



COLORADO STATE
UNIVERSITY



Fort Collins Sales Tax Forecast



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Rockwell West Rm 107

Who We Are

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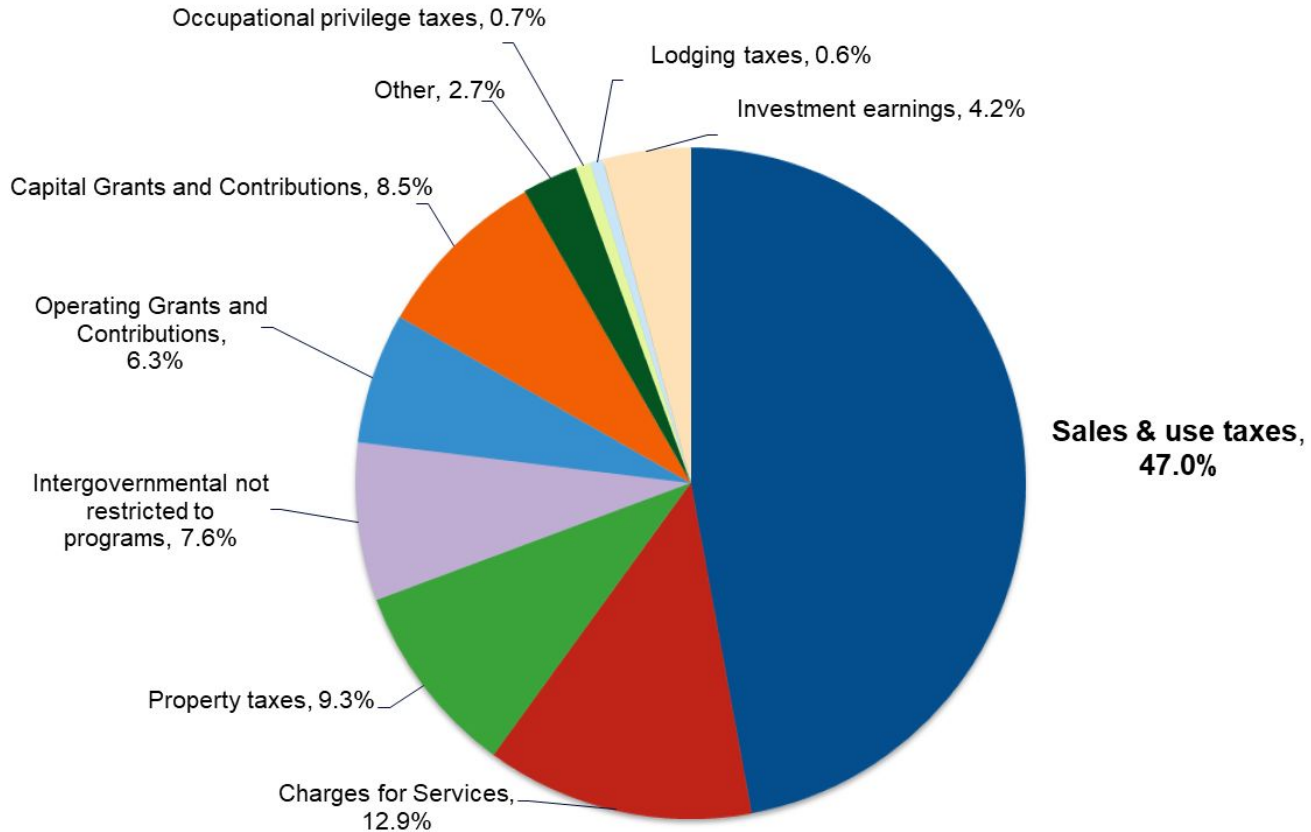


Introduction

- Economic forecasting can help inform the budget of the city of Fort Collins
- Use of cointegrated data spanning from 2012-2024
- Use of a Vector Error Correction Model to predict the sales tax of Fort Collins, CO
- Estimated 2024's sales tax to test for accuracy then estimated 2025's tax



2023 Revenue by Source - Governmental Activities \$379.0 million



Outline

- Economic Theory
- Data
- Overview of the Models
- Results
- Limitations and Uncertainty



Economic Theory

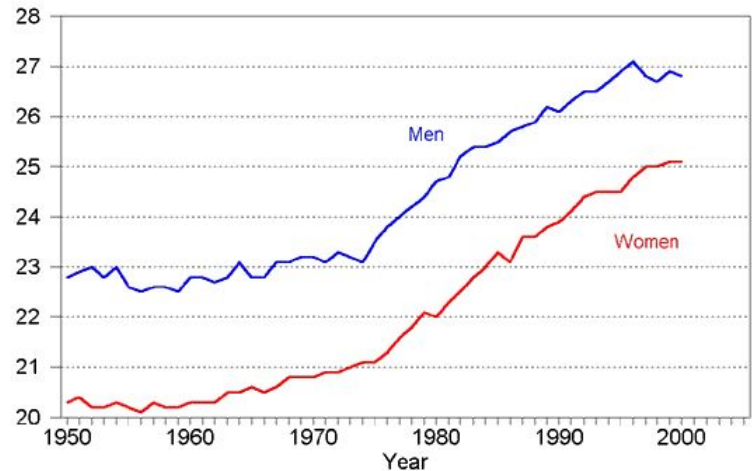
- Model built on premise that related economic forces tend toward balance in the long run but with **temporary disturbances** .
- In Fort Collins, traffic, employment, and unemployment tend to move with sales tax revenue over time.
- Use cointegration and a Vector Error Correction Model (VECM) to capture and adjust for these relationships.



Economic Theory

- Johansen cointegration test confirms long-run relationship among these variables and justifies their inclusion in the model, paving the way for the application of VECM.
- VECM framework adjusts for the short-run deviations as the model may deviate from the long-run trend.
- Incorporating error correction term makes model dynamic and responsive to **immediate fluctuations** while **preserving long-term consistency**.

Average age at first marriage



Source: Census: <http://www.census.gov/population/www/socdemo/mh-fam.html>

Figure 8. Net Taxable

	December			Year to Date		
	Actual 2023	Actual 2024	% Change	Actual 2023	Actual 2024	% Change
\$ in Millions						
SALES TAX						
Grocery, Convenience, Liquor	\$56.2	\$54.8	-2.5%	\$687.3	\$692.9	0.8%
Restaurants, Caterers and Bars	45.5	49.0	7.7%	614.1	630.2	2.6%
General Merchandise	33.4	35.9	7.5%	411.5	442.1	7.4%
Vehicle Sales, Parts and Repairs	22.5	23.4	4.0%	287.9	276.9	-3.8%
Building Materials, Garden Equipment & Supplies	24.5	19.4	-20.6%	313.7	289.6	-7.7%
Sporting, Hobby, Book, Music	10.5	10.7	2.3%	143.7	134.7	-6.2%
Broadcasting and Telecommunications	7.7	7.6	-1.6%	91.8	86.5	-5.8%
Electronics and Appliances	9.9	10.5	5.7%	126.1	121.8	-3.4%
Miscellaneous Retailers	50.9	55.8	9.6%	575.2	654.2	13.7%
Utilities	11.7	11.9	1.3%	171.0	161.2	-5.7%
Clothing and Accessories	10.6	11.1	3.9%	131.8	135.3	2.7%
Pharmacy, Salon and Laundry	11.0	11.6	6.0%	151.3	142.6	-5.8%
Other	8.2	9.2	12.2%	127.1	146.8	15.4%
Rental and Leasing Services	4.1	4.0	-3.9%	59.9	63.1	5.5%
Furniture and Home Furnishings	5.8	6.2	7.3%	76.2	70.9	-7.1%
Wholesale Trade	4.8	5.6	16.5%	80.4	84.9	5.6%
Lodging	5.4	5.3	-0.5%	92.3	92.3	0.1%
Manufacturing	5.2	7.6	46.0%	98.8	115.4	16.7%
NET TAXABLE SUBJECT TO SALES TAX	327.9	339.6	3.6%	4,239.9	4,341.3	2.4%

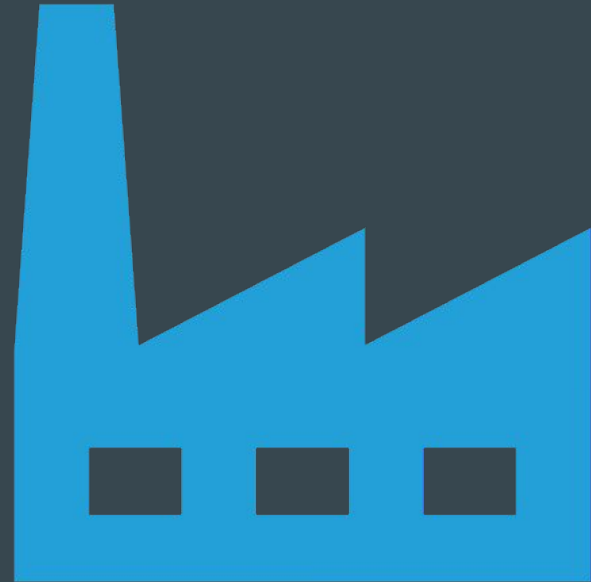
Bureau of Labor Statistics Data Supply Side Labor

- Who: Retail Trade employees, local restaurant employees, grocery store employees, etc.
- Cointegrated: labor in these sectors is a proxy of the respective sales
- Sales Tax: generated from goods sold by these laborers.



Bureau of Labor Statistics Data Demand Side Labor

- Who: Manufacturing, services, transportation, etc.
- Cointegrated: more people working more things they can buy
- Sales tax: generated from purchases made by these laborers as consumers

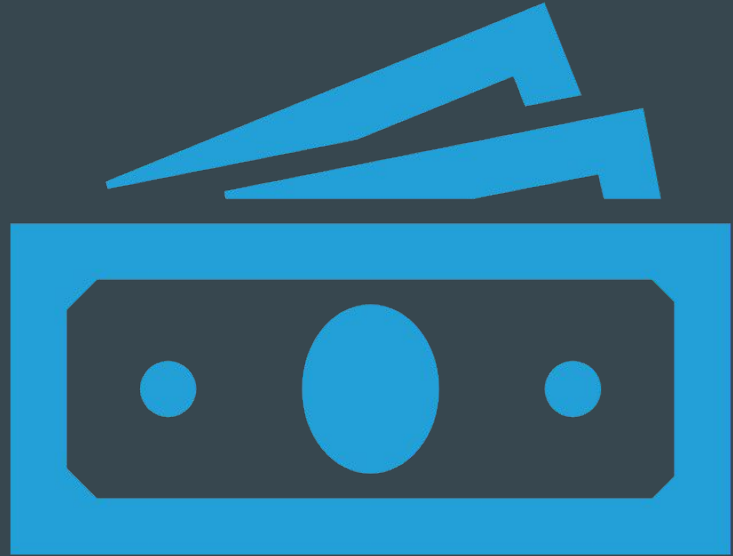


Business License Counts

Where: City of Fort Collins provided license count data

Cointegrated: more businesses = more sales

Sales tax: Sales tax generated from businesses selling their goods



Alternative Data

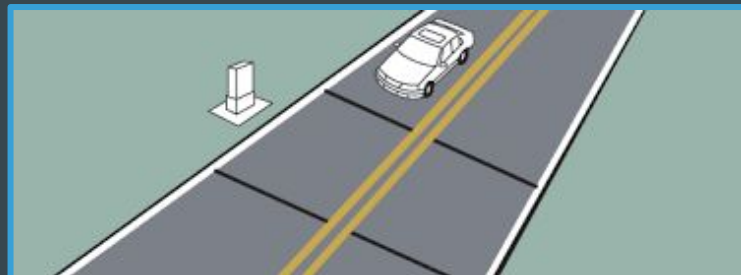
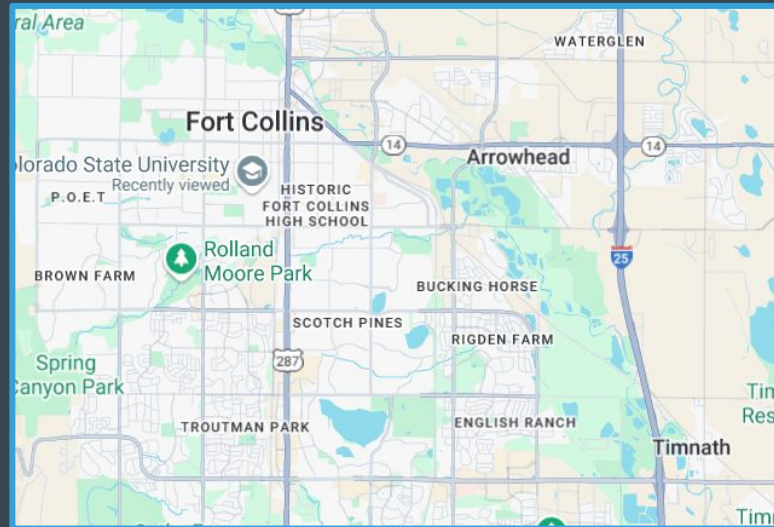
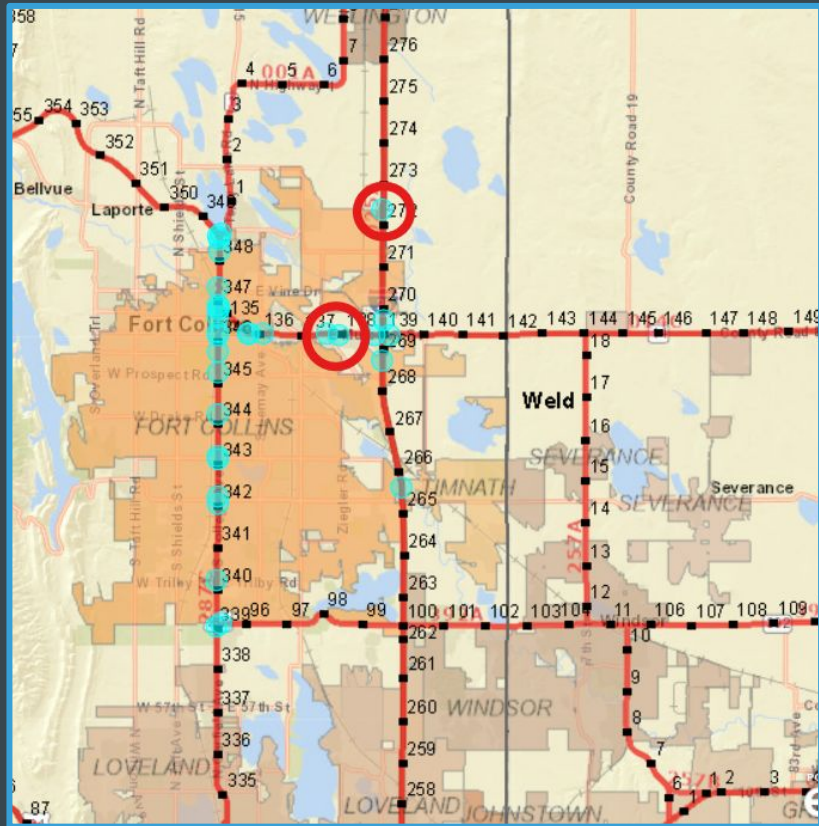
Online Transportation and Information System traffic data:

- Where: CDOT registers the number of vehicles that pass traffic stations.
- Cointegrated: more cars going through a city is more sales
- Sales Tax: generated by purchases made by drivers

FRED Unemployment Rate and Average weekly hours of all Employees:

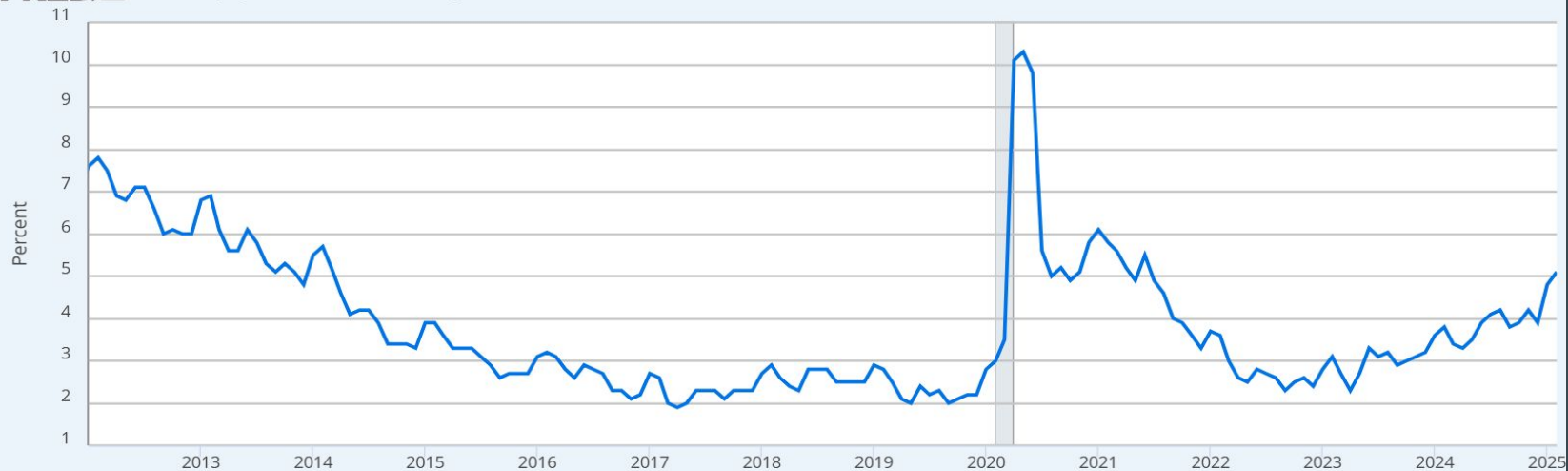
- Where: Data posted by the Federal Reserve retrieved from the BLS
- Cointegrated: more workers working more hours more money to buy things
- Sales Tax: generated by purchases made by workers

Colorado Department of Transportation Data

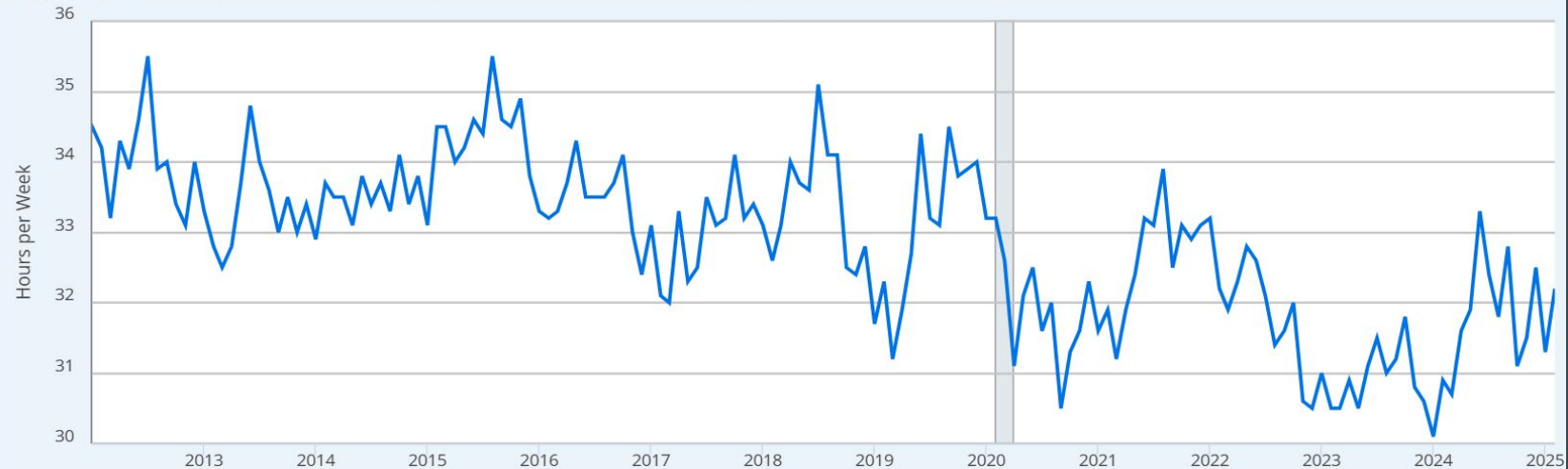


Inroad sensor used to measure volume

FRED — Unemployment Rate in Larimer County, CO



FRED — Average Weekly Hours of All Employees: Total Private in Fort Collins-Loveland, CO (MSA)



Overview of the Model

- **Goal: Analyze and forecast Fort Collins Sales Tax for 2025**
- Used historical sales tax, Bureau of Labor Statistics (BLS) variables, and outside data sources
- Monthly, from January 2012 to January 2025
- Test the model's prediction accuracy against known 2024 tax receipts
- Forecast values for 2025

Model Example

Our dataset consists of monthly economic indicators- cointegrated:

- Bureau of Labor Statistics Employment Data (BLS):
 - Mining, Logging and Construction (MLC)
 - Manufacturing (MAN)
 - Wholesale Trade (WT)
 - Trade, Transportation, and Utilities (TTU)
 - Retail Trade (RT)
- Outside Data Source : Larimer County Unemployment Rate

