WageCAN

Analyzing Wages in Canada

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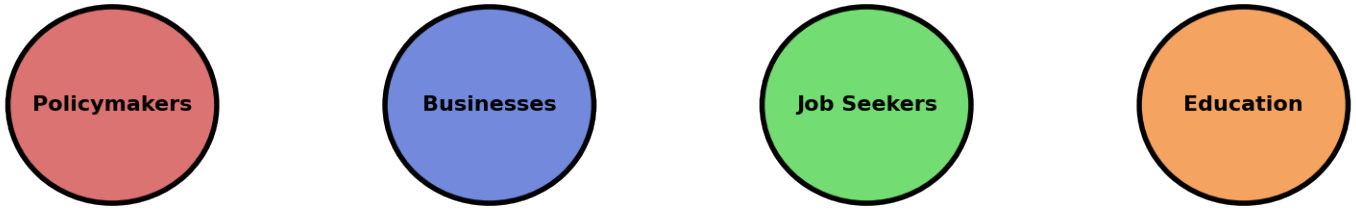
Research Presentation, April 2025

Problem Context

- Wages are a key indicator of economic health, labor stability, and inequality
- COVID-19, inflation, and technological changes have reshaped labor markets
- Lack of structured, longitudinal, predictive wage studies in Canada
- Critical for policymakers, businesses, educators, and job seekers

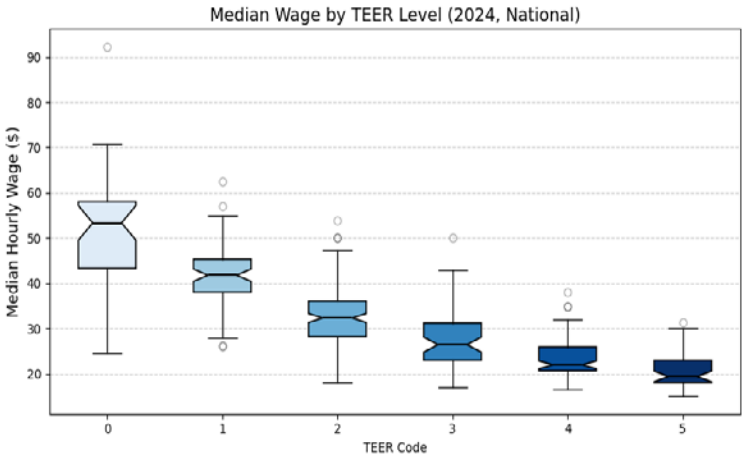


Project Summary

- Analyzed wages in Canada (2016–2024)
- Examined national, provincial, and regional disparities
- Identified **main wage drivers**
- Combined **descriptive**, **unsupervised**, and **supervised** methods
- Tested the stability of wage structures from 2016 to 2024

Key Findings

- **TEER level** (Training, Education, Experience, Responsibilities) is the strongest predictor of wages
- **Occupational category (BOC)** has secondary influence
- **Provincial effects** are modest
- **Regional outliers** exist but are not dominant drivers
- **Wage structures remained stable** from 2016 to 2024



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Methodology Overview

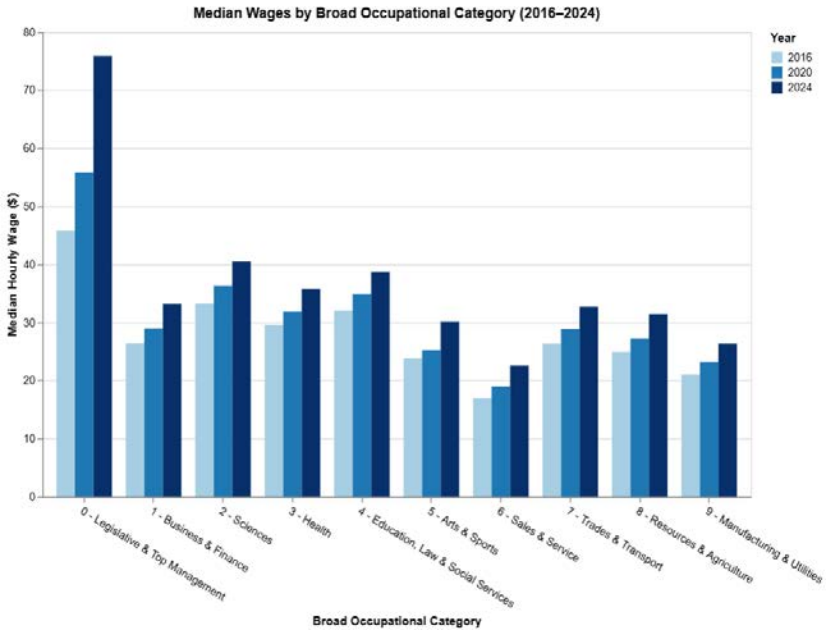
- Collected and unified Canadian wage datasets (2016, 2020, 2024)
- Mapped NOC 2016 codes to NOC 2021 codes
- Engineered features: TEER, Broad Category, Major Group
- Conducted Descriptive Analysis, Clustering and Predictive Modeling
- Evaluated correlation, clustering coherence, and model accuracy

