

Investigation of Forensic Crime Lab Characteristics and their Impact on Competency Testing Results

Calvin H.L. Cho (Duke University) | Mentors: Matt Hickman (American Society of Criminology) and Matt Durose (Bureau of Justice Statistics)



Introduction

- The Census of Publicly Funded Forensic Crime Laboratories, 2020 (ICPSR 38901) provides data on forensic crime laboratories from four jurisdictions: federal, state, county, and municipal.
- In a 2023 study, Connor Brooks utilized this dataset and showcased a trend where a lab's competency testing results (the evaluation of a person's knowledge and abilities before performing independent forensic case work) differed significantly depending on the jurisdiction it was under: 93.9% of labs under federal jurisdiction performed competency testing of their analysts, while state, county, and municipal (city) labs were at 91.3%, 85.5%, and 77.4%, respectively.

What are Forensic Crime Laboratories?

- A specialized facility that processes physical evidence from criminal investigations, providing critical data for solving crimes through scientific analysis.
- They often rely on third-party groups to conduct competency / proficiency testing.



- To better assess what factors could be contributing to these differing percentages, the first step was to evaluate budget allocation, number of labs, and the workload in terms of cases handled by each agency type to understand the relationship between resