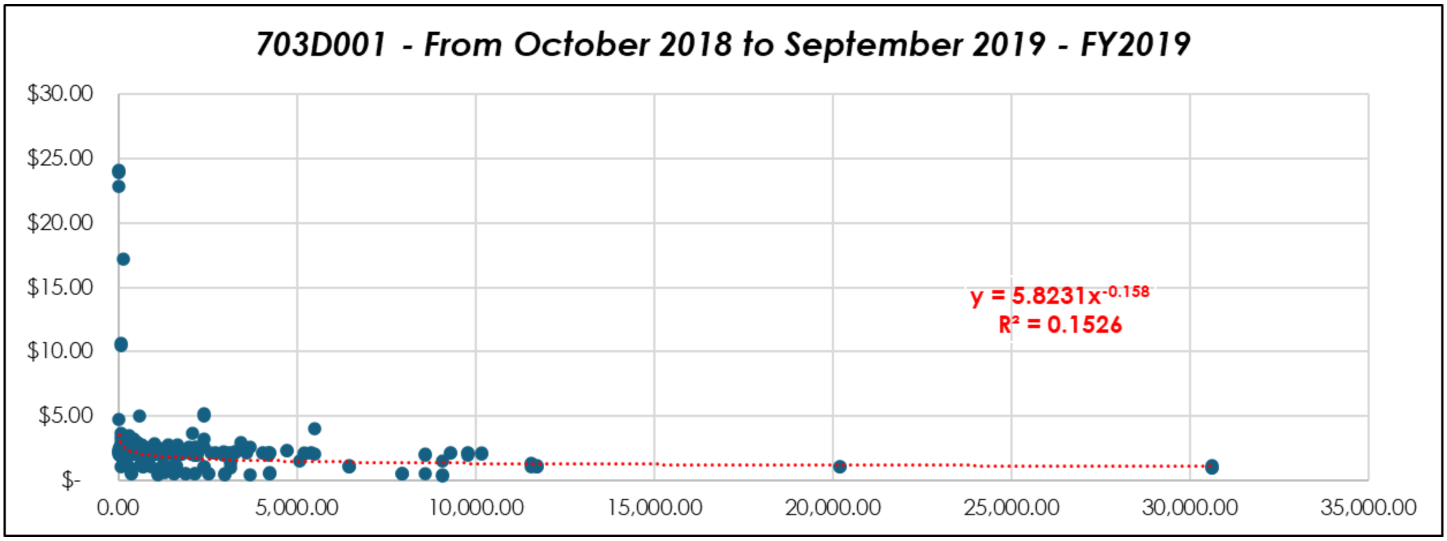

701C000 - From October 2018 to September 2019 - FY2019
$3,500.00
$3,000.00
$2,500.00
$2,000.00
$1,500.00
$1,000.00
$500.00
$-
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
180.00
y = 981.74x-0.044
R² = 0.1099



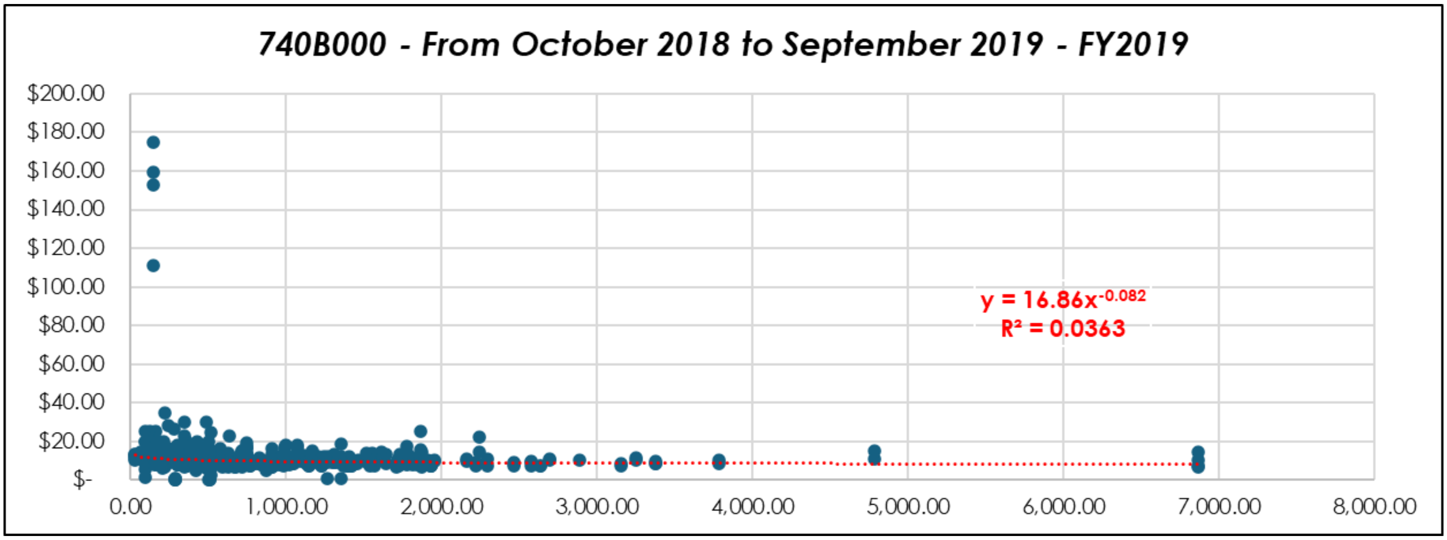
701C001 - From October 2018 to September 2019 - FY2019
$4,000.00
$3,500.00
$3,000.00
$2,500.00
$2,000.00
$1,500.00
$1,000.00
$500.00
$-
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
y = 1312.8x-0.101
R² = 0.3246



703A002 - From October 2018 to September 2019 - FY2019
$70.00
$60.00
$50.00
$40.00
$30.00
$20.00
$10.00
$-
0.00
5,000.00
10,000.00
15,000.00
20,000.00
25,000.00
y = 12.164x-0.114
R² = 0.0661



703D001 - From October 2018 to September 2019 - FY2019
$30.00
$25.00
$20.00
$15.00
$10.00
$5.00
$-
0.00
5,000.00
10,000.00
15,000.00
20,000.00
25,000.00
30,000.00
35,000.00
y = 5.8231x-0.158
R² = 0.1526



APPENDIX C: Index Hierarchical Structure by Levels

Pay Item Level	Sub-Division Level	Division Level	Division Level
206C000	206	2	**ALDOT_CCI**
206C001			
206C002			
206C003			
206C010			
206D000			
206D001			
206D002			
206D003			
206D005			
206D011			
210A000	210		
210D001			
210D011			
210D021			
212A000	212		
214A000	214		
214B001			
230A000	230		
301A012	301	3	
305B077	305		
305B078			
401A000	401	4	

Pay Item Level	Sub-Division Level	Division Level	Division Level
401B100			
401B108			
405A000	405		
408A051			
408A052			
408A053	408		
408A054			
408B000			
408B001			
424A340			
424A360	424		
424A369			
424B650			
430B043	430		
502A000	502		
508A000	508		
510A007	510	5	
510E000			
524A010	524		
524B011			
610D003	610		
618A000	618		
630A001	630		
650A000	650		
652C000	652	6	
654A001	654		
665B001			
665I000	665		
665J002			**ALDOT_CCI**
665O001			
701A227			
701A230	701		
701C000			
701C001		7	
703A002	703		
703D001			
740B000	740		

APPENDIX D: Pay Item Level Indices

Pay Item	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
206C000	0.892	0.997	0.996	1.056	1.381	1.362
206C002	1.054	1.042	1.488	1.404	1.698	2.637
206C003	1.310	1.083	0.765	1.493	1.661	1.551
206C010	0.899	0.975	0.890	0.906	1.129	1.309
206D000	0.981	1.059	1.101	1.112	1.391	1.744
206D001	0.852	0.960	0.950	0.945	1.189	1.013
206D002	1.036	1.036	1.096	1.275	1.386	1.623
206D003	0.818	1.119	1.047	1.217	1.907	1.781
206D005	1.006	1.058	1.408	1.749	1.283	1.469
206D011	1.269	1.045	0.953	1.380	1.754	1.852
210A000	0.886	1.025	1.148	1.127	1.502	1.718
210D001	0.862	1.100	1.240	1.032	1.384	1.652
210D011	0.848	0.961	0.847	1.240	1.373	1.430
210D021	0.856	1.005	1.029	1.053	1.234	1.527
212A000	0.967	1.048	1.086	0.929	1.147	1.339
214A000	0.964	1.018	0.856	1.011	1.193	1.303
214B001	0.972	1.030	0.992	1.071	1.303	1.365
301A012	1.016	1.025	1.070	1.237	1.495	1.601
305B077	0.926	0.999	1.033	0.987	1.299	1.429
305B078	0.964	0.976	0.946	0.938	1.663	1.491
401A000	0.933	0.987	0.944	0.876	1.190	0.951
401B100	1.060	1.167	1.355	1.356	1.745	1.493

Pay Item	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
401B108	0.890	1.010	1.020	1.095	1.174	1.387
405A000	0.911	0.995	0.966	0.997	1.113	1.176
408A051	0.956	1.102	0.564	0.750	1.255	0.811
408A052	0.971	1.047	0.965	1.009	1.381	1.539
408A053	1.230	1.885	1.121	1.318	1.695	1.488
408A054	0.662	1.008	0.883	0.897	1.046	1.164
408B000	0.937	1.003	0.863	0.885	1.150	0.999
408B001	0.863	1.026	0.973	1.097	1.230	1.136
424A340	0.897	1.009	0.979	1.018	1.193	1.198
424A360	0.896	1.009	0.966	0.990	1.196	1.280
424A369	0.867	0.977	0.964	0.936	1.140	1.172
424B650	0.848	1.004	0.996	1.036	1.141	1.133
430B043	0.922	1.002	1.011	1.143	1.354	1.320
502A000	1.046	1.090	1.052	1.291	1.699	1.658
508A000	1.070	0.994	1.106	1.183	1.449	1.688
510A007	1.037	1.021	1.108	1.948	1.652	2.812
510E000	1.205	1.110	1.444	1.255	1.464	1.365
524A010	0.784	0.956	0.853	0.960	1.155	1.289
524B011	0.456	0.753	0.790	0.791	1.478	0.839
610D003	1.004	1.016	0.987	1.141	1.364	1.433
618A000	0.915	1.018	1.023	0.808	1.012	1.054
630A001	0.970	1.043	0.975	1.072	1.453	1.294
650A000	0.937	1.005	1.065	1.114	1.389	1.454
652C000	0.967	0.987	1.044	1.061	1.176	1.421
654A001	1.160	1.061	1.122	1.125	1.330	1.652
665B001	0.859	1.001	1.025	1.039	1.173	1.560
665I000	0.983	1.001	0.989	1.075	1.311	1.220
665J002	0.990	1.000	1.018	1.004	1.064	1.317
665O001	0.934	1.001	1.100	1.079	1.179	1.345
701A227	0.983	1.012	1.027	1.052	1.224	1.282
701A230	0.973	1.012	1.021	1.050	1.199	1.272
701C000	0.975	1.010	1.033	1.083	1.330	1.254
701C001	0.973	1.019	1.062	1.105	1.189	1.379
703A002	0.974	1.003	1.059	1.123	1.234	1.298
703D001	0.983	1.004	1.085	1.134	1.104	1.147
740B000	0.728	0.978	0.878	0.775	0.784	0.748

APPENDIX E: Taxpayers’ Financial Capacity Index

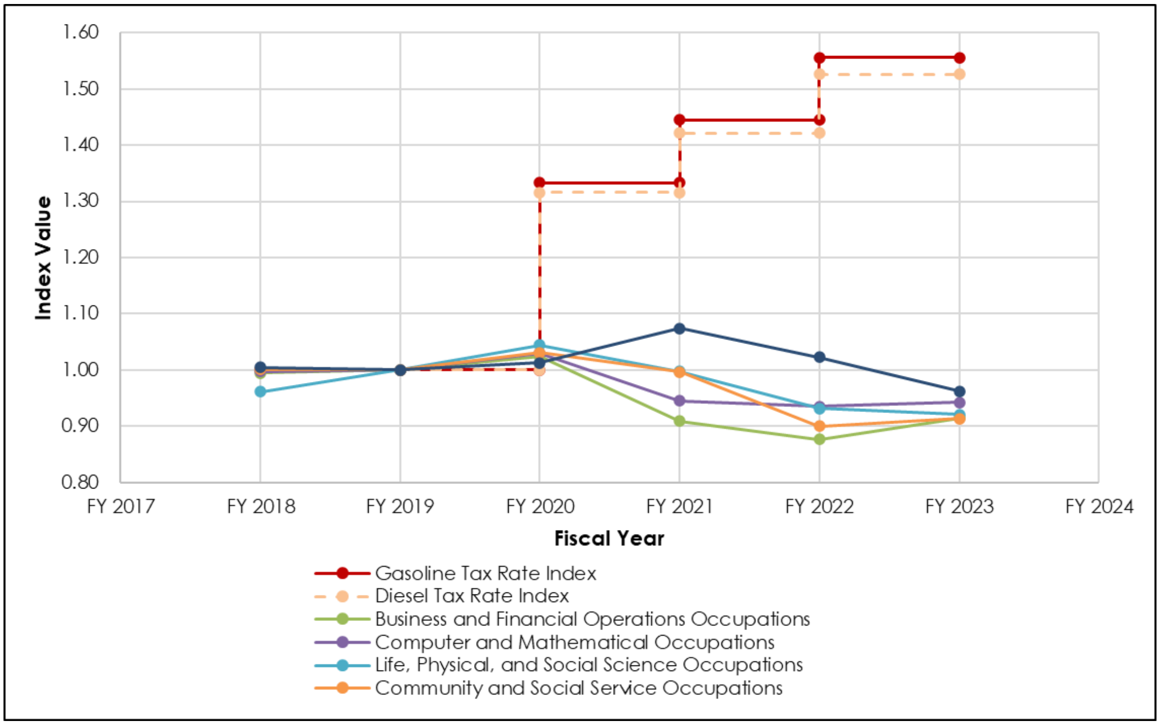
Table 7-2. TAXPAYERS’ FINANCIAL CAPACITY INDEX (TFCI)