Example of Code Used:

```
df ← data.frame(FinalData$MLC, FinalData$MAN, FinalData$WT, FinalData$TTU, larimer_unem$unem, FinalData$RT)
```


Process: VECM Example

Data preparation: lead-lag adjustment, inflation (CPI), 2024 tax rate, log transformation

Johansen Test for Cointegration: identify the number of long-term relationships among variables

Result : 4 Cointegrated Vectors

	[,1]	[,2]	[,3]	[,4]
MLC.l12	1.000	0.000	0.000	0.000
MAN.l12	0.000	1.000	0.000	0.000
WT.l12	0.000	0.000	1.000	0.000
TTU.l12	0.000	0.000	0.000	1.000
LAEM.l12	0.140	0.054	-0.020	-0.039
RT.l12	0.770	1.021	1.096	-0.771
Lead_STF_real.l12	-1.788	-1.440	-2.285	-0.488

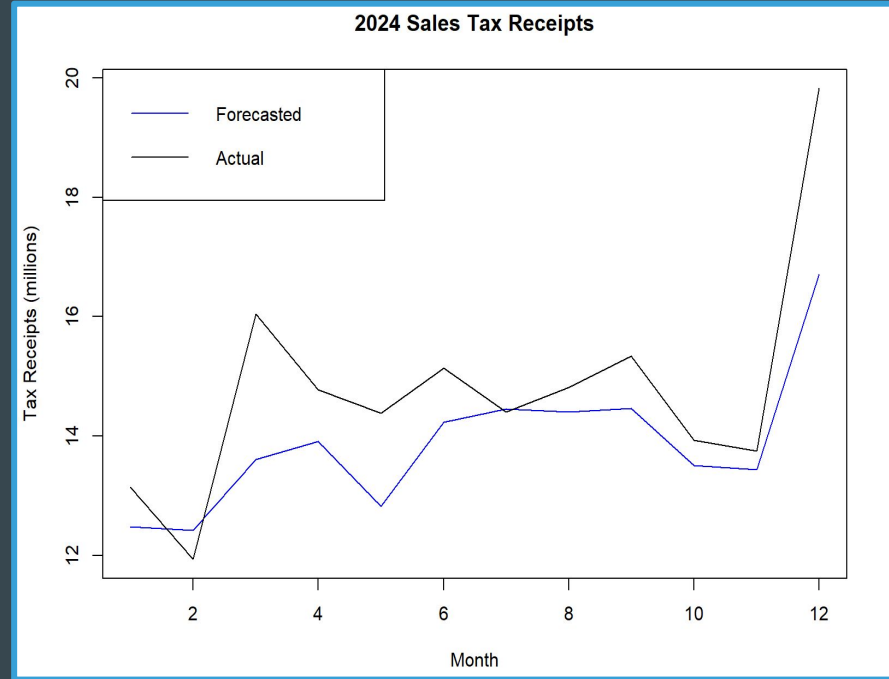
Long-run Dynamics: how different variables move together over the long time horizon

Short-run Dynamics: shocks in the short run taking variables out of their long-run equilibrium

Error Correction: the manner by which variables returned to their long-term equilibrium after a disturbance/shock in the system

Testing Accuracy and Forecasting

- To ensure model accuracy:
 - Fit the model using data up to December 2024
 - Forecasted sales tax for 2024
 - Compared known actual vs forecasted
 - Mean Absolute Error (MAE) = 1.011
- Forecasting Future Sales Tax Revenue:
 - Using data up to January 2025, we forecasted sales tax revenue for the year 2025
 - Time horizon: 11 months of sales tax revenues (February to December)



