U.S. Border Crossing: Comparative Research into U.S. Border Crossings

Corey Waldner

School of Technology and Engineering, National University

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Dr. Joseph Issa

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Abstract

This literature reviews the differences in the inbound crossings at the U.S.-Canada and the U.S.-Mexico border at the port level from data.gov (data.gov, 2024). After applying advanced statistical analysis and data visualization techniques to the border crossing dataset, notable disparities in crossing patterns were uncovered between the two borders. These discoveries could hold significant implications for border security and policies. The research highlights the necessity of ongoing exploration and policy formulation in this area.

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International border crossings are pivotal in facilitating trade, managing immigration flows, and ensuring national security. Understanding the dynamics of border crossings is crucial for policymakers, law enforcement agencies, and stakeholders involved in border management. The United States, with its extensive land borders spanning 7,500 miles with Canada and Mexico (DHS, 2024), stands at the forefront of managing cross-border movements.

U.S. Customs and Border Protection (CBP), is the largest law enforcement agency globally, plays a central role in safeguarding the nation's borders. By integrating customs, immigration, border security, and agricultural protection efforts, CBP adopts a holistic approach to border management to ensure the smooth and secure flow of goods and people across international boundaries (DHS, 2024).

The significance of individual border crossings cannot be overstated. For instance, the Ambassador Bridge in Michigan serves as a critical international gateway, facilitating the daily movement of approximately $356 million worth of goods between Detroit and Windsor, Ontario (LaReau, 2022). Such examples underscore the economic and social importance of efficient border operations.

This study seeks to analyze the disparities in border crossings between the US-Mexico and US-Canada borders. By examining factors such as frequency, types of crossings, and geographical distribution, this study aims to identify potential drivers behind these differences. This analysis seeks to contribute to a deeper understanding of border dynamics and inform evidence-based policy decisions to enhance border security, trade facilitation, and crossing management.

Literature Review

Considerable scholarly work has been dedicated to border crossings, covering various perspectives, from political considerations to social and cultural dimensions. Isacson (2023) examines the political implications of policies such as the end of Title 42, shedding light on their effects on border management and immigration enforcement efforts.

In social research, Deutsch and Gavious (2023) provide insights into the social dynamics surrounding border crossings, including community interactions and cross-border relationships. Troncoso (2011) contributes to our understanding of the cultural aspects of border crossings, exploring the intersection of identity, heritage, and borderland narratives.

Furthermore, studies on wait times for border crossings have garnered significant attention. Sakhare, Desai, Saldivar-Carranza, and Bullock (2024) investigate the impact of wait times on travelers and border communities, highlighting the challenges and inefficiencies inherent in border management systems.

Despite the breadth of research in this area, there remains a notable gap in the literature regarding the types of crossings and their significance. Little attention has been paid to categorizing and analyzing the various types of border crossings and their implications for border security, trade facilitation, and immigration management.

It is important to note that the available data for this research is limited to U.S. ports of entry, with no information on egressing types of transportation. Additionally, the data provided by the Canadian Open government is constrained by limited details and aggregation by region and month (Canada.ca, 2024). Similarly, Mexico's open data platform does not offer comprehensive port data for entry (DataMexico, 2024), further underscoring the need for in-depth analysis and research in this area.

Methods

The research utilized Border Crossing Entry Data from data.gov, a government repository of datasets providing summary statistics for inbound crossings at the U.S.-Canada and U.S.-Mexico borders at the port level (data.gov, 2024). This dataset was the primary source of information for analyzing border crossing patterns and trends.

Statistical techniques such as hypothesis testing and regression analysis were used for descriptive analysis, leveraging various packages available in R Studio, including ggplot2, scales, dplyr, and leaflet. These packages enabled data visualization, manipulation, and spatial analysis, allowing for a comprehensive exploration and interpretation of the dataset.

A hypothesis testing approach was adopted to address the research question about differences in border crossings between the US-Mexico and US-Canada borders. The Null Hypothesis (H0) posited no difference in the populations' sums, while the alternative Hypothesis (H1) suggested the presence of a difference in border crossings between the two countries.