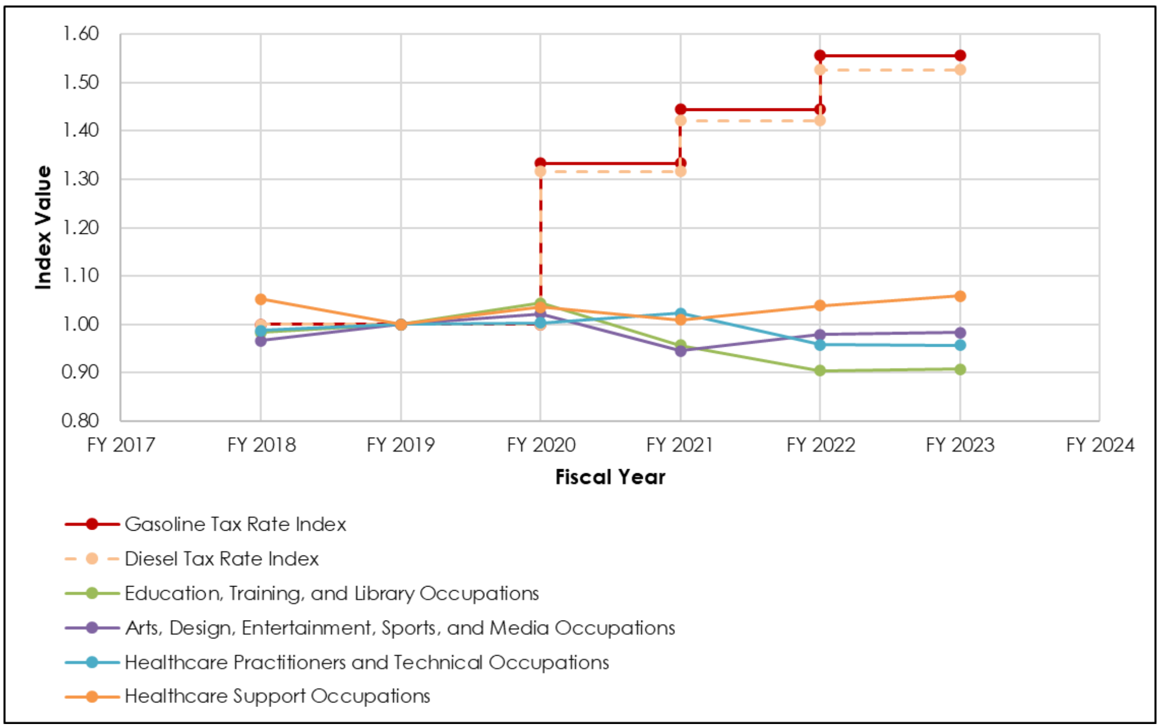
CODE	TITLE	2,003	2,004	2,005	2,006	2,007	2,008	2,009	2,010	2,011	2,012	2,013	2,014	2,015	2,016	2,017	2,018	2,019	2,020	2,021	2,022	2,023
00-0000	All Occupations	0.961	0.952	0.951	0.944	0.965	0.956	0.999	0.997	0.972	0.959	0.960	0.954	0.976	0.983	0.986	0.973	1.000	1.049	1.007	0.966	0.993
11-0000	Management Occupations	0.938	0.954	0.948	0.949	0.969	0.965	1.008	1.044	1.064	1.069	1.087	1.075	1.098	1.091	1.084	1.025	1.000	1.023	0.951	0.895	0.890
13-0000	Business and Financial Operations Occupations	0.974	0.952	0.955	0.983	0.990	0.974	1.021	1.033	1.032	1.027	1.034	1.023	1.036	1.030	1.029	0.994	1.000	1.025	0.909	0.877	0.914
15-0000	Computer and Mathematical Occupations	0.986	0.964	0.944	0.954	0.979	0.963	1.009	1.005	0.970	0.966	0.983	0.993	1.014	1.014	1.021	0.997	1.000	1.030	0.946	0.935	0.943
17-0000	Architecture and Engineering Occupations	0.915	0.911	0.934	0.924	0.952	0.943	0.978	0.994	0.984	0.991	1.004	1.012	1.045	1.038	1.043	0.988	1.000	1.014	0.925	0.911	0.954
19-0000	Life, Physical, and Social Science Occupations	0.992	0.990	0.991	0.979	0.987	0.985	0.997	0.986	0.997	0.988	0.952	0.944	0.989	1.034	1.006	0.961	1.000	1.045	0.997	0.932	0.921
21-0000	Community and Social Service Occupations	0.933	0.955	0.981	0.993	1.025	1.015	1.059	1.037	1.015	1.008	0.998	0.980	1.025	1.014	1.023	1.001	1.000	1.031	0.997	0.900	0.913
23-0000	Legal Occupations	1.074	1.145	1.145	1.283	1.210	1.213	1.189	1.149	1.086	1.068	1.054	1.060	1.052	1.050	1.047	1.005	1.000	1.013	1.074	1.023	0.962
25-0000	Education, Training, and Library Occupations	1.024	0.999	0.965	0.960	0.997	1.010	1.071	1.063	1.035	1.010	0.990	0.983	0.995	0.996	0.990	0.983	1.000	1.044	0.957	0.904	0.908
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	0.975	0.958	0.963	0.955	1.024	1.013	1.069	0.996	0.892	0.860	0.934	0.971	0.985	0.919	0.979	0.967	1.000	1.022	0.946	0.979	0.983
29-0000	Healthcare Practitioners and Technical Occupations	0.948	0.948	0.973	0.983	1.020	1.005	1.044	1.028	1.000	0.998	0.993	0.983	1.003	1.007	1.008	0.988	1.000	1.003	1.024	0.958	0.957
31-0000	Healthcare Support Occupations	1.026	1.006	0.990	1.000	1.027	1.022	1.051	1.057	1.040	1.041	1.039	1.038	1.051	1.064	1.065	1.053	1.000	1.035	1.009	1.039	1.059
33-0000	Protective Service Occupations	0.972	0.943	0.932	0.922	0.947	0.933	1.002	0.992	0.983	0.986	0.990	0.957	0.979	0.969	0.978	0.975	1.000	1.027	0.973	0.865	0.903
35-0000	Food Preparation and Serving Related Occupations	0.986	0.961	0.933	0.921	0.931	0.945	1.008	1.067	1.062	1.043	1.034	1.014	1.027	1.035	1.030	0.995	1.000	1.014	1.008	1.018	1.050

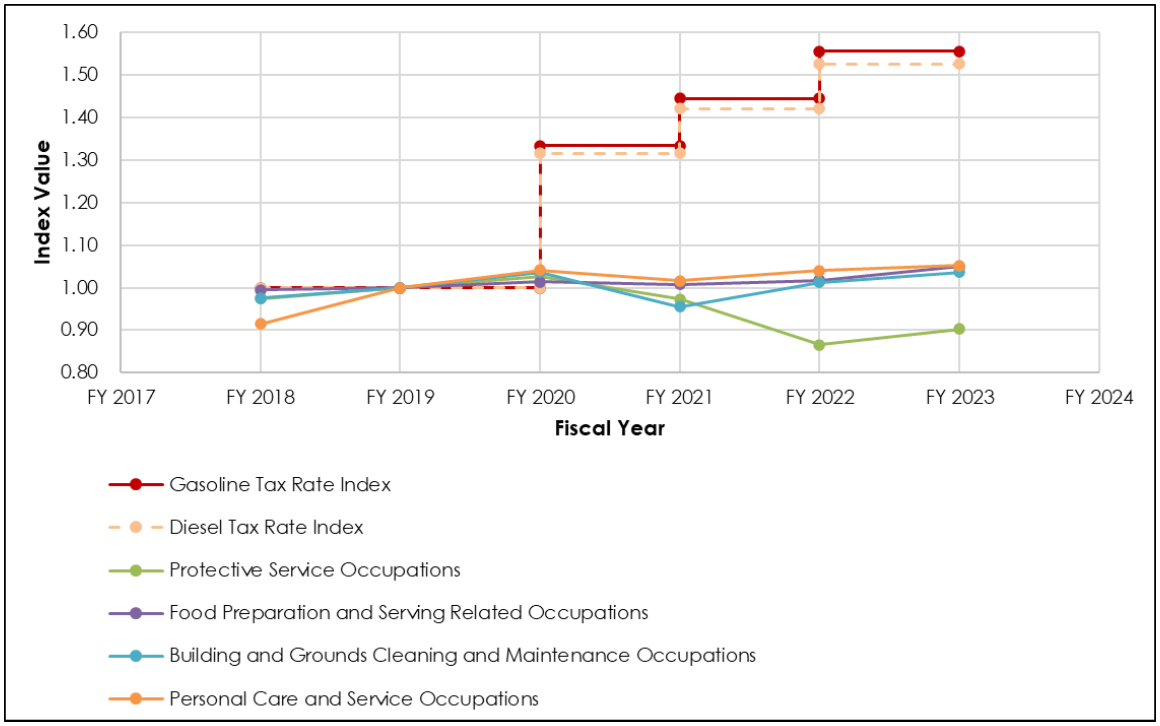
Table 7-2. TAXPAYERS' FINANCIAL CAPACITY INDEX (TFCI)

CODE	TITLE	2,003	2,004	2,005	2,006	2,007	2,008	2,009	2,010	2,011	2,012	2,013	2,014	2,015	2,016	2,017	2,018	2,019	2,020	2,021	2,022	2,023
37-0000	Building and Grounds Cleaning and Maintenance Occupations	0.951	0.953	0.933	0.930	0.941	0.936	0.971	0.958	0.943	0.922	0.923	0.916	0.946	0.974	0.988	0.975	1.000	1.037	0.955	1.013	1.037
39-0000	Personal Care and Service Occupations	0.970	0.946	0.944	0.936	0.950	0.954	0.993	0.995	0.975	0.957	0.945	0.927	0.939	0.938	0.932	0.915	1.000	1.042	1.016	1.040	1.052
41-0000	Sales and Related Occupations	1.002	1.006	1.010	1.004	0.999	0.968	0.988	0.987	0.977	0.960	0.957	0.954	0.966	0.991	0.987	0.973	1.000	1.059	1.062	1.007	1.035
43-0000	Office and Administrative Support Occupations	0.933	0.930	0.933	0.917	0.926	0.915	0.957	0.955	0.942	0.935	0.937	0.930	0.958	0.969	0.970	0.954	1.000	1.034	1.009	0.940	0.936
45-0000	Farming, Fishing, and Forestry Occupations	1.031	1.078	1.038	1.038	1.067	1.056	1.070	1.108	1.144	1.106	1.115	1.033	1.036	1.085	1.105	1.055	1.000	1.029	1.013	1.024	1.054
47-0000	Construction and Extraction Occupations	0.943	0.930	0.914	0.902	0.907	0.914	0.939	0.944	0.934	0.943	0.957	0.956	0.975	0.987	0.991	0.989	1.000	1.014	0.908	0.897	0.973
49-0000	Installation, Maintenance, and Repair Occupations	0.955	0.960	0.954	0.938	0.956	0.965	1.003	1.008	0.996	0.984	0.989	0.979	1.014	1.004	1.010	0.979	1.000	1.035	1.002	0.961	0.942
51-0000	Production Occupations	1.010	0.966	0.953	0.936	0.974	0.976	1.031	1.032	0.991	0.983	0.978	0.996	1.008	1.016	0.993	0.986	1.000	1.058	1.057	1.003	1.001
53-0000	Transportation and Material Moving Occupations	1.004	1.009	1.004	0.996	1.002	1.001	1.041	1.037	1.004	0.984	0.987	0.993	1.004	0.997	1.014	1.004	1.000	1.042	0.975	1.036	1.047

APPENDIX F: TFCI Vs Fuel Tax Rate Index






1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
Index Value
FY 2017
FY 2018
FY 2019
FY 2020
FY 2021
FY 2022
FY 2023
FY 2024
Fiscal Year
Gasoline Tax Rate Index
Diesel Tax Rate Index
Protective Service Occupations
Food Preparation and Serving Related Occupations
Building and Grounds Cleaning and Maintenance Occupations
Personal Care and Service Occupations

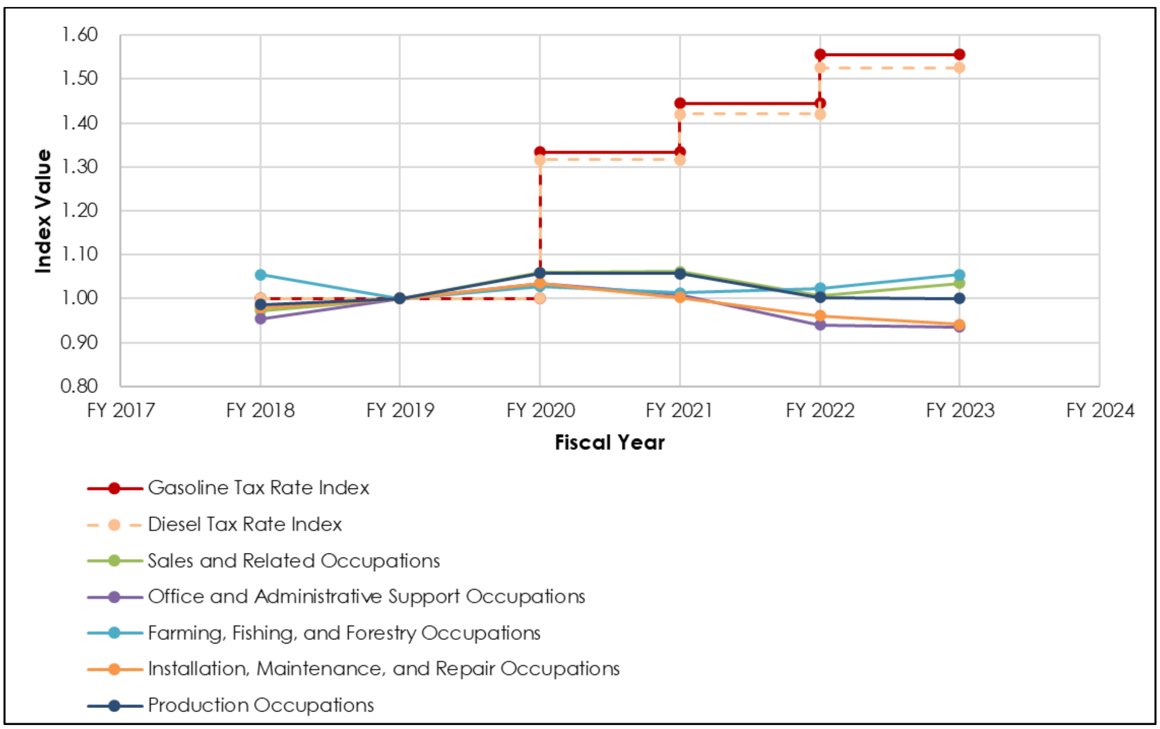

1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
Index Value
FY 2017
FY 2018
FY 2019
FY 2020
FY 2021
FY 2022
FY 2023
FY 2024
Fiscal Year
Gasoline Tax Rate Index
Diesel Tax Rate Index
Sales and Related Occupations
Office and Administrative Support Occupations
Farming, Fishing, and Forestry Occupations
Installation, Maintenance, and Repair Occupations
Production Occupations