Results

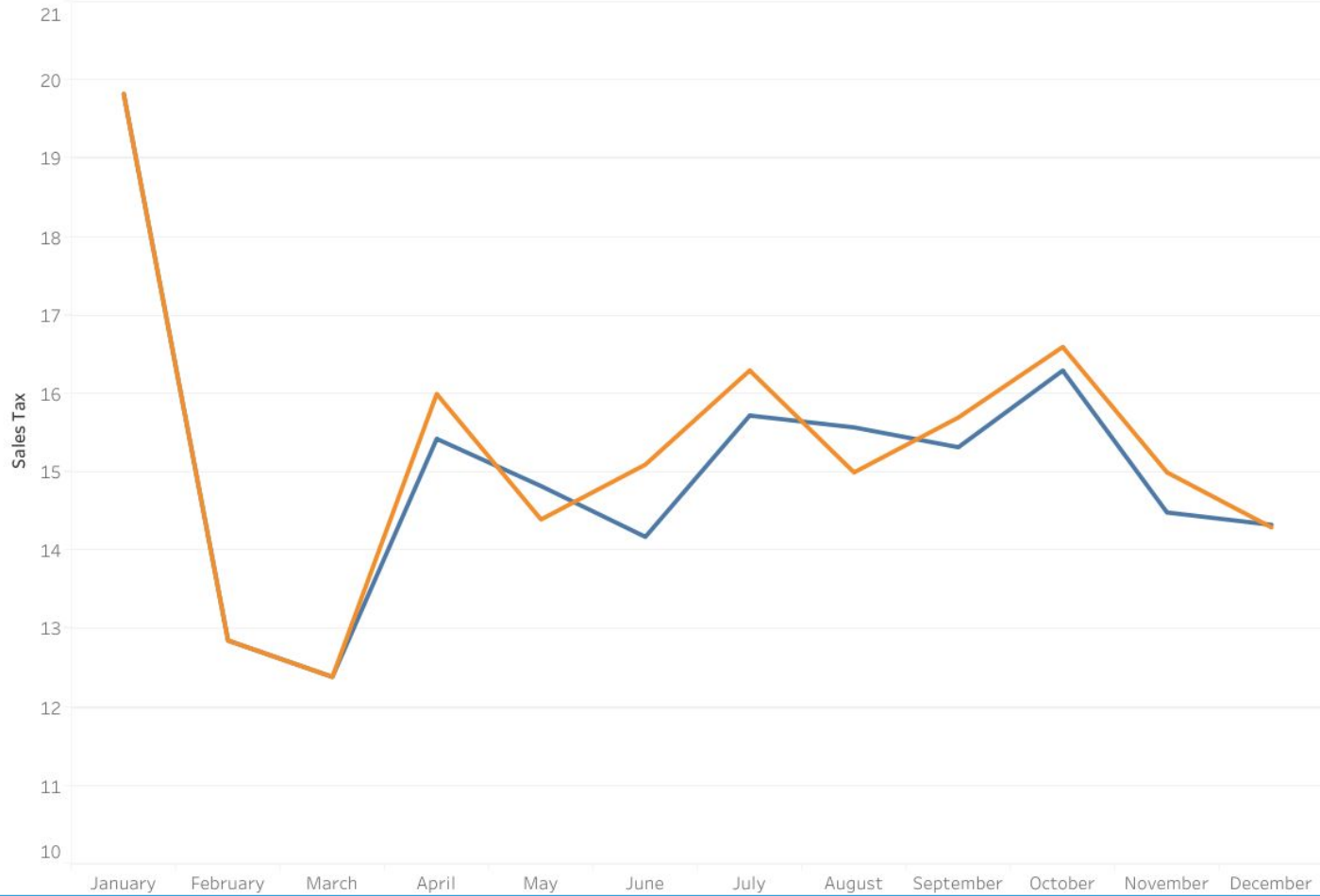
Forecasted Sales Tax - Class Average

MONTH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
FORECAST	19.826	12.856	12.392	15.428	14.826	14.178	15.725	15.574	15.321	16.299	14.489	14.332	181.245
F.C. BUDGET	19.826	12.856	12.392	16.000	14.400	15.100	16.300	15.000	15.700	16.600	15.000	14.300	183.470

\$ in Millions



Sales Tax Forecast: Class Average



Limitations due to Uncertainty

- Current economic climate very uncertain making it extremely hard to forecast accurately
- Forecasts are based on past results and may not be relevant to the new policy landscape
- Uncertainty about the future may lead to lower spending and higher savings