Data Source and Preprocessing

- **Source -** Government of Canada wage reports (open.canada.ca)
- Standardized **column** names and **formats**
- **Mapped** occupations from **NOC 2016 to NOC 2021**
- Cleaned **occupation** titles and **province** names
- **Filtered** outdated entries and **handled** missing data
- Created unified dataset (11,448 records) ready for analysis

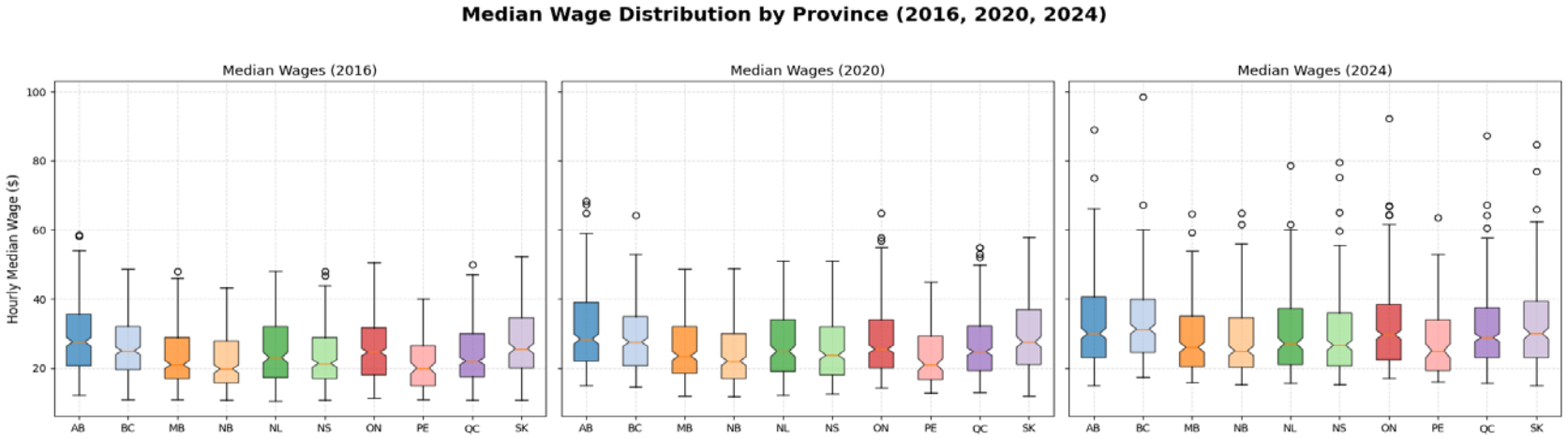
EDA - National-Level Insights

- **TEER** is the strongest predictor of wages
- Broad Occupational Category **(BOC)** shows secondary but noticeable impact
- Consistent wage stratification:
  - TEER 0–1 → Highest wages
  - TEER 4–5 → Lowest wages
- Stable patterns across 2016, 2020, and 2024 datasets