Table 7-3. Business & Financial Occupations Vs GTRI Analysis

$TFCI_{13\text{-}0000}$	95.0%		80.0%		50.0%		Median
	2.5th %tile	97.5th %tile	10th %tile	90th %tile	25th %tile	75th %tile	50th %tile
FY 2,024	0.547	0.589	0.555	0.581	0.562	0.574	0.568
FY 2,025	0.539	0.599	0.550	0.587	0.559	0.578	0.568
FY 2,026	0.517	0.695	0.529	0.621	0.540	0.575	0.554
FY 2,027	0.513	0.697	0.527	0.622	0.539	0.578	0.555
FY 2,028	0.493	0.732	0.509	0.646	0.525	0.587	0.546
FY 2,029	0.489	0.730	0.507	0.647	0.524	0.588	0.548
FY 2,030	0.473	0.773	0.492	0.661	0.512	0.593	0.542
FY 2,031	0.471	0.776	0.491	0.662	0.512	0.595	0.544
FY 2,032	0.456	0.788	0.478	0.673	0.502	0.598	0.539
FY 2,033	0.455	0.789	0.478	0.674	0.503	0.599	0.540
FY 2,034	0.442	0.805	0.466	0.684	0.493	0.602	0.537
FY 2,035	0.441	0.808	0.466	0.685	0.493	0.602	0.537
FY 2,036	0.429	0.828	0.456	0.691	0.486	0.604	0.534
FY 2,037	0.428	0.831	0.456	0.692	0.487	0.605	0.535
FY 2,038	0.417	0.844	0.445	0.699	0.480	0.607	0.533
FY 2,039	0.416	0.844	0.446	0.700	0.480	0.609	0.533
FY 2,040	0.406	0.861	0.437	0.701	0.474	0.610	0.530
FY 2,041	0.406	0.861	0.436	0.702	0.475	0.611	0.531
FY 2,042	0.396	0.874	0.429	0.708	0.468	0.611	0.528
FY 2,043	0.395	0.882	0.429	0.709	0.468	0.612	0.529

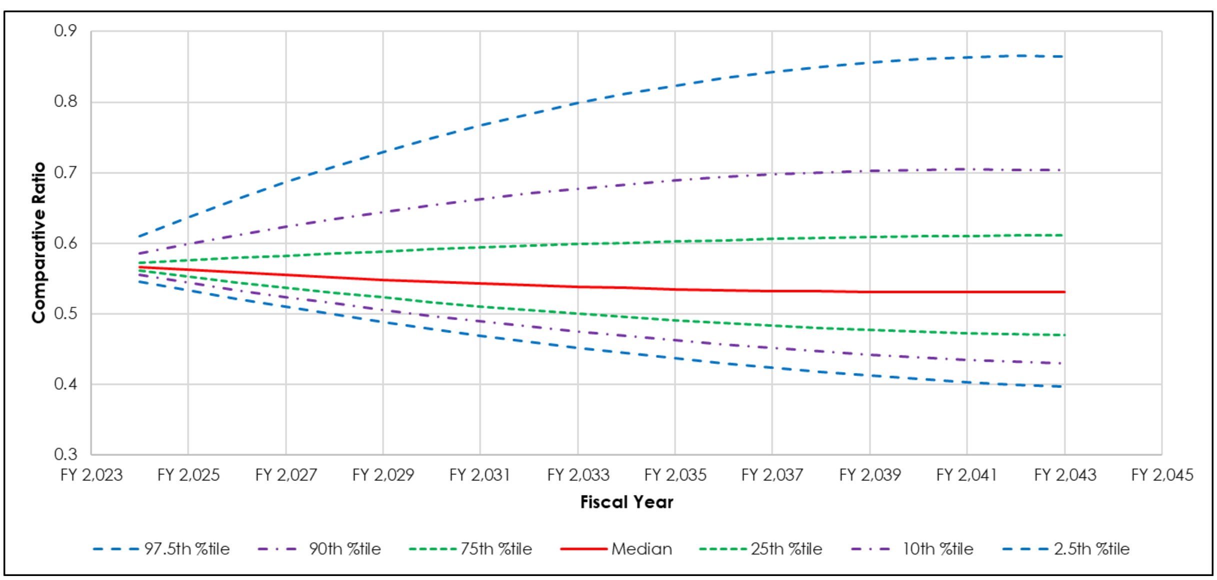


Figure 7-1. $TFCI_{13\text{-}0000}$ Analysis

Table 7-4. Computer & Mathematical Occupations Vs GTRI Analysis

$TFCI_{15\text{-}0000}$	95.0%		80.0%		50.0%		Median
	2.5th %tile	97.5th %tile	10th %tile	90th %tile	25th %tile	75th %tile	50th %tile
FY 2,024	0.566	0.620	0.571	0.604	0.576	0.593	0.584
FY 2,025	0.556	0.633	0.564	0.613	0.573	0.598	0.584
FY 2,026	0.531	0.734	0.541	0.647	0.553	0.598	0.570
FY 2,027	0.525	0.739	0.538	0.651	0.552	0.602	0.572
FY 2,028	0.504	0.773	0.519	0.680	0.536	0.611	0.563
FY 2,029	0.500	0.777	0.517	0.683	0.536	0.613	0.565
FY 2,030	0.481	0.818	0.501	0.697	0.524	0.619	0.561
FY 2,031	0.480	0.825	0.500	0.700	0.524	0.621	0.562
FY 2,032	0.463	0.840	0.486	0.712	0.513	0.624	0.558
FY 2,033	0.461	0.842	0.485	0.716	0.514	0.626	0.559
FY 2,034	0.447	0.867	0.472	0.723	0.505	0.631	0.557
FY 2,035	0.446	0.869	0.473	0.726	0.505	0.632	0.558
FY 2,036	0.432	0.892	0.461	0.734	0.498	0.635	0.555
FY 2,037	0.431	0.894	0.462	0.737	0.499	0.636	0.555
FY 2,038	0.419	0.918	0.452	0.744	0.493	0.637	0.553
FY 2,039	0.418	0.915	0.452	0.745	0.492	0.640	0.554
FY 2,040	0.406	0.943	0.443	0.751	0.485	0.641	0.552
FY 2,041	0.405	0.948	0.442	0.754	0.487	0.643	0.553
FY 2,042	0.397	0.960	0.434	0.759	0.481	0.644	0.550
FY 2,043	0.396	0.963	0.434	0.764	0.480	0.646	0.551

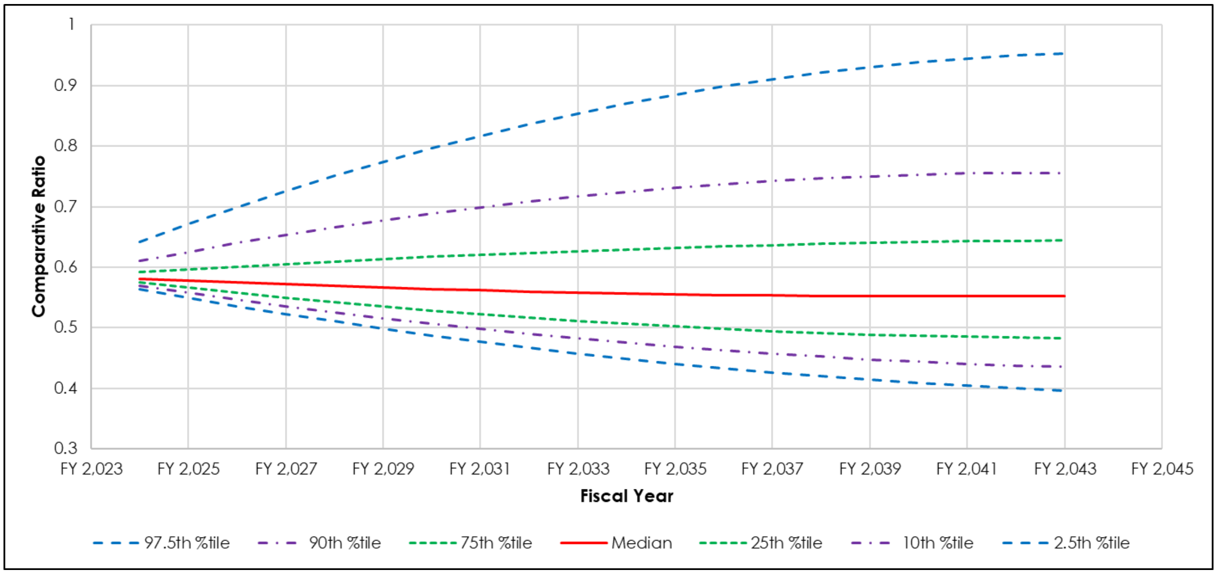


Figure 7-2. $TFCI_{15\text{-}0000}$ Analysis

Table 7-5. Life, Physical, & Social Science Occupations Vs GTRI Analysis

$TFCI_{19\text{-}0000}$	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	0.546	0.605	0.554	0.592	0.562	0.582	0.571
FY 2,025	0.535	0.618	0.546	0.600	0.558	0.586	0.571
FY 2,026	0.509	0.713	0.523	0.633	0.538	0.585	0.557
FY 2,027	0.503	0.717	0.519	0.638	0.536	0.589	0.558
FY 2,028	0.482	0.755	0.501	0.662	0.521	0.596	0.550
FY 2,029	0.478	0.760	0.498	0.665	0.520	0.599	0.551
FY 2,030	0.459	0.799	0.482	0.680	0.507	0.604	0.546
FY 2,031	0.455	0.805	0.481	0.683	0.507	0.606	0.547
FY 2,032	0.439	0.827	0.466	0.694	0.496	0.608	0.543
FY 2,033	0.436	0.830	0.464	0.695	0.497	0.610	0.544
FY 2,034	0.422	0.849	0.453	0.709	0.488	0.613	0.539
FY 2,035	0.420	0.851	0.452	0.712	0.487	0.614	0.540
FY 2,036	0.408	0.874	0.443	0.718	0.479	0.616	0.537
FY 2,037	0.406	0.874	0.441	0.719	0.478	0.617	0.537
FY 2,038	0.395	0.891	0.432	0.727	0.472	0.620	0.534
FY 2,039	0.393	0.891	0.431	0.728	0.472	0.621	0.534
FY 2,040	0.384	0.908	0.422	0.732	0.464	0.623	0.531
FY 2,041	0.383	0.910	0.421	0.735	0.465	0.625	0.532
FY 2,042	0.374	0.931	0.412	0.739	0.458	0.627	0.529
FY 2,043	0.373	0.926	0.412	0.739	0.458	0.628	0.530

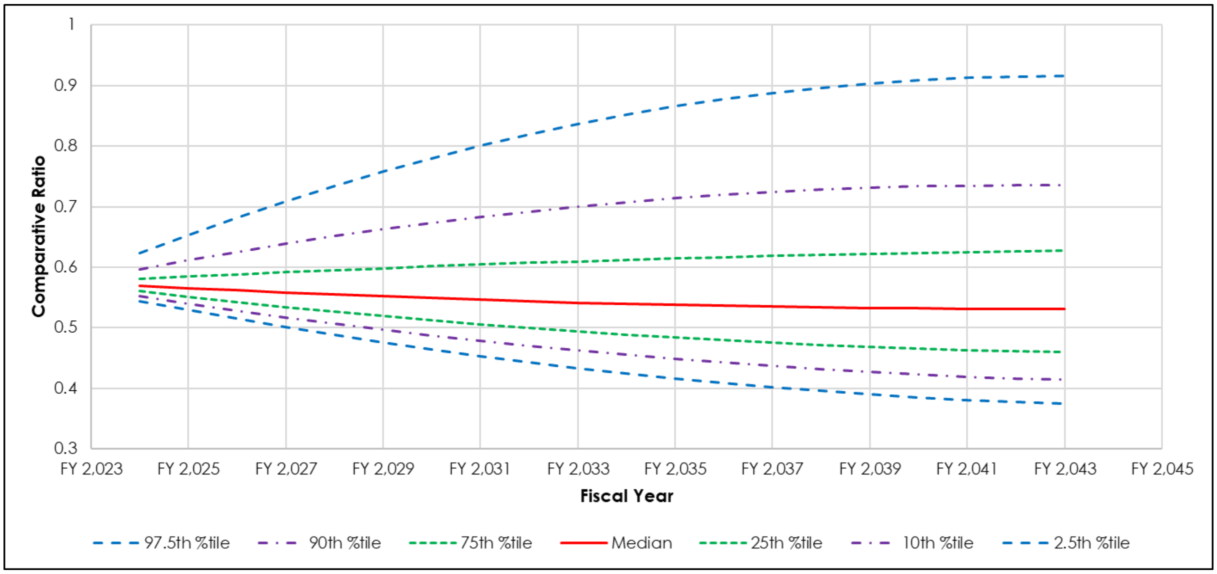


Figure 7-3. $TFCI_{19\text{-}0000}$ Analysis

Table 7-6. Community & Social Service Occupations Vs GTRI Analysis

$TFCI_{21\text{-}0000}$	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	0.555	0.663	0.556	0.600	0.558	0.575	0.563
FY 2,025	0.545	0.718	0.548	0.627	0.553	0.587	0.565
FY 2,026	0.519	0.860	0.524	0.681	0.533	0.600	0.553
FY 2,027	0.513	0.893	0.520	0.701	0.533	0.613	0.559
FY 2,028	0.491	0.976	0.501	0.747	0.518	0.630	0.556
FY 2,029	0.486	1.005	0.499	0.761	0.520	0.642	0.562
FY 2,030	0.467	1.071	0.485	0.798	0.510	0.657	0.561
FY 2,031	0.465	1.100	0.484	0.813	0.513	0.667	0.568
FY 2,032	0.449	1.169	0.470	0.843	0.504	0.682	0.569
FY 2,033	0.447	1.186	0.470	0.859	0.508	0.692	0.574
FY 2,034	0.433	1.239	0.460	0.892	0.501	0.704	0.576
FY 2,035	0.431	1.276	0.461	0.910	0.504	0.713	0.581
FY 2,036	0.418	1.359	0.451	0.939	0.498	0.722	0.583
FY 2,037	0.417	1.385	0.453	0.956	0.502	0.734	0.588
FY 2,038	0.407	1.436	0.444	0.988	0.497	0.746	0.589
FY 2,039	0.406	1.469	0.446	0.998	0.502	0.758	0.596
FY 2,040	0.396	1.535	0.438	1.025	0.497	0.770	0.599
FY 2,041	0.396	1.560	0.439	1.043	0.500	0.780	0.605
FY 2,042	0.387	1.654	0.434	1.064	0.496	0.791	0.608
FY 2,043	0.387	1.684	0.435	1.080	0.500	0.802	0.617