Tariff Uncertainty

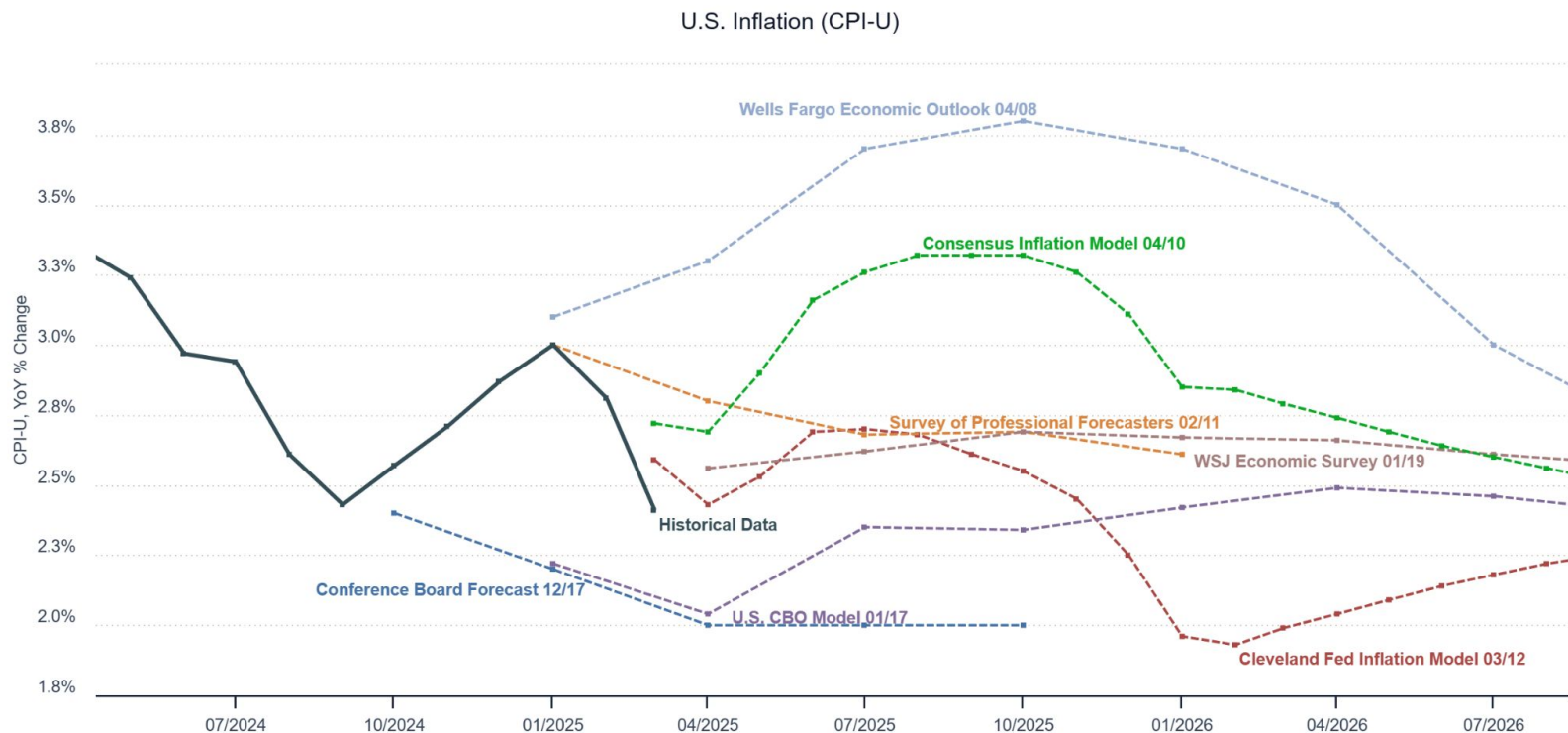


- If significant tariffs go into effect, sales tax receipts will likely be affected via decreased spending on imported goods
- Extreme policy volatility makes it very hard to accurately forecast both long and short run outcomes

Inflation Uncertainty

- Model based on real sales tax receipts (without inflation)
- Final numbers had to be re-inflated based on predicted CPI
- Significant limitations with the current volatility
- Used the Consensus Inflation Model to estimate CPI because it was the most recent estimate, but this is only one of many available forecasts

Range of CPI Estimates



Other Limitations

- One of our biggest struggles was lack of hyperlocal or even semi-local monthly datasets.
- Likely that other cointegrating factors exist that we could not account for.
- All data has potential for errors and possible that the data we used is subject to flaws in reporting/collection, especially data around the 2020 pandemic.
- Had to adjust for the city tax rate changing from 3.85% in 2012-2023 to 4.35% in 2024.
- Businesses remit sales tax to the city on different schedules based on total revenue

Questions?