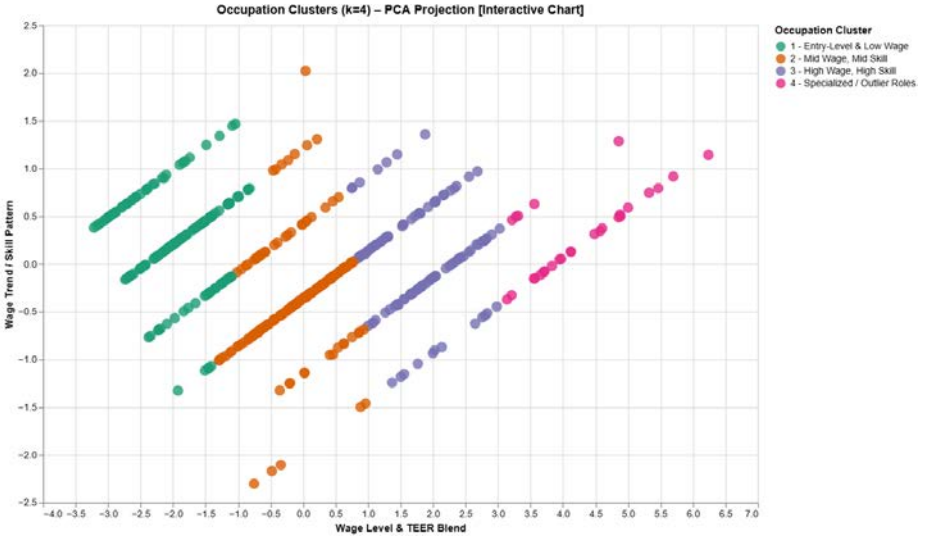
Provincial and Regional Analysis

- Provinces have **minor impact** on wages compared to TEER
- **Alberta**, **BC**, and **Ontario** show **slightly higher** median wages
- **Regional outliers** identified in some economic zones
- Regional effects are **not significant** overall



Pattern Detection via Clustering

- **K-Means and Hierarchical Clustering** on occupational wage data
- Clusters based on **TEER level** and **median wages** (2016–2024)
- **High TEER** and skill level → consistently **higher wages**
- Wage structures are stable across provinces
- PCA confirms strong structure (first PC >95% variance)

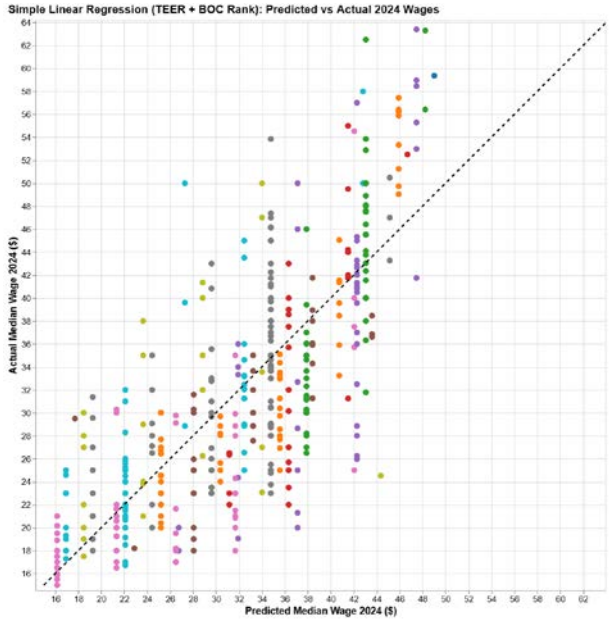


Supervised ML Wage Prediction

- **Built models using:**

  TEER, BOC, Province, Embedded Titles
- **Models:**

  Linear Regression, Random Forest, Gradient Boosting
- **Key Insight:**
  - Simple models **(TEER + BOC)** perform nearly as well as complex ones
  - Embedded titles add little predictive power and risk overfitting



Wage Stability Modelling

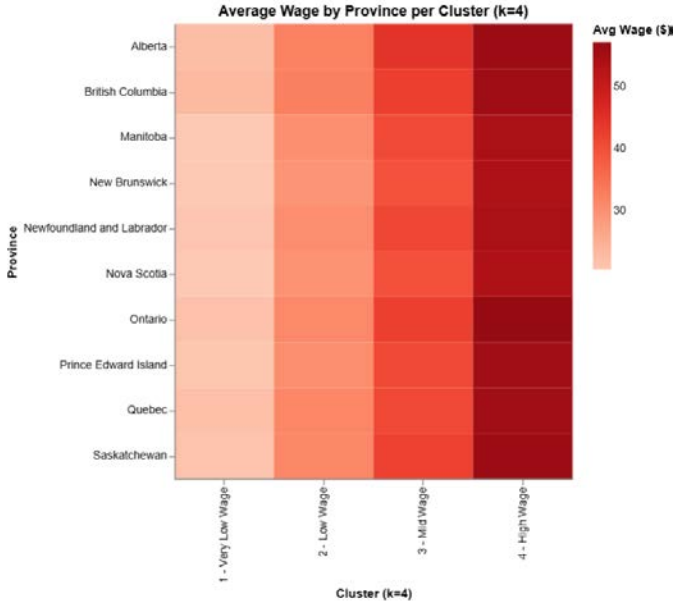
- **Goal:**
  Predict 2024 wages using 2016 and 2020 data only
- **Models:**
  Linear Regression, Random Forest, Gradient Boosting
- **Results:**
  - **High accuracy** ($R^2 > 0.90$)
  - **Low RMSE** across all models
- **Conclusion:**
  Wage growth patterns are highly stable and predictable, even through global disruptions