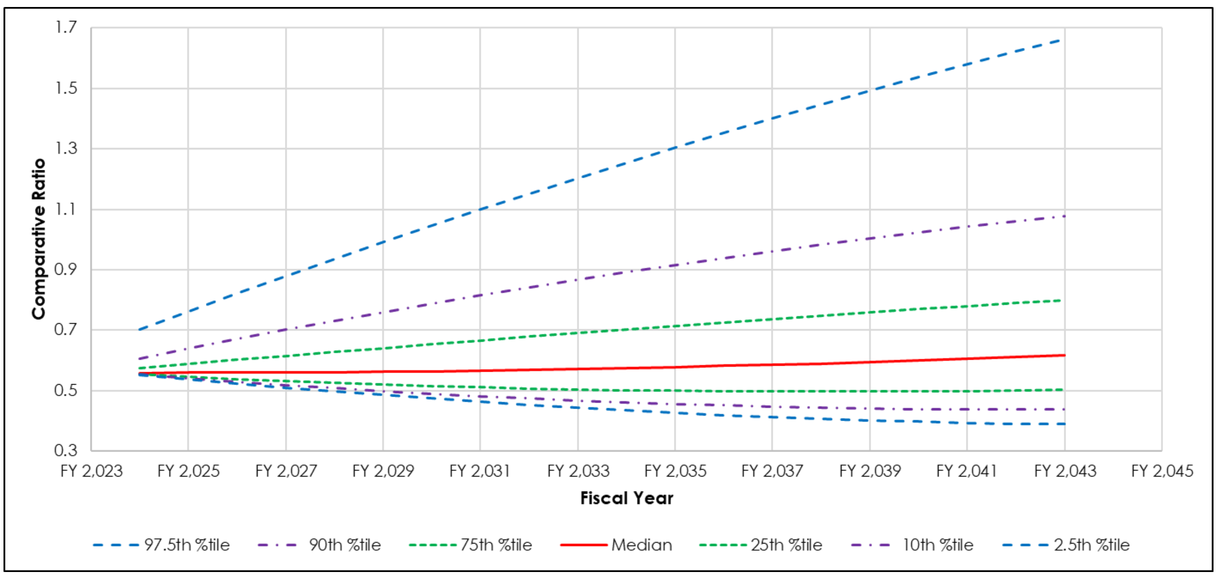


Figure 7-4. $TFCI_{21\text{-}0000}$ Analysis

Table 7-7. Legal Occupations Vs GTRI Analysis

$TFCI_{23\text{-}0000}$	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	0.562	0.677	0.565	0.634	0.571	0.605	0.583
FY 2,025	0.536	0.699	0.544	0.648	0.557	0.609	0.578
FY 2,026	0.499	0.743	0.515	0.668	0.534	0.613	0.567
FY 2,027	0.482	0.757	0.502	0.673	0.526	0.613	0.562
FY 2,028	0.456	0.790	0.480	0.680	0.510	0.613	0.553
FY 2,029	0.442	0.799	0.470	0.685	0.503	0.610	0.549
FY 2,030	0.421	0.818	0.452	0.695	0.489	0.608	0.540
FY 2,031	0.411	0.828	0.444	0.696	0.483	0.605	0.535
FY 2,032	0.393	0.835	0.430	0.696	0.470	0.603	0.528
FY 2,033	0.384	0.838	0.422	0.698	0.463	0.601	0.523
FY 2,034	0.370	0.848	0.408	0.702	0.451	0.599	0.515
FY 2,035	0.361	0.852	0.402	0.701	0.446	0.597	0.510
FY 2,036	0.348	0.861	0.390	0.702	0.437	0.592	0.503
FY 2,037	0.341	0.865	0.383	0.698	0.431	0.590	0.499
FY 2,038	0.329	0.875	0.374	0.699	0.421	0.586	0.493
FY 2,039	0.323	0.876	0.368	0.695	0.416	0.583	0.489
FY 2,040	0.311	0.883	0.357	0.696	0.408	0.578	0.483
FY 2,041	0.304	0.872	0.352	0.697	0.403	0.574	0.478
FY 2,042	0.294	0.888	0.342	0.697	0.396	0.571	0.471
FY 2,043	0.289	0.885	0.337	0.695	0.392	0.567	0.467

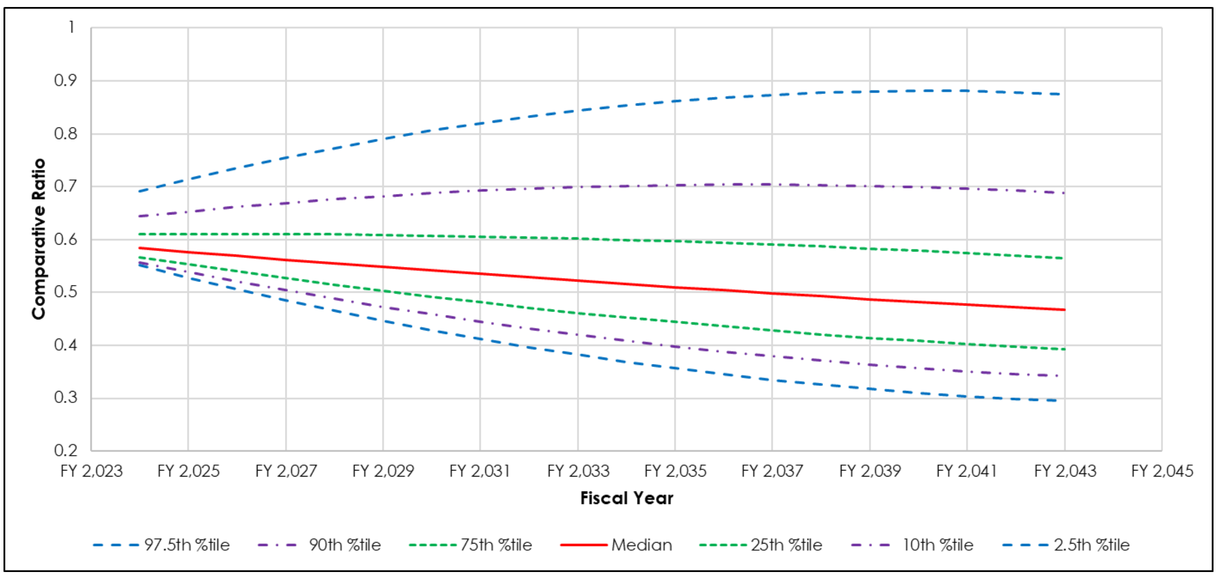


Figure 7-5. TFCI $_{23\text{-}0000}$ Analysis

Table 7-8. Education, Training, & Library Occupations Vs GTRI Analysis

$TFCI_{25\text{-}0000}$	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	0.543	0.594	0.548	0.580	0.553	0.569	0.560
FY 2,025	0.533	0.605	0.540	0.586	0.548	0.572	0.559
FY 2,026	0.506	0.703	0.516	0.620	0.527	0.570	0.543
FY 2,027	0.500	0.703	0.512	0.621	0.525	0.571	0.543
FY 2,028	0.477	0.742	0.492	0.644	0.507	0.579	0.533
FY 2,029	0.472	0.741	0.488	0.645	0.506	0.579	0.533
FY 2,030	0.454	0.779	0.471	0.659	0.492	0.583	0.526
FY 2,031	0.450	0.776	0.469	0.658	0.491	0.583	0.526
FY 2,032	0.433	0.796	0.454	0.669	0.479	0.585	0.521
FY 2,033	0.429	0.797	0.452	0.668	0.478	0.584	0.521
FY 2,034	0.414	0.816	0.438	0.678	0.468	0.586	0.517
FY 2,035	0.412	0.813	0.437	0.678	0.466	0.585	0.516
FY 2,036	0.398	0.842	0.425	0.682	0.457	0.586	0.511
FY 2,037	0.396	0.839	0.424	0.682	0.456	0.587	0.510
FY 2,038	0.383	0.852	0.413	0.685	0.449	0.586	0.505
FY 2,039	0.381	0.848	0.411	0.688	0.448	0.587	0.504
FY 2,040	0.370	0.866	0.401	0.691	0.441	0.589	0.501
FY 2,041	0.367	0.869	0.400	0.689	0.440	0.587	0.500
FY 2,042	0.357	0.885	0.391	0.693	0.433	0.586	0.497
FY 2,043	0.355	0.883	0.390	0.691	0.431	0.586	0.496

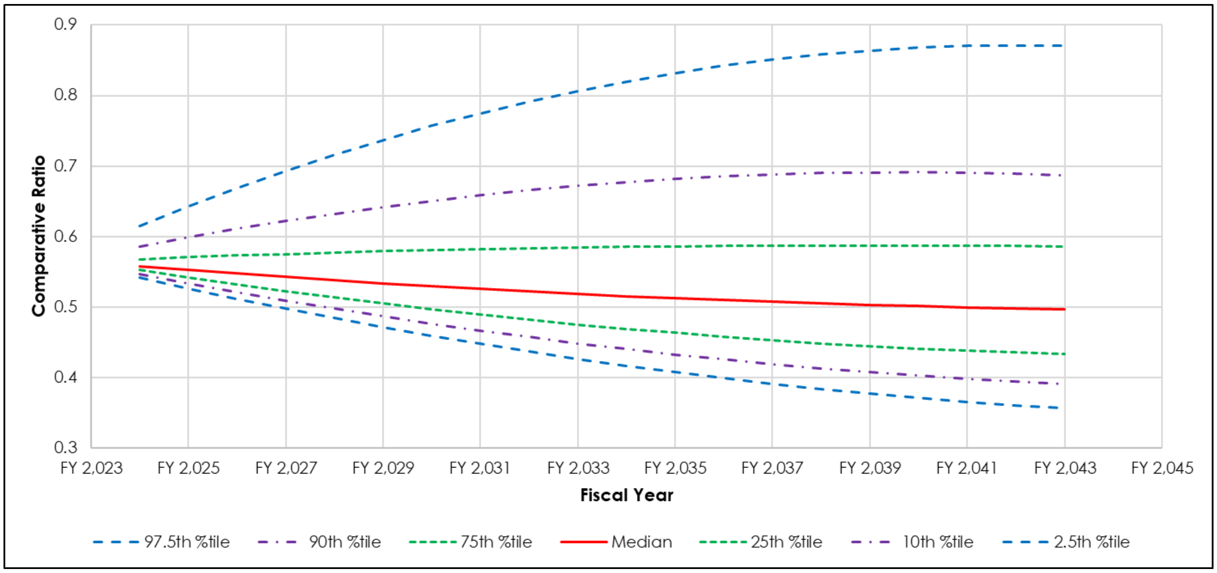


Figure 7-6. $TFCI_{25\text{-}0000}$ Analysis

Table 7-9. Art, Design, Entertainment, Sports, & Media Occupations Vs GTRI Analysis

$TFCI_{27\text{-}0000}$	95.0%		80.0%		50.0%		Median
	2.5th %tile	97.5th %tile	10th %tile	90th %tile	25th %tile	75th %tile	50th %tile
FY 2,024	0.543	0.683	0.571	0.655	0.592	0.634	0.613
FY 2,025	0.519	0.719	0.554	0.678	0.583	0.647	0.615
FY 2,026	0.489	0.795	0.530	0.709	0.566	0.654	0.607
FY 2,027	0.475	0.814	0.521	0.722	0.562	0.664	0.610
FY 2,028	0.454	0.862	0.503	0.749	0.550	0.671	0.605
FY 2,029	0.447	0.879	0.498	0.759	0.549	0.678	0.607
FY 2,030	0.429	0.910	0.483	0.779	0.537	0.685	0.603
FY 2,031	0.421	0.929	0.479	0.788	0.535	0.692	0.606
FY 2,032	0.408	0.957	0.467	0.804	0.527	0.698	0.603
FY 2,033	0.404	0.972	0.463	0.812	0.526	0.703	0.605
FY 2,034	0.393	1.004	0.452	0.824	0.518	0.707	0.603
FY 2,035	0.387	1.018	0.450	0.831	0.517	0.713	0.604
FY 2,036	0.374	1.038	0.441	0.845	0.511	0.718	0.603
FY 2,037	0.367	1.060	0.438	0.857	0.511	0.722	0.607
FY 2,038	0.359	1.077	0.430	0.864	0.505	0.726	0.605
FY 2,039	0.356	1.091	0.425	0.875	0.503	0.734	0.607
FY 2,040	0.347	1.130	0.417	0.886	0.498	0.735	0.603
FY 2,041	0.344	1.134	0.417	0.891	0.498	0.741	0.605
FY 2,042	0.335	1.158	0.411	0.905	0.491	0.740	0.604
FY 2,043	0.333	1.169	0.409	0.914	0.491	0.747	0.605

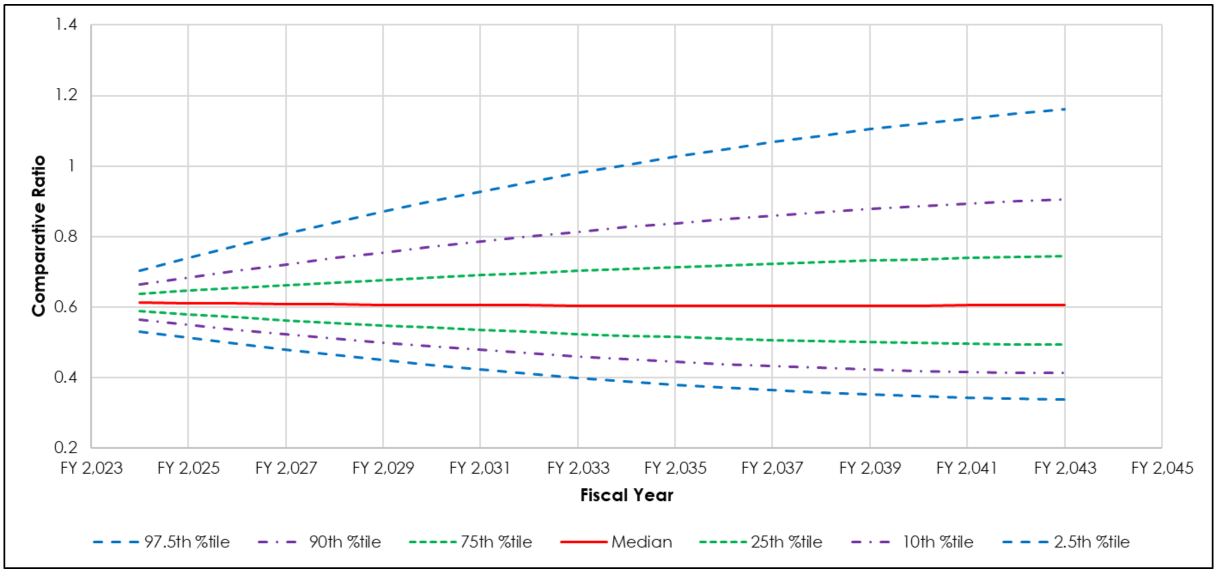


Figure 7-7. $TFCI_{27\text{-}0000}$ Analysis

Table 7-10. Healthcare Practitioners & technical Occupations Vs GTRI Analysis

TFCI$_{29\text{-}0000}$	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	0.577	0.629	0.583	0.612	0.588	0.603	0.595
FY 2,025	0.570	0.644	0.578	0.622	0.587	0.609	0.597
FY 2,026	0.547	0.753	0.557	0.665	0.567	0.610	0.582
FY 2,027	0.542	0.760	0.555	0.669	0.568	0.615	0.585
FY 2,028	0.522	0.810	0.536	0.701	0.552	0.628	0.577
FY 2,029	0.520	0.813	0.536	0.706	0.553	0.632	0.580
FY 2,030	0.502	0.853	0.520	0.727	0.540	0.641	0.577
FY 2,031	0.501	0.860	0.520	0.730	0.542	0.644	0.580
FY 2,032	0.486	0.891	0.506	0.744	0.532	0.651	0.578
FY 2,033	0.484	0.901	0.507	0.749	0.533	0.654	0.581
FY 2,034	0.469	0.922	0.494	0.763	0.525	0.659	0.580
FY 2,035	0.469	0.928	0.494	0.767	0.527	0.662	0.583
FY 2,036	0.456	0.960	0.484	0.778	0.520	0.668	0.581
FY 2,037	0.456	0.961	0.485	0.779	0.522	0.673	0.584
FY 2,038	0.445	0.986	0.476	0.795	0.517	0.676	0.582
FY 2,039	0.443	0.991	0.477	0.799	0.519	0.681	0.585
FY 2,040	0.432	1.010	0.468	0.810	0.513	0.684	0.584
FY 2,041	0.433	1.013	0.469	0.814	0.515	0.687	0.586
FY 2,042	0.424	1.046	0.461	0.822	0.509	0.690	0.585
FY 2,043	0.424	1.046	0.462	0.826	0.511	0.695	0.588

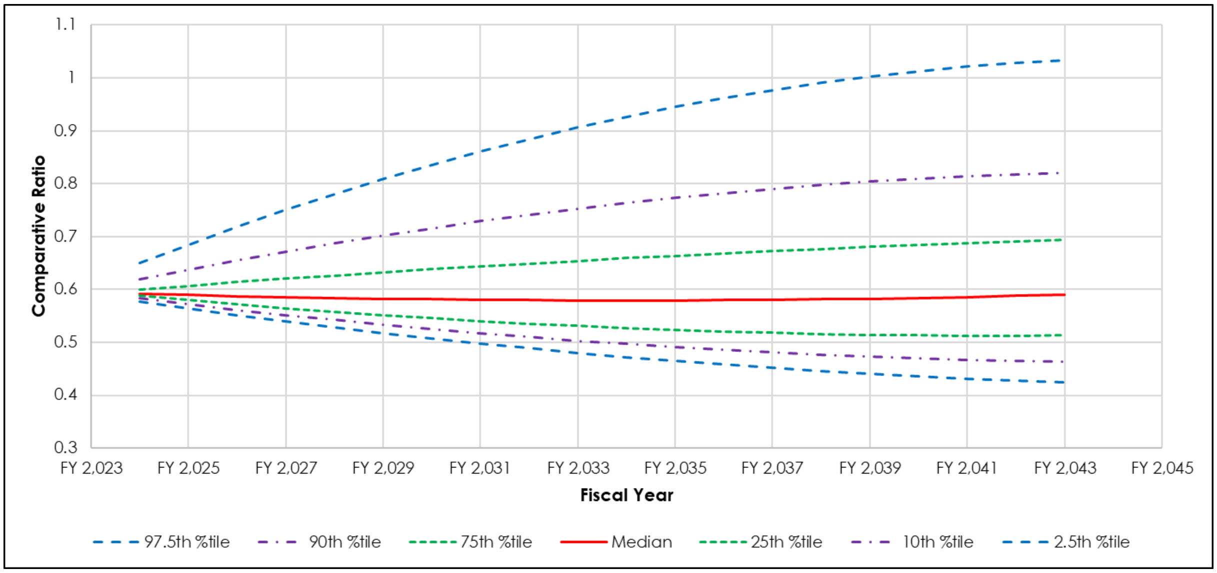


Figure 7-8. TFCI$_{29\text{-}0000}$ Analysis

Table 7-11. Healthcare Support Occupations Vs GTRI Analysis

$TFCI_{31-0000}$	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	0.633	0.681	0.642	0.671	0.650	0.664	0.657
FY 2,025	0.624	0.690	0.636	0.678	0.646	0.667	0.656
FY 2,026	0.597	0.790	0.612	0.710	0.625	0.663	0.640
FY 2,027	0.592	0.793	0.608	0.711	0.623	0.665	0.641
FY 2,028	0.570	0.832	0.588	0.736	0.606	0.672	0.630
FY 2,029	0.565	0.832	0.585	0.736	0.605	0.673	0.631
FY 2,030	0.546	0.863	0.569	0.748	0.591	0.678	0.623
FY 2,031	0.544	0.865	0.567	0.749	0.590	0.678	0.623
FY 2,032	0.527	0.880	0.553	0.759	0.578	0.679	0.618
FY 2,033	0.525	0.880	0.551	0.760	0.577	0.680	0.618
FY 2,034	0.510	0.897	0.538	0.767	0.567	0.682	0.614
FY 2,035	0.508	0.899	0.537	0.768	0.567	0.682	0.614
FY 2,036	0.493	0.918	0.524	0.773	0.557	0.684	0.610
FY 2,037	0.492	0.919	0.524	0.772	0.557	0.684	0.608
FY 2,038	0.480	0.932	0.512	0.779	0.550	0.684	0.605
FY 2,039	0.478	0.931	0.512	0.780	0.549	0.685	0.605
FY 2,040	0.465	0.947	0.501	0.784	0.542	0.682	0.601
FY 2,041	0.462	0.951	0.500	0.783	0.541	0.684	0.601
FY 2,042	0.452	0.956	0.491	0.788	0.535	0.681	0.598
FY 2,043	0.451	0.955	0.490	0.789	0.532	0.682	0.597

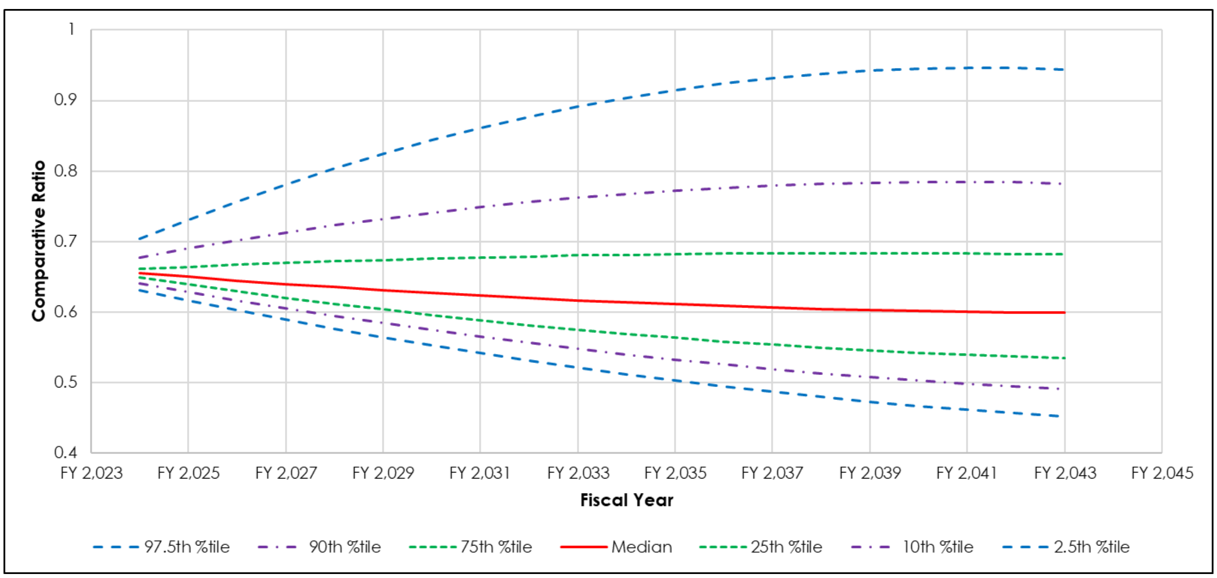


Figure 7-9. $TFCI_{31-0000}$ Analysis

Table 7-12. Protective Service Occupations Vs GTRI Analysis

$TFCI_{33\text{-}0000}$	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	0.533	0.587	0.544	0.576	0.552	0.568	0.560
FY 2,025	0.522	0.598	0.536	0.583	0.547	0.571	0.560
FY 2,026	0.497	0.701	0.513	0.620	0.527	0.568	0.543
FY 2,027	0.490	0.701	0.509	0.621	0.524	0.570	0.544
FY 2,028	0.469	0.742	0.489	0.644	0.507	0.581	0.533
FY 2,029	0.465	0.739	0.486	0.644	0.506	0.581	0.534
FY 2,030	0.446	0.780	0.468	0.661	0.492	0.585	0.528
FY 2,031	0.441	0.779	0.466	0.661	0.491	0.586	0.528
FY 2,032	0.426	0.798	0.451	0.671	0.480	0.588	0.523
FY 2,033	0.423	0.799	0.450	0.672	0.479	0.587	0.523
FY 2,034	0.408	0.821	0.437	0.682	0.469	0.590	0.519
FY 2,035	0.405	0.822	0.435	0.683	0.468	0.590	0.519
FY 2,036	0.392	0.846	0.424	0.689	0.460	0.591	0.514
FY 2,037	0.390	0.850	0.423	0.690	0.459	0.591	0.514
FY 2,038	0.378	0.862	0.413	0.695	0.452	0.594	0.510
FY 2,039	0.376	0.863	0.411	0.693	0.451	0.593	0.510
FY 2,040	0.365	0.878	0.402	0.697	0.444	0.595	0.508
FY 2,041	0.364	0.876	0.400	0.697	0.443	0.594	0.507
FY 2,042	0.354	0.890	0.391	0.702	0.436	0.594	0.503
FY 2,043	0.353	0.892	0.389	0.702	0.435	0.594	0.502

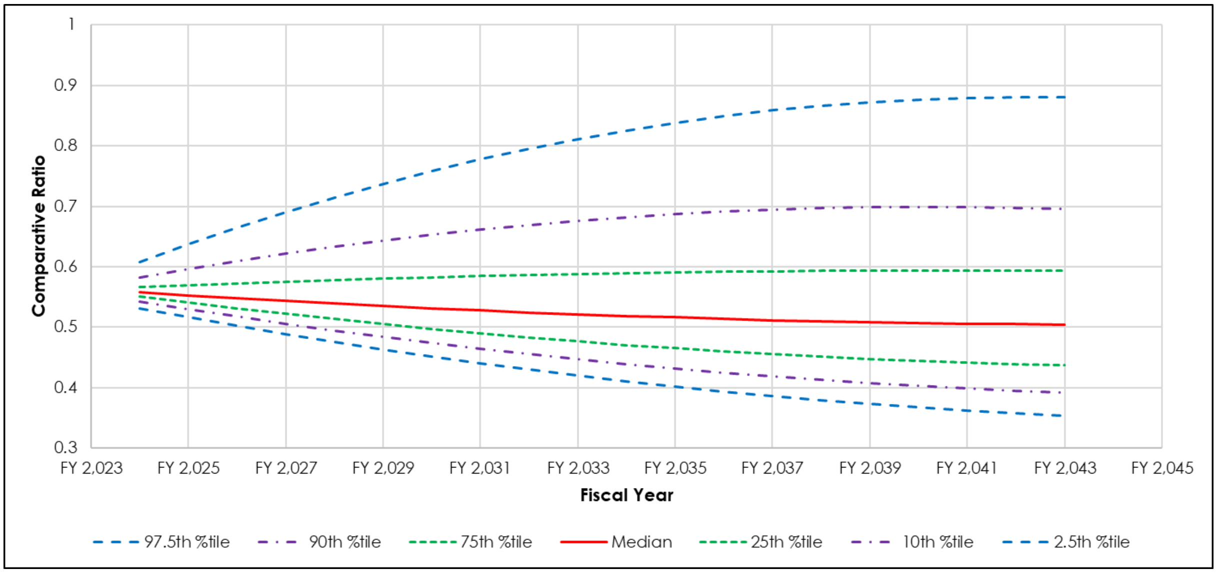


Figure 7-10. $TFCI_{33\text{-}0000}$ Analysis

Table 7-13. Food Preparation & Serving Related Occupations Vs GTRI Analysis

$TFCI_{35\text{-}0000}$	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	0.628	0.692	0.634	0.674	0.640	0.661	0.649
FY 2,025	0.616	0.707	0.626	0.683	0.636	0.666	0.650
FY 2,026	0.587	0.805	0.600	0.716	0.615	0.666	0.635
FY 2,027	0.579	0.811	0.596	0.719	0.613	0.669	0.636
FY 2,028	0.557	0.853	0.575	0.745	0.596	0.676	0.627
FY 2,029	0.551	0.859	0.572	0.747	0.595	0.678	0.629
FY 2,030	0.532	0.895	0.555	0.763	0.581	0.683	0.622
FY 2,031	0.528	0.899	0.553	0.765	0.581	0.684	0.623
FY 2,032	0.512	0.914	0.538	0.779	0.570	0.688	0.618
FY 2,033	0.509	0.921	0.536	0.779	0.569	0.688	0.619
FY 2,034	0.494	0.945	0.524	0.790	0.560	0.690	0.614
FY 2,035	0.491	0.946	0.523	0.791	0.560	0.693	0.614
FY 2,036	0.477	0.971	0.511	0.796	0.550	0.695	0.609
FY 2,037	0.474	0.972	0.509	0.800	0.550	0.696	0.610
FY 2,038	0.461	0.981	0.498	0.807	0.542	0.698	0.607
FY 2,039	0.459	0.982	0.498	0.807	0.541	0.699	0.607
FY 2,040	0.446	1.003	0.487	0.813	0.535	0.699	0.603
FY 2,041	0.444	1.001	0.486	0.815	0.534	0.699	0.605
FY 2,042	0.433	1.022	0.477	0.820	0.526	0.701	0.602
FY 2,043	0.431	1.025	0.477	0.822	0.527	0.701	0.602

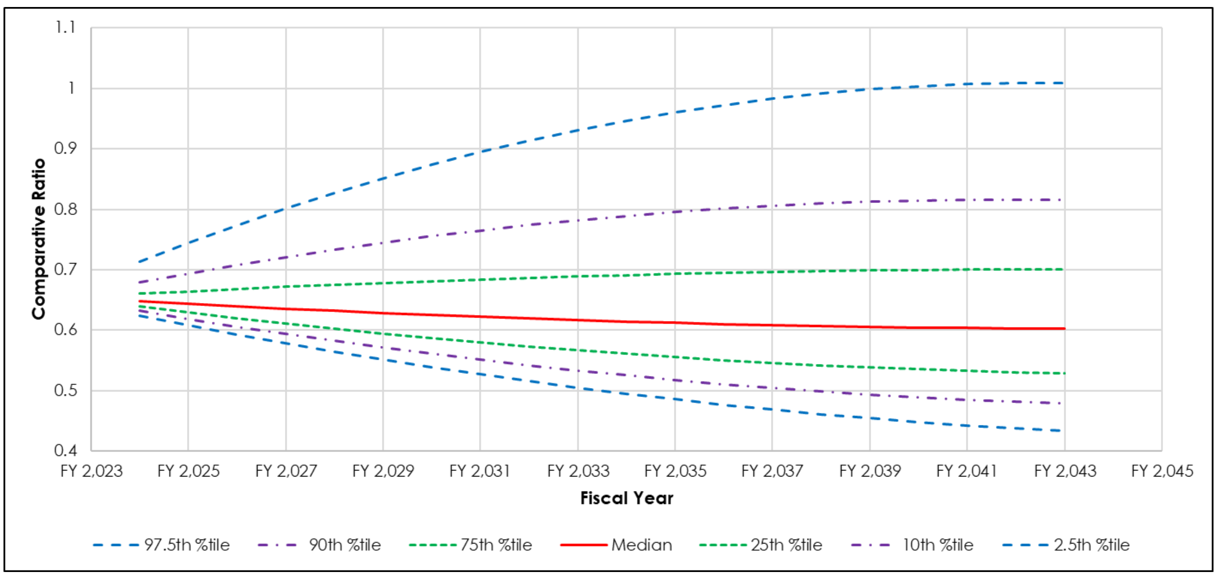


Figure 7-11. $TFCI_{35\text{-}0000}$ Analysis

Table 7-14. Building & Grounds Cleaning & Maintenance Occupations Vs GTRI Analysis

$TFCI_{37\text{-}0000}$	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	0.629	0.680	0.632	0.663	0.636	0.652	0.643
FY 2,025	0.620	0.695	0.627	0.674	0.634	0.658	0.644
FY 2,026	0.595	0.782	0.605	0.703	0.616	0.660	0.633
FY 2,027	0.591	0.787	0.603	0.708	0.616	0.665	0.636
FY 2,028	0.570	0.826	0.585	0.733	0.602	0.672	0.629
FY 2,029	0.567	0.830	0.584	0.738	0.603	0.675	0.632
FY 2,030	0.551	0.863	0.570	0.751	0.593	0.681	0.628
FY 2,031	0.550	0.868	0.569	0.755	0.594	0.685	0.631
FY 2,032	0.534	0.889	0.557	0.768	0.585	0.689	0.627
FY 2,033	0.534	0.899	0.557	0.771	0.586	0.692	0.630
FY 2,034	0.521	0.906	0.547	0.780	0.578	0.695	0.627
FY 2,035	0.520	0.911	0.547	0.783	0.580	0.699	0.629
FY 2,036	0.507	0.935	0.538	0.792	0.572	0.701	0.627
FY 2,037	0.507	0.938	0.538	0.796	0.574	0.705	0.629
FY 2,038	0.497	0.950	0.530	0.806	0.569	0.707	0.626
FY 2,039	0.496	0.954	0.530	0.810	0.570	0.710	0.629
FY 2,040	0.487	0.979	0.523	0.812	0.564	0.712	0.627
FY 2,041	0.487	0.984	0.523	0.818	0.566	0.714	0.629
FY 2,042	0.477	1.007	0.516	0.825	0.561	0.715	0.628
FY 2,043	0.477	1.008	0.516	0.827	0.562	0.718	0.629

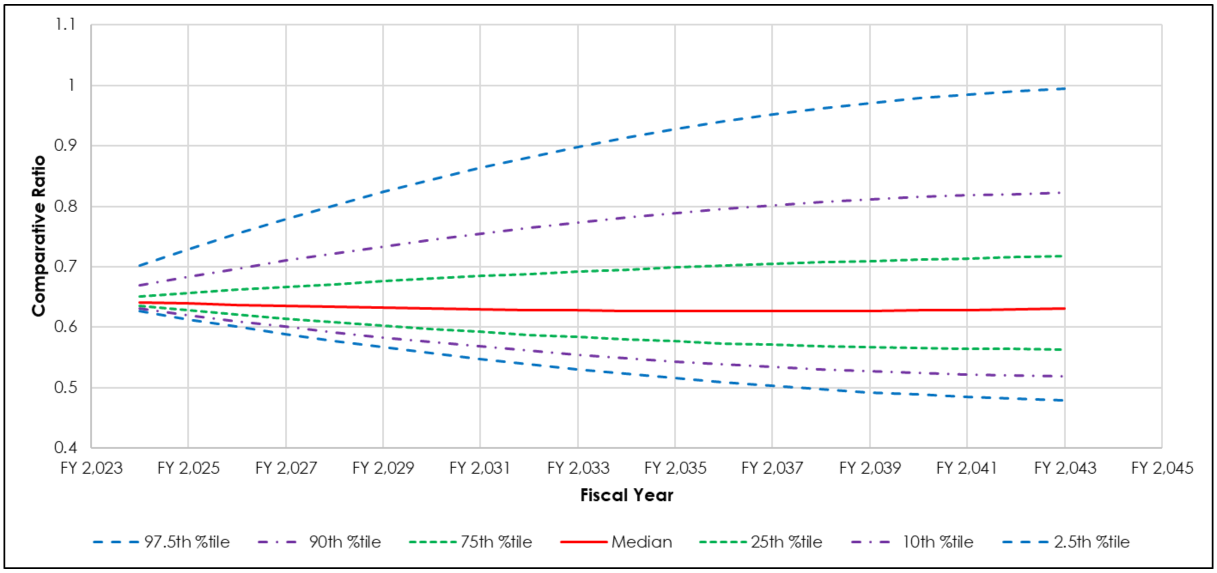


Figure 7-12. $TFCI_{37\text{-}0000}$ Analysis

Table 7-15. Personal Care & Service Occupations Vs GTRI Analysis

$TFCI_{39\text{-}0000}$	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	0.637	0.730	0.639	0.678	0.642	0.659	0.648
FY 2,025	0.626	0.783	0.631	0.697	0.637	0.667	0.648
FY 2,026	0.598	0.869	0.606	0.745	0.617	0.677	0.638
FY 2,027	0.590	0.901	0.601	0.759	0.615	0.684	0.640
FY 2,028	0.567	0.957	0.581	0.783	0.600	0.699	0.636
FY 2,029	0.562	0.979	0.578	0.797	0.600	0.706	0.639
FY 2,030	0.542	1.025	0.562	0.817	0.589	0.716	0.637
FY 2,031	0.540	1.041	0.561	0.829	0.590	0.721	0.640
FY 2,032	0.523	1.080	0.548	0.849	0.581	0.727	0.639
FY 2,033	0.520	1.107	0.547	0.857	0.581	0.733	0.643
FY 2,034	0.505	1.147	0.536	0.871	0.575	0.737	0.642
FY 2,035	0.502	1.175	0.534	0.884	0.577	0.744	0.645
FY 2,036	0.490	1.210	0.525	0.901	0.570	0.751	0.643
FY 2,037	0.489	1.227	0.524	0.915	0.571	0.755	0.647
FY 2,038	0.477	1.272	0.516	0.931	0.566	0.761	0.646
FY 2,039	0.474	1.285	0.515	0.940	0.568	0.767	0.650
FY 2,040	0.464	1.328	0.508	0.949	0.562	0.772	0.649
FY 2,041	0.463	1.350	0.508	0.963	0.564	0.778	0.652
FY 2,042	0.456	1.358	0.501	0.976	0.559	0.786	0.649
FY 2,043	0.456	1.375	0.501	0.989	0.560	0.792	0.654

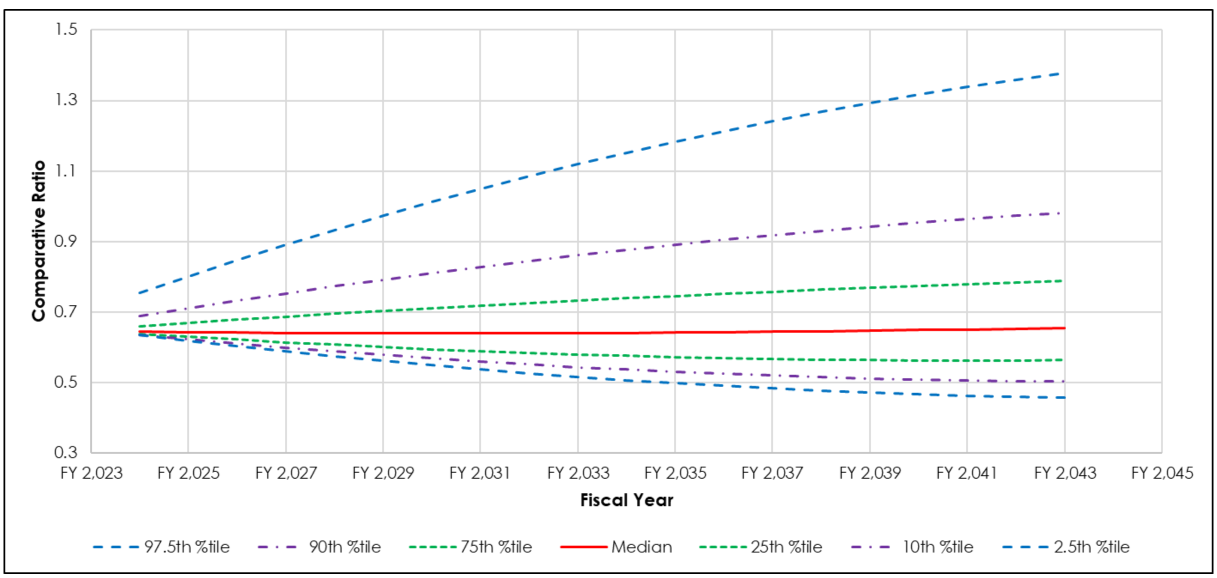


Figure 7-13. $TFCI_{39\text{-}0000}$ Analysis

Table 7-16. Sales & Related Occupations Vs GTRI Analysis

$TFCI_{41\text{-}0000}$	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	0.619	0.663	0.629	0.653	0.636	0.646	0.641
FY 2,025	0.609	0.669	0.621	0.657	0.631	0.647	0.639
FY 2,026	0.582	0.775	0.596	0.696	0.607	0.641	0.619
FY 2,027	0.575	0.774	0.591	0.695	0.604	0.642	0.619
FY 2,028	0.551	0.810	0.569	0.715	0.584	0.652	0.606
FY 2,029	0.547	0.808	0.566	0.714	0.582	0.651	0.605
FY 2,030	0.526	0.846	0.546	0.726	0.566	0.654	0.597
FY 2,031	0.523	0.847	0.543	0.725	0.564	0.652	0.596
FY 2,032	0.504	0.864	0.526	0.735	0.550	0.654	0.590
FY 2,033	0.501	0.864	0.524	0.733	0.548	0.652	0.588
FY 2,034	0.484	0.880	0.509	0.743	0.537	0.653	0.583
FY 2,035	0.480	0.878	0.506	0.741	0.535	0.650	0.582
FY 2,036	0.466	0.893	0.493	0.746	0.525	0.650	0.575
FY 2,037	0.463	0.888	0.491	0.744	0.524	0.649	0.574
FY 2,038	0.450	0.900	0.480	0.747	0.515	0.648	0.569
FY 2,039	0.447	0.897	0.478	0.746	0.513	0.646	0.568
FY 2,040	0.434	0.911	0.468	0.748	0.504	0.647	0.563
FY 2,041	0.433	0.908	0.466	0.746	0.502	0.645	0.562
FY 2,042	0.422	0.917	0.456	0.746	0.494	0.643	0.557
FY 2,043	0.419	0.916	0.454	0.745	0.493	0.642	0.555

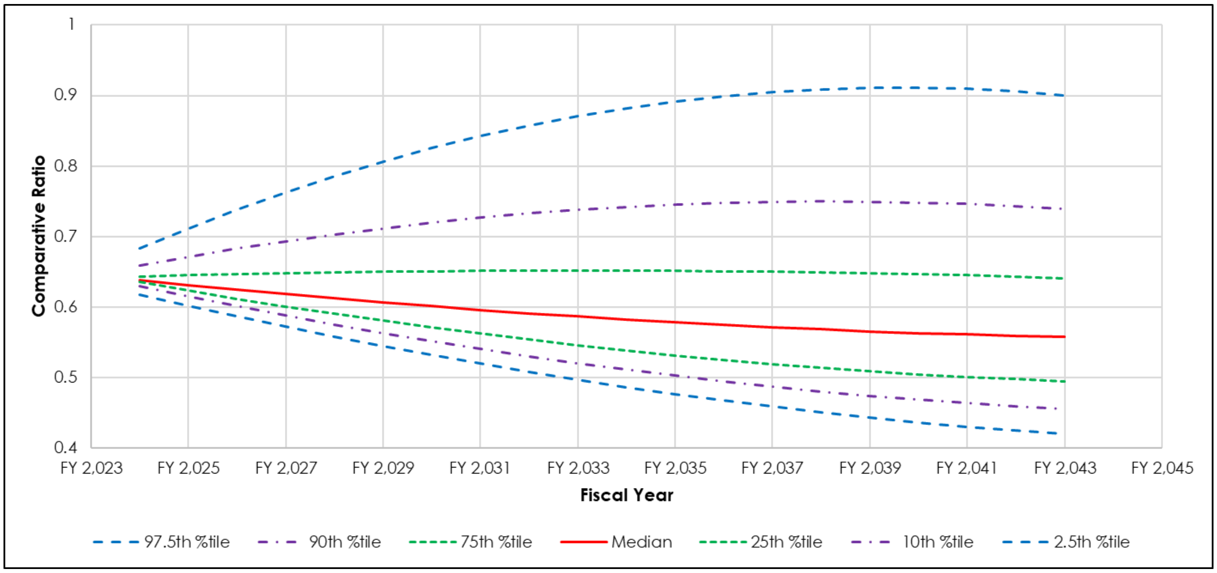


Figure 7-14. $TFCI_{41\text{-}0000}$ Analysis

Table 7-17. Office & Administrative Support Occupations Vs GTRI Analysis

$TFCI_{43\text{-}0000}$	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	0.568	0.607	0.572	0.596	0.576	0.588	0.581
FY 2,025	0.562	0.618	0.569	0.604	0.575	0.593	0.583
FY 2,026	0.540	0.726	0.548	0.645	0.556	0.591	0.568
FY 2,027	0.538	0.729	0.547	0.649	0.557	0.595	0.571
FY 2,028	0.519	0.772	0.528	0.677	0.541	0.610	0.562
FY 2,029	0.516	0.775	0.528	0.679	0.542	0.612	0.565
FY 2,030	0.499	0.816	0.513	0.697	0.529	0.621	0.562
FY 2,031	0.497	0.821	0.513	0.699	0.531	0.623	0.564
FY 2,032	0.482	0.846	0.499	0.713	0.521	0.629	0.563
FY 2,033	0.481	0.851	0.500	0.717	0.523	0.631	0.565
FY 2,034	0.467	0.869	0.488	0.732	0.514	0.635	0.565
FY 2,035	0.467	0.873	0.489	0.735	0.516	0.638	0.567
FY 2,036	0.455	0.904	0.478	0.745	0.510	0.642	0.564
FY 2,037	0.454	0.910	0.479	0.747	0.511	0.645	0.566
FY 2,038	0.443	0.930	0.469	0.754	0.507	0.650	0.565
FY 2,039	0.442	0.933	0.471	0.757	0.508	0.653	0.566
FY 2,040	0.432	0.947	0.462	0.766	0.503	0.657	0.565
FY 2,041	0.434	0.952	0.463	0.768	0.504	0.660	0.567
FY 2,042	0.425	0.976	0.456	0.776	0.498	0.662	0.566
FY 2,043	0.425	0.977	0.457	0.780	0.499	0.665	0.567

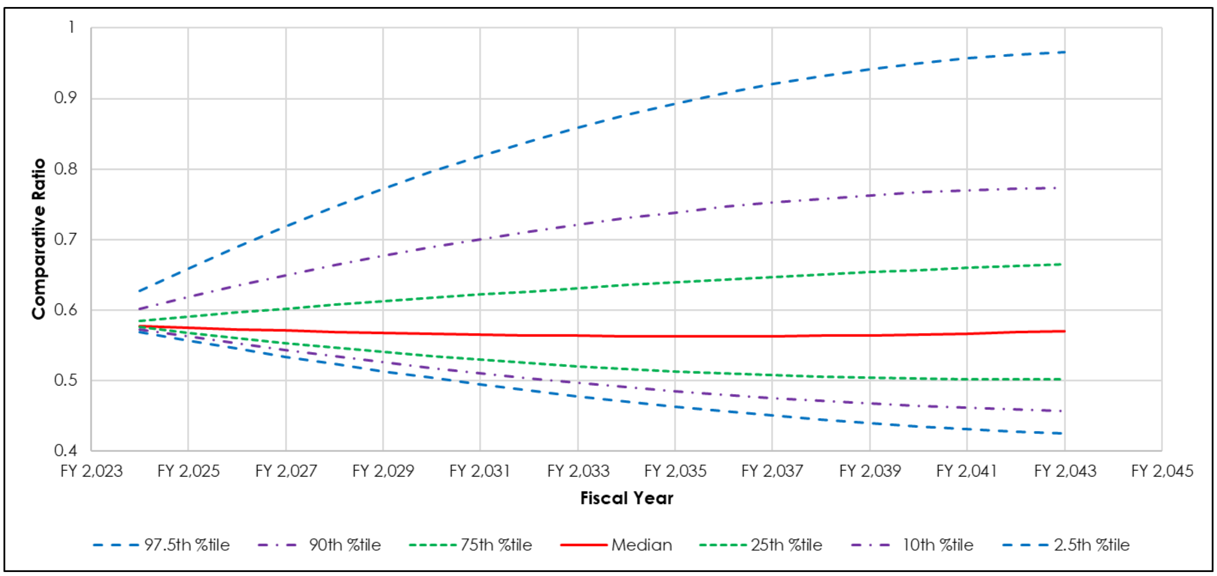


Figure 7-15. $TFCI_{43\text{-}0000}$ Analysis

Table 7-18. Farming, Fishing, & Forestry Occupations Vs GTRI Analysis

$TFCI_{45\text{-}0000}$	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	0.603	0.707	0.624	0.687	0.640	0.671	0.655
FY 2,025	0.586	0.730	0.611	0.702	0.632	0.679	0.656
FY 2,026	0.556	0.814	0.585	0.730	0.612	0.682	0.644
FY 2,027	0.543	0.821	0.578	0.738	0.610	0.688	0.646
FY 2,028	0.520	0.870	0.558	0.760	0.595	0.693	0.638
FY 2,029	0.512	0.876	0.553	0.768	0.592	0.698	0.639
FY 2,030	0.493	0.915	0.536	0.783	0.580	0.703	0.632
FY 2,031	0.489	0.921	0.533	0.790	0.578	0.705	0.633
FY 2,032	0.473	0.950	0.521	0.802	0.568	0.707	0.628
FY 2,033	0.469	0.958	0.518	0.804	0.566	0.710	0.629
FY 2,034	0.455	0.975	0.507	0.814	0.558	0.712	0.625
FY 2,035	0.452	0.980	0.505	0.816	0.556	0.714	0.625
FY 2,036	0.437	0.997	0.493	0.829	0.549	0.714	0.621
FY 2,037	0.435	1.005	0.489	0.827	0.547	0.719	0.623
FY 2,038	0.422	1.019	0.481	0.839	0.540	0.720	0.619
FY 2,039	0.419	1.025	0.478	0.842	0.539	0.721	0.620
FY 2,040	0.409	1.044	0.468	0.848	0.532	0.724	0.616
FY 2,041	0.406	1.046	0.466	0.852	0.531	0.726	0.616
FY 2,042	0.397	1.061	0.456	0.860	0.524	0.726	0.612
FY 2,043	0.393	1.073	0.455	0.863	0.523	0.728	0.613

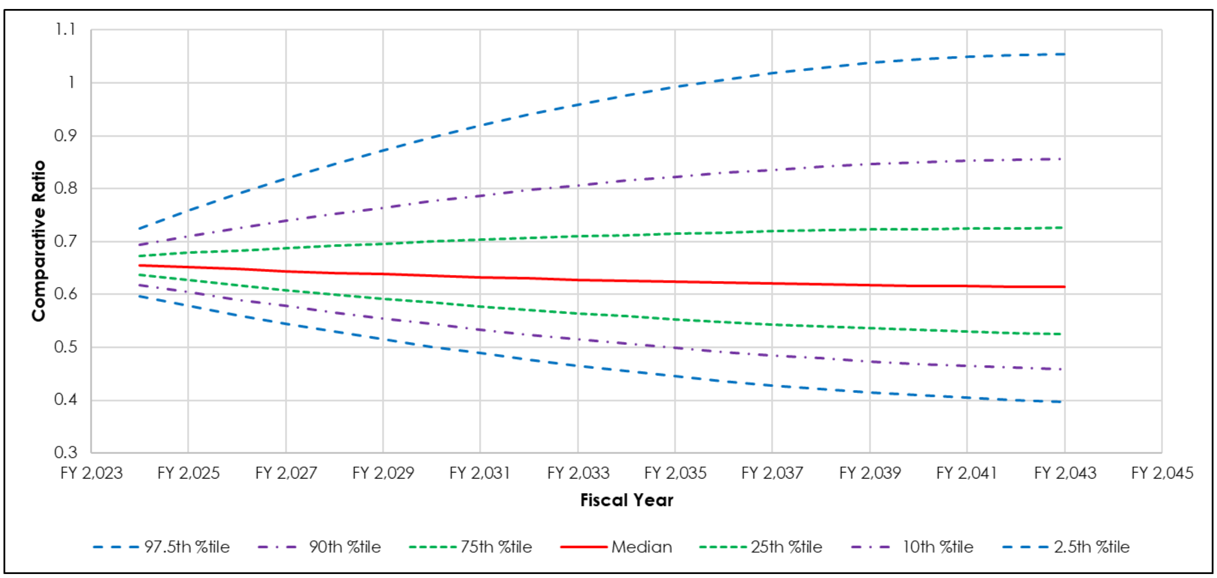


Figure 7-16. $TFCI_{45\text{-}0000}$ Analysis

Table 7-19. Installation, Maintenance, & Repair Occupations Vs GTRI Analysis

$TFCI_{49\text{-}0000}$	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	0.569	0.616	0.573	0.602	0.578	0.593	0.585
FY 2,025	0.562	0.628	0.569	0.611	0.576	0.598	0.586
FY 2,026	0.538	0.737	0.547	0.651	0.557	0.598	0.572
FY 2,027	0.534	0.740	0.545	0.655	0.558	0.603	0.574
FY 2,028	0.514	0.787	0.527	0.683	0.542	0.615	0.566
FY 2,029	0.512	0.790	0.526	0.688	0.543	0.618	0.569
FY 2,030	0.494	0.832	0.510	0.705	0.530	0.627	0.565
FY 2,031	0.493	0.837	0.510	0.709	0.531	0.629	0.569
FY 2,032	0.476	0.860	0.497	0.724	0.522	0.634	0.565
FY 2,033	0.475	0.864	0.497	0.726	0.523	0.637	0.567
FY 2,034	0.461	0.887	0.485	0.741	0.515	0.641	0.566
FY 2,035	0.461	0.892	0.485	0.745	0.516	0.643	0.568
FY 2,036	0.448	0.919	0.474	0.752	0.509	0.648	0.567
FY 2,037	0.448	0.925	0.475	0.756	0.510	0.652	0.569
FY 2,038	0.435	0.948	0.466	0.764	0.505	0.657	0.566
FY 2,039	0.435	0.949	0.467	0.768	0.507	0.661	0.569
FY 2,040	0.425	0.966	0.458	0.777	0.501	0.664	0.567
FY 2,041	0.425	0.974	0.458	0.780	0.501	0.665	0.570
FY 2,042	0.415	0.999	0.451	0.791	0.496	0.668	0.567
FY 2,043	0.417	1.002	0.452	0.793	0.497	0.672	0.569

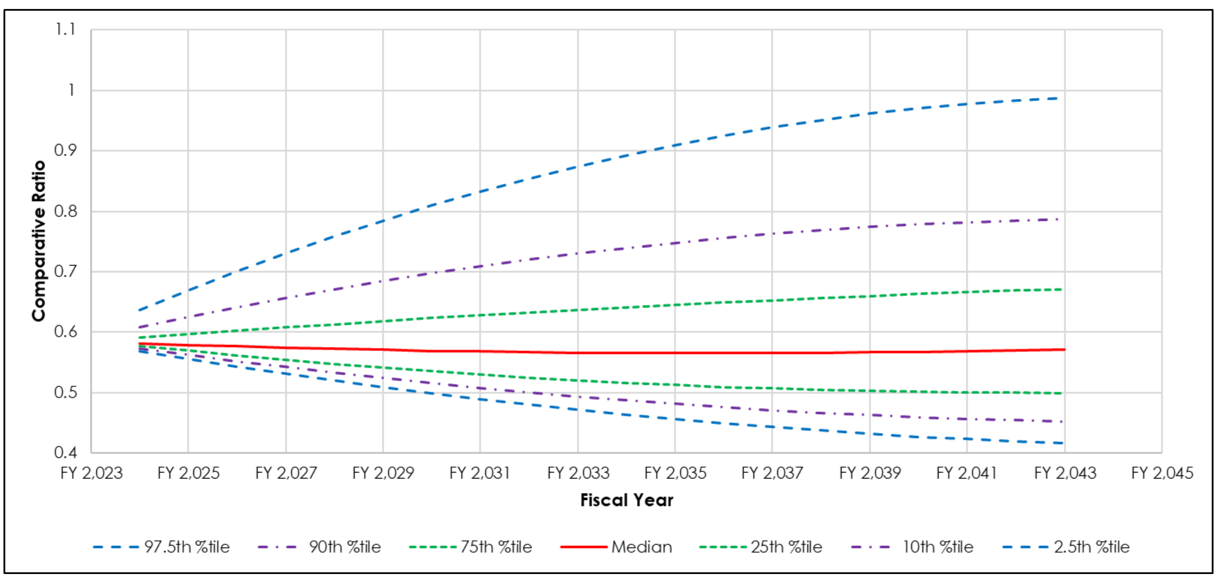


Figure 7-17. $TFCI_{49\text{-}0000}$ Analysis

Table 7-20. Production Occupations Vs GTRI Analysis

$TFCI_{51\text{-}0000}$	95.0% 2.5th %tile	95.0% 97.5th %tile	80.0% 10th %tile	80.0% 90th %tile	50.0% 25th %tile	50.0% 75th %tile	Median 50th %tile
FY 2,024	0.588	0.652	0.601	0.640	0.611	0.630	0.620
FY 2,025	0.575	0.665	0.592	0.647	0.605	0.634	0.620
FY 2,026	0.548	0.779	0.565	0.688	0.582	0.630	0.600
FY 2,027	0.539	0.782	0.560	0.689	0.578	0.633	0.601
FY 2,028	0.515	0.822	0.537	0.716	0.559	0.642	0.590
FY 2,029	0.508	0.822	0.534	0.717	0.557	0.642	0.590
FY 2,030	0.488	0.866	0.514	0.732	0.542	0.649	0.583
FY 2,031	0.484	0.867	0.512	0.732	0.540	0.648	0.583
FY 2,032	0.464	0.888	0.495	0.745	0.528	0.651	0.577
FY 2,033	0.462	0.890	0.492	0.744	0.526	0.652	0.577
FY 2,034	0.445	0.916	0.478	0.757	0.514	0.654	0.572
FY 2,035	0.441	0.917	0.476	0.757	0.513	0.652	0.572
FY 2,036	0.426	0.949	0.462	0.763	0.504	0.653	0.567
FY 2,037	0.423	0.946	0.462	0.760	0.503	0.653	0.566
FY 2,038	0.409	0.958	0.449	0.771	0.495	0.655	0.562
FY 2,039	0.407	0.953	0.447	0.772	0.494	0.655	0.561
FY 2,040	0.393	0.970	0.436	0.777	0.484	0.654	0.557
FY 2,041	0.392	0.970	0.434	0.779	0.484	0.654	0.556
FY 2,042	0.381	0.991	0.425	0.781	0.477	0.653	0.551
FY 2,043	0.380	0.987	0.423	0.781	0.475	0.653	0.550