Welch's T-test was the preferred statistical method to test these hypotheses. Unlike the traditional independent-sample t-test, which assumes equal variances between populations, Welch's T-test is robust to unequal variances. It is suitable for scenarios where population variances differ (Lu & Yuan, 2022), as shown in Figure 1. This approach allows for a rigorous

Figure 1
Welche's t Test

$$df_w = \frac{\left(s_1^2/n_1 + s_2^2/n_2\right)^2}{\frac{\left(s_1^2/n_1\right)^2}{n_1-1} + \frac{\left(s_2^2/n_2\right)^2}{n_2-1}}$$

Note. The test compares tw against the distribution t(dfw) for significance. Source: Lu and Yuan (2022)

examination of potential differences in border crossing patterns between the US-Mexico and US-Canada borders, providing insights into cross-border dynamics and implications for border management.

The Auto-Regressive Integrated Moving Average (ARIMA) model was used to forecast border crossings over the next five years. ARIMA is a classical statistical model for time series forecasting that captures the trend changes in the time series data (Lv, 2024).

Findings

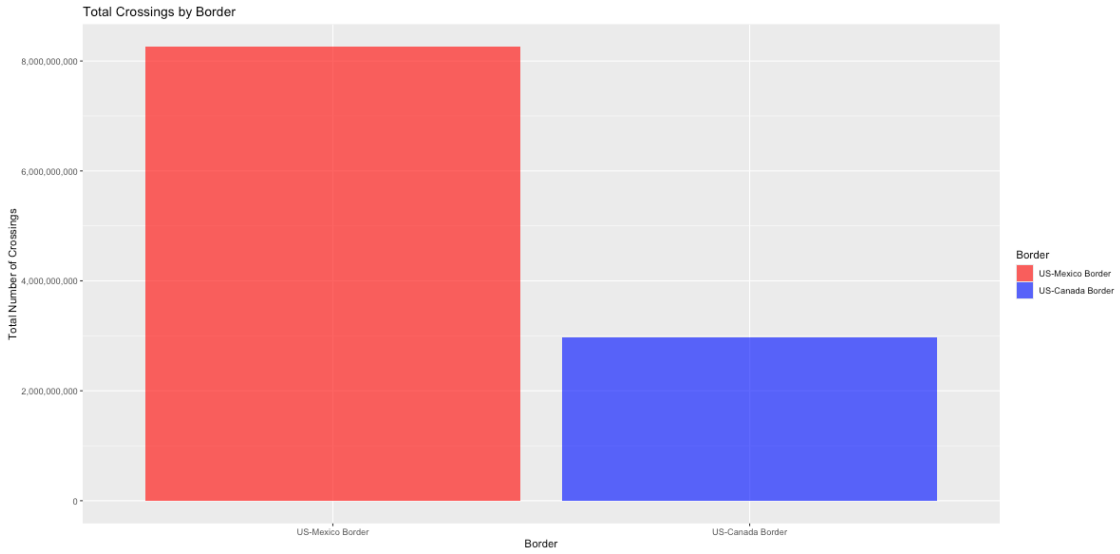
The U.S.-Canadian border, excluding Alaska, spans approximately 3,987 miles, while the U.S.-Mexican border measures about 1,933 miles. The Alaska-Canada border alone stretches 1,538 miles (Beaver, 2006). In total, the U.S. shares 7,458 miles of land border with Canada and Mexico, with 116 ports of entry. Blue markers indicate all U.S.-Canada port entries, while red markers indicate all U.S.-Mexico port entries (Figure 2).

Figure 2
Port Locations

Note. This map was generated using R Studio.

Despite having more ports of entry along the Canadian border, the total value of crossings in 2023 was significantly higher at the Mexican border (Figure 3).

Figure 3
Total Crossings by Border



Note. This bar chart was generated using R Studio.

This finding was confirmed through hypothesis testing, as illustrated in Figure 4.