Evaluation - Correlation and Clustering

- Strong negative **TEER-wage correlation:**

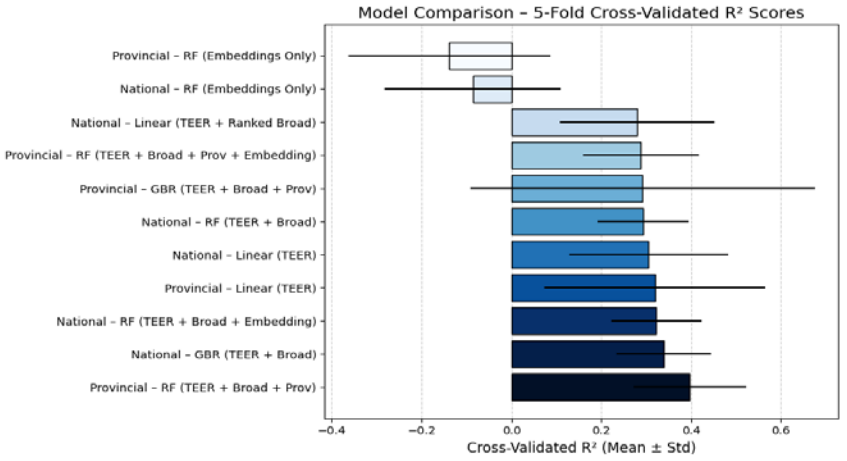
  Pearson −0.75, Spearman −0.77
- Moderate negative **BOC-wage correlation:**

  Pearson −0.34, Spearman −0.31
- **Clustering validated:**
  - Clear **TEER-wage** clusters
  - PCA >95% variance explained
  - Highest-paid clusters showed higher dispersion

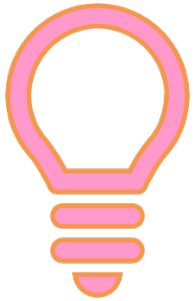


Evaluation – Model Performance

- Compared models using
  - **R^2** (explained variance) and **RMSE** (prediction error)
  - 5-fold-cross-validation to assess generalization
- **Results**:
  - TEER is the strongest predictor of wages
  - Adding BOC and Province gives only minor gains
  - Embeddings caused clear overfitting (negative R^2)



Challenges & Solutions



- **NOC 2016 → NOC 2021 mapping:**
  Resolved with concordance tables + LLM assisted refinement
- **Missing Values:**
  Imputed using national medians or removed
- **Data integrity:**
  Maintained across merged datasets
- **Pipeline design:**
  Modular pipeline built for efficient EDA and modelling

Potential Next Steps

- Expand **longitudinal modelling** to future datasets (2026, 2028)
- Communicate findings to Statistics Canada and stakeholders
- Explore advanced modelling (e.g., neural networks with TensorFlow, PyTorch)
- Monitor for structural shifts in labor markets over time



Biases and Limitations

- **Data Structure Bias:** Dataset differences across years
- **Mapping Uncertainty:** Potential manual errors during NOC transitions
- **Selection Bias:** Excluded low-data territories
- **Overfitting Risk:** Complex models showed optimism bias
- **External Factors:** Future wage shifts (e.g., policy, technology) may break historical trends

Conclusion

- **TEER level** remains the strongest predictor of wages
- Wage structures were **stable and predictable** from 2016–2024
- **Provincial and regional** effects are minor compared to training and education
- **GitHub Repository:** https://github.com/nickshlepov/WageCAN_Project

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