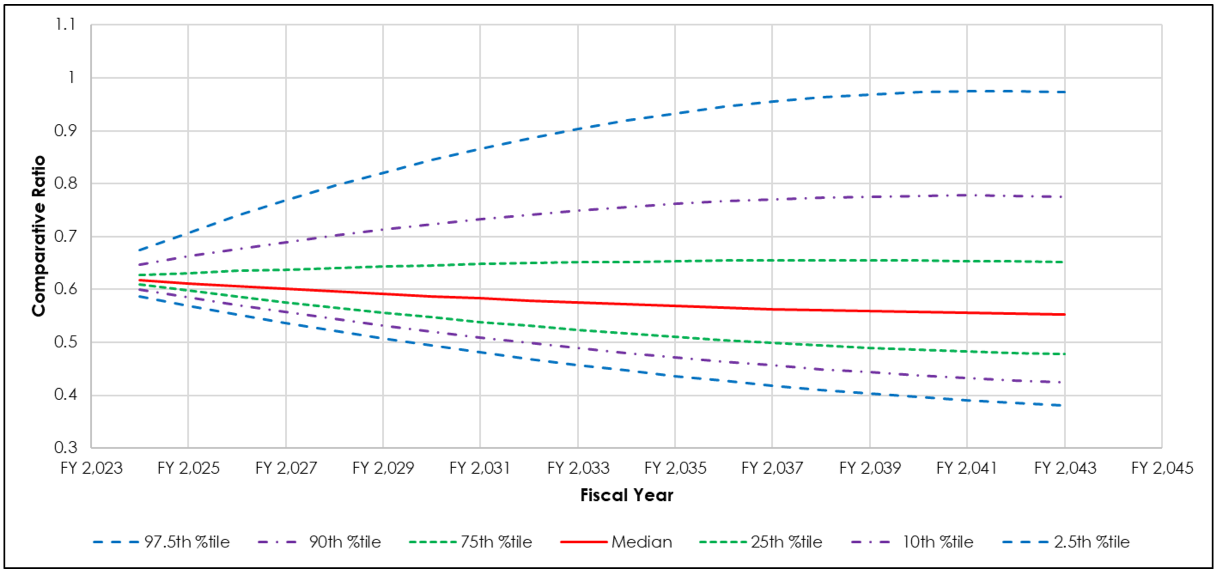


Figure 7-18. $TFCI_{51\text{-}0000}$ Analysis

APPENDIX H: 20-year of Gasoline & Diesel Consumption Forecasts

Table 7-21. Gasoline Consumption 20-year forecast

Gasoline Consumption	95.0%		80.0%		50.0%		Median
	2.5th %tile	97.5th %tile	10th %tile	90th %tile	25th %tile	75th %tile	50th %tile
FY 2,024	2,464,811,979.79	2,916,947,135.50	2,543,102,073.35	2,838,814,429.96	2,613,158,649.09	2,768,789,405.25	2,690,964,782.16
FY 2,025	2,406,589,082.45	3,050,940,567.40	2,514,367,921.15	2,927,717,036.39	2,607,414,128.92	2,825,863,214.43	2,715,604,240.55
FY 2,026	2,362,448,036.79	3,154,159,171.92	2,490,838,152.02	3,009,207,261.51	2,608,329,156.33	2,879,856,790.69	2,743,669,149.57
FY 2,027	2,335,533,711.33	3,258,728,445.19	2,476,973,006.95	3,077,414,410.96	2,611,504,692.06	2,929,188,994.98	2,767,877,409.44
FY 2,028	2,319,543,808.29	3,354,277,175.76	2,465,786,113.38	3,148,533,837.75	2,618,619,682.16	2,980,216,304.06	2,792,713,720.31
FY 2,029	2,288,159,059.30	3,455,614,627.80	2,464,240,172.02	3,218,496,311.93	2,628,721,684.62	3,023,726,726.12	2,819,028,457.16
FY 2,030	2,276,465,270.09	3,547,007,281.37	2,462,751,565.43	3,282,433,102.01	2,635,401,644.11	3,066,647,472.62	2,845,914,366.80
FY 2,031	2,258,893,434.36	3,627,191,230.63	2,459,086,840.21	3,343,934,829.75	2,647,476,355.07	3,114,269,423.49	2,872,298,169.53
FY 2,032	2,248,258,321.97	3,712,098,965.80	2,458,171,729.19	3,413,108,674.90	2,659,536,402.37	3,159,051,883.45	2,901,195,492.71
FY 2,033	2,235,950,222.23	3,806,866,782.88	2,464,733,287.44	3,471,690,702.44	2,667,421,810.61	3,202,830,722.04	2,928,400,184.56
FY 2,034	2,228,432,238.84	3,881,551,370.56	2,459,577,029.66	3,529,937,040.70	2,684,896,015.71	3,246,802,839.12	2,956,649,470.46
FY 2,035	2,228,267,709.55	3,960,081,479.40	2,470,348,581.58	3,597,689,416.99	2,698,571,610.81	3,292,920,319.19	2,984,107,582.32
FY 2,036	2,212,412,786.85	4,062,179,836.76	2,469,853,435.73	3,657,723,601.82	2,717,044,280.79	3,332,803,218.93	3,011,387,872.47
FY 2,037	2,213,219,430.95	4,151,404,892.19	2,472,833,678.56	3,717,677,055.06	2,725,531,899.48	3,382,817,592.03	3,041,734,862.52
FY 2,038	2,204,405,065.29	4,207,958,210.98	2,479,372,033.63	3,790,746,806.49	2,740,343,069.22	3,429,986,665.02	3,070,587,085.14
FY 2,039	2,203,949,047.54	4,314,879,497.54	2,482,377,259.69	3,847,579,358.90	2,756,932,748.66	3,475,967,504.20	3,097,045,687.05
FY 2,040	2,201,539,322.79	4,398,813,740.80	2,485,478,104.50	3,914,740,878.77	2,773,636,986.82	3,522,082,299.17	3,127,363,499.52
FY 2,041	2,202,166,891.55	4,472,521,378.12	2,501,340,261.96	3,973,070,399.27	2,797,657,257.75	3,563,149,374.92	3,153,841,812.58
FY 2,042	2,196,664,363.11	4,580,353,824.94	2,501,658,437.99	4,044,741,425.92	2,810,908,437.50	3,610,675,051.59	3,181,539,742.88
FY 2,043	2,197,187,483.58	4,670,401,241.31	2,509,161,777.89	4,099,818,802.02	2,827,225,446.74	3,662,291,361.90	3,214,368,748.23

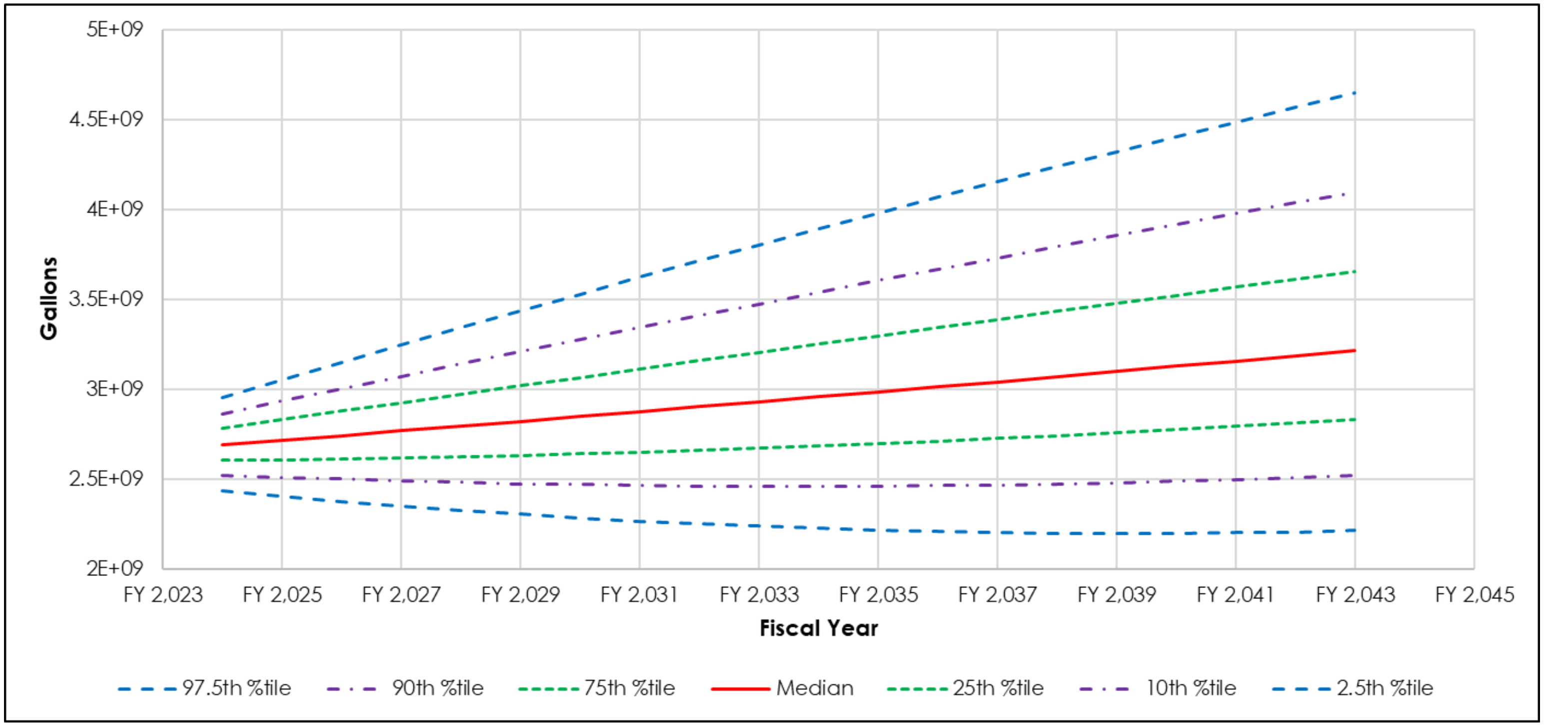


Figure 7-19. Gasoline Consumption Analysis

Table 7-22. Diesel Consumption 20-year forecast

diesel	95.0%	80.0%	50.0%	Median

consumption	2.5th %tile	97.5th %tile	10th %tile	90th %tile	25th %tile	75th %tile	50th %tile
FY 2,024	790,242,262.18	1,046,647,847.64	834,641,635.00	1,002,333,371.55	874,374,255.93	962,624,890.61	918,492,476.50
FY 2,025	756,399,794.64	1,129,019,867.22	817,524,133.36	1,061,644,244.52	871,410,635.07	1,000,375,779.33	934,534,884.81
FY 2,026	739,765,202.36	1,200,921,937.90	809,324,568.93	1,110,356,950.49	873,072,678.84	1,034,970,388.62	951,316,429.06
FY 2,027	723,388,982.80	1,270,117,371.83	801,047,779.03	1,159,671,169.05	875,943,446.31	1,066,692,945.02	969,138,277.64
FY 2,028	713,426,285.76	1,337,988,697.63	798,494,942.04	1,209,527,772.09	882,741,068.96	1,096,723,400.23	984,903,823.52
FY 2,029	708,410,951.18	1,403,542,571.32	798,131,601.88	1,252,229,334.45	889,570,408.30	1,128,632,835.96	1,001,547,294.24
FY 2,030	704,646,162.11	1,467,997,266.63	796,618,794.73	1,297,162,998.60	898,899,639.40	1,158,629,124.64	1,019,620,015.54
FY 2,031	696,163,920.00	1,530,947,688.21	798,675,539.46	1,343,710,364.06	905,613,231.84	1,187,523,125.13	1,039,761,208.89
FY 2,032	692,809,008.76	1,597,892,160.44	803,739,636.63	1,382,902,388.26	913,279,751.09	1,221,993,449.26	1,058,120,949.94
FY 2,033	685,767,054.09	1,663,369,683.24	805,055,783.69	1,428,878,403.31	923,699,323.66	1,249,902,466.38	1,077,603,049.52
FY 2,034	682,113,964.02	1,734,058,222.83	804,683,593.09	1,475,694,386.60	932,871,131.33	1,283,083,960.82	1,097,000,267.34
FY 2,035	681,104,979.99	1,804,953,656.23	810,288,354.86	1,529,839,900.43	941,873,604.52	1,314,032,438.13	1,114,948,565.31
FY 2,036	678,748,833.15	1,876,430,236.96	812,902,319.49	1,567,985,123.33	953,783,640.49	1,349,402,479.35	1,135,883,652.22
FY 2,037	676,076,318.71	1,949,399,844.36	814,853,619.71	1,616,653,402.20	963,629,381.57	1,383,464,297.07	1,157,514,651.41
FY 2,038	678,574,606.55	2,038,412,763.62	818,950,744.43	1,660,852,837.58	975,884,582.70	1,411,122,040.94	1,177,422,349.02
FY 2,039	678,779,700.62	2,076,369,164.35	828,484,707.11	1,716,009,086.25	989,269,205.73	1,445,698,155.84	1,192,778,672.55
FY 2,040	680,718,150.16	2,147,209,165.63	834,153,664.50	1,771,983,408.06	999,530,177.68	1,485,885,982.51	1,216,022,810.29
FY 2,041	678,653,662.94	2,229,558,813.56	838,246,718.77	1,820,656,801.46	1,011,103,966.23	1,516,430,503.68	1,240,366,599.84
FY 2,042	683,245,066.68	2,287,080,655.32	845,538,413.30	1,867,845,756.02	1,023,860,073.81	1,552,948,983.48	1,263,806,546.38
FY 2,043	683,595,101.01	2,375,839,652.66	849,640,652.84	1,925,091,908.40	1,031,777,329.31	1,586,322,790.63	1,286,898,683.97

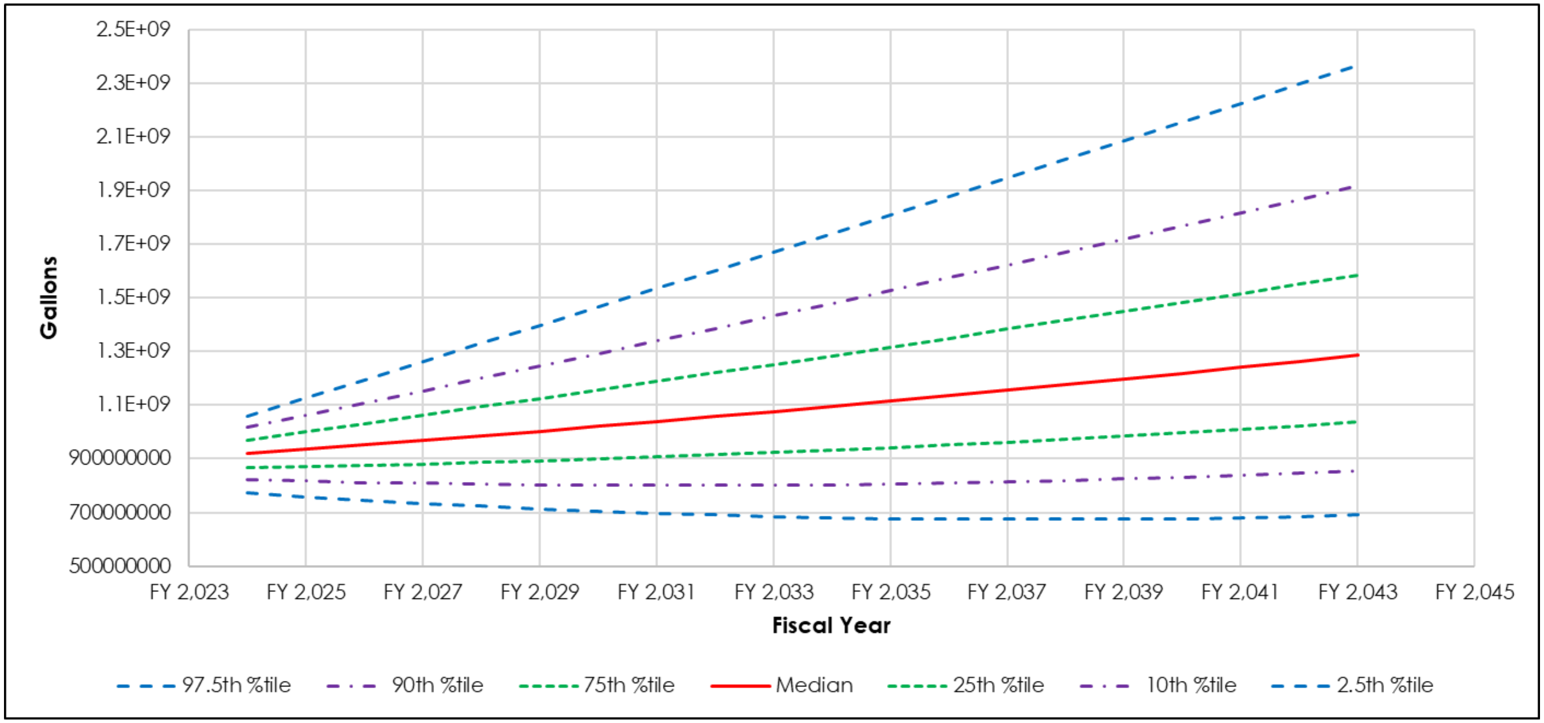


Figure 7-20. Diesel Consumption Analysis