Figure 4
Welch's Hypothesis Testing

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Welch Two Sample t-test

data:  mexico_border$Value and canada_border$Value
t = 86.427, df = 95071, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 77912.42 81528.22
sample estimates:
mean of x mean of y
89652.124  9931.805
```

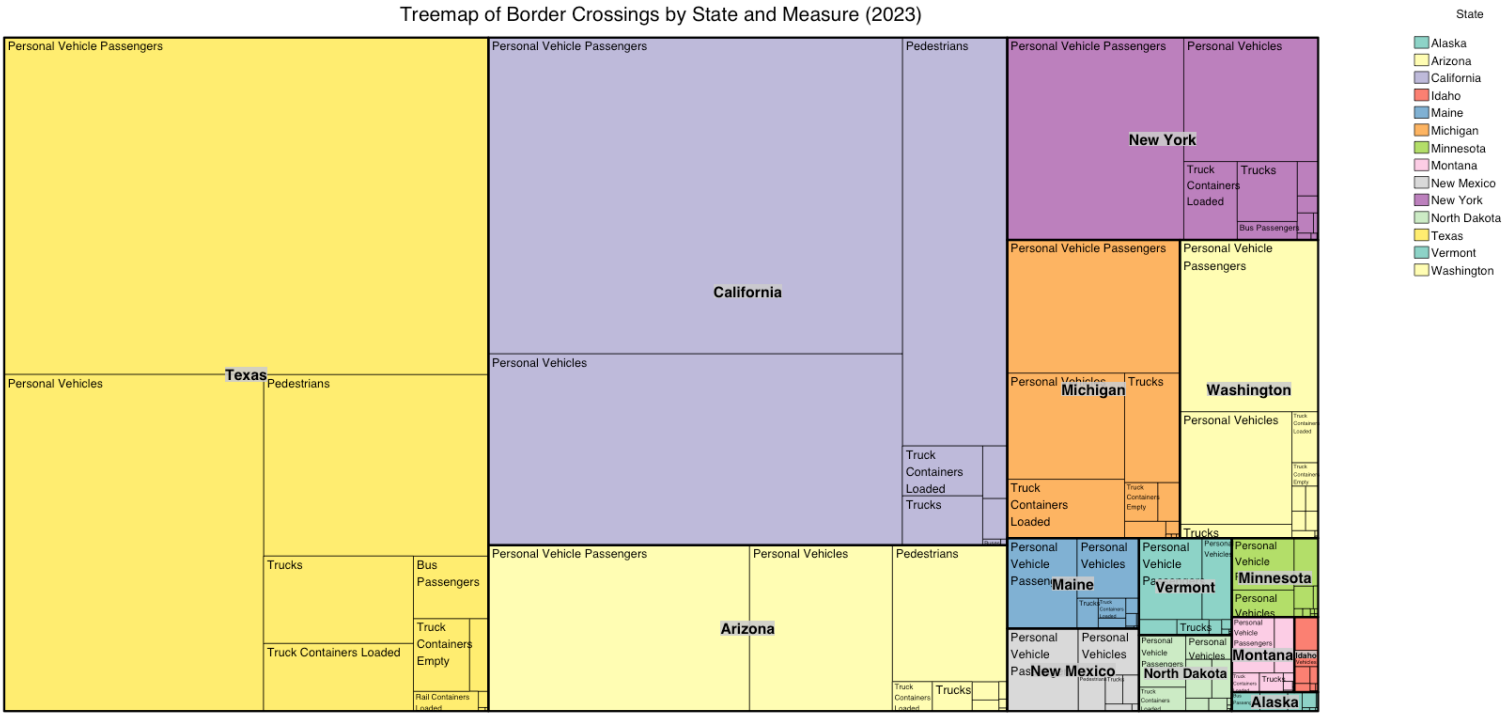
Note. This output was generated using R Studio.

The statistical analysis compared the values of border crossings for the US-Mexico border (mexico_border$Value) and the US-Canada border (canada_border$Value). The t-test statistic measured the difference between the means of the two samples, accounting for variability within the samples. The degrees of freedom (df) for the t-distribution, the p-value indicating the likelihood of observing such a test statistic under the null hypothesis, and the 95% confidence interval for the difference in means were all reported. The mean number of border

crossings for the US-Mexico border was 89,652.124, whereas for the US-Canada border, it was 9,931.805.

In 2023, the southern border saw a much higher volume of Personal Vehicle passengers, as shown in Figure 5. While each state's most prominent type of crossing was personal vehicles, the volume of Personal Vehicle passengers at the Mexico border exceeded the total 'Value' of

Figure 5
Tree Map of Border Crossing Type

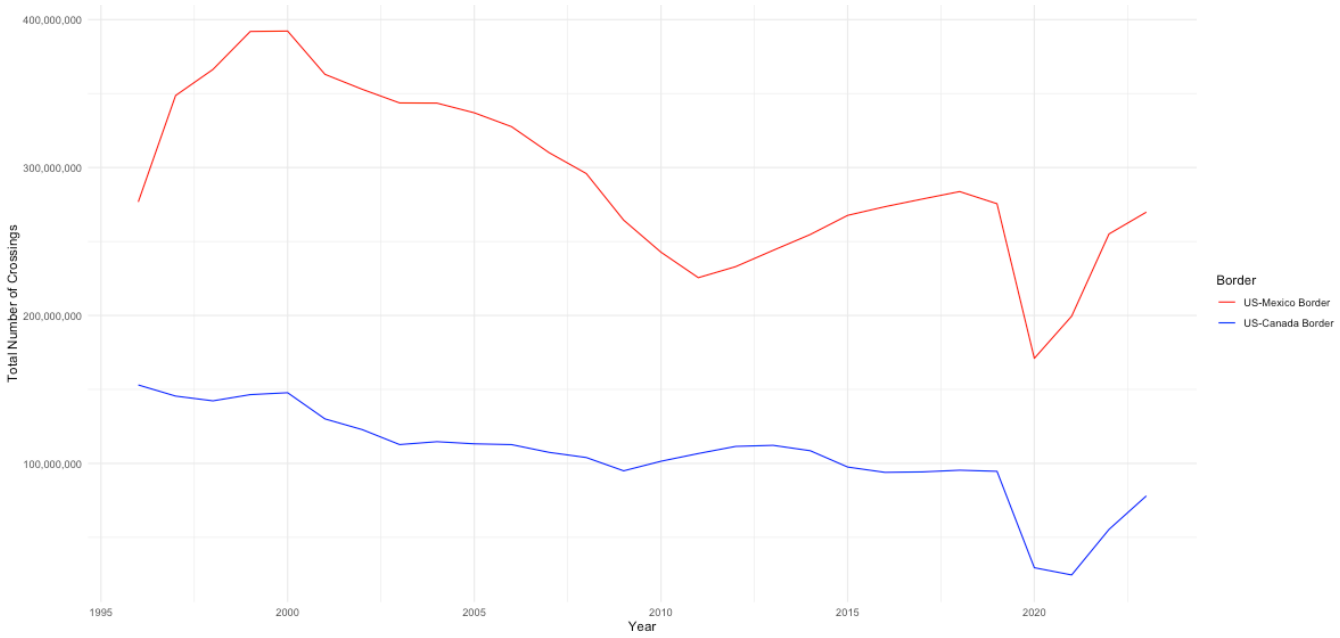


Note. This tree map was generated using R Studio.

crossings for most states.

This pattern of higher crossings at the southern border was also observed over time, as depicted in Figure 6. There was a steep drop in the number of crossings in 2020 due to the Department of Homeland Security's policy to close border crossings in response to the coronavirus pandemic (DHS, 2020).

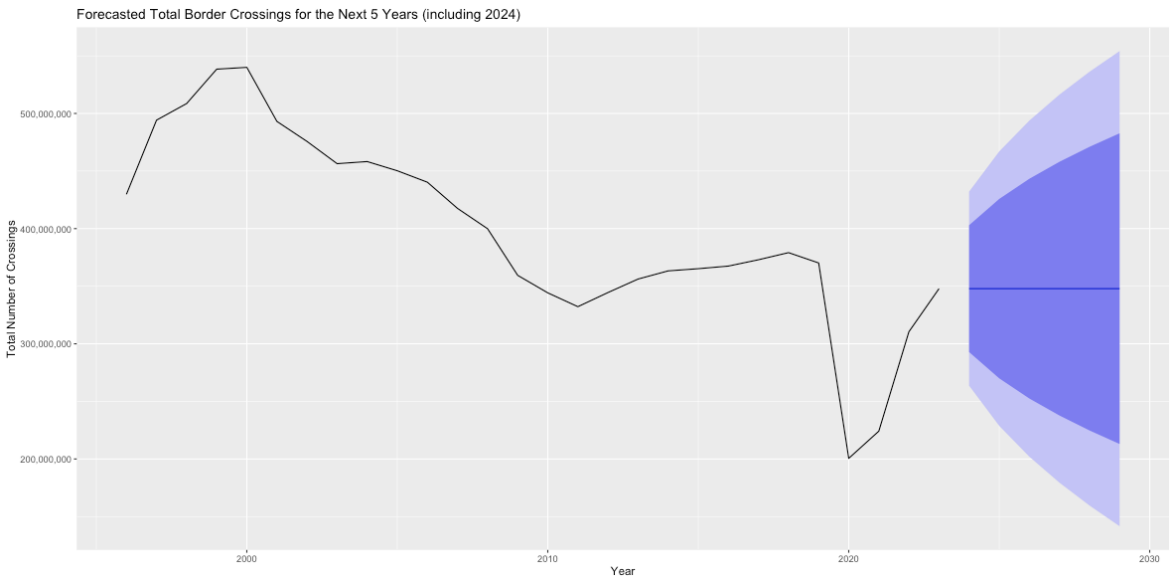
Figure 6
Year over Year Crossings by Border



Note. This time series graph was generated using R Studio.

Lastly, the auto-regression testing using the ARIMA modeling forecasts that over the next five years, the combination of border crossings will continue to remain high (Figure 7). The drop in border crossings in 2020 has caused the funnel forecasted date to open.

Figure 7
Forecasted Border Crossing



Implications

The findings of this research indicate that it is crucial for resource and infrastructure development to prioritize the Mexico border. It is highly anticipated that there will be an increase in border crossings at both borders in the next five years, highlighting the need for improved infrastructure at these ports to accommodate the expected surge in traffic. Specifically, these facilities must be equipped to handle the influx of personal vehicles and their passengers, as this represents the most common type of border crossing.

Furthermore, this research underscores the importance of implementing advanced technology, such as AI, at the borders, as recommended by the IEEE Public Safety Technology publication (IEEE, 2024). It also emphasizes the necessity for cohesive strategic plans among policymakers, given the widespread impact of this issue on multiple states and borders. Managing the high volume of border crossings on both the Mexico and Canadian borders presents numerous challenges, and there is a need to raise public awareness in non-border states about the significant resources and technology required by border states to effectively manage the diverse and substantial volume of crossings each year.

Future Directions and Conclusions

Future research should prioritize studying border crossing changes over time, focusing on the impact of specific policies or events, such as Title 42 and COVID-19. It is essential to conduct comparative analyses to determine if there is a correlation between the type of crossings and specific ports. This research will be crucial in guiding the allocation of resources and the implementation of appropriate technology at each port.

Furthermore, future studies should emphasize the need for comprehensive egress data from Mexico and Canada. This will provide a more complete understanding of the types of

crossings and any emerging patterns, offering valuable insights for border management and policy development.

In conclusion, this research comprehensively analyzes border crossings between the United States and its neighboring countries, Canada and Mexico. The findings reveal significant disparities in the volume and types of crossings at the two borders, with the US-Mexico border experiencing substantially higher traffic. Overall, this research contributes valuable insights into border crossing dynamics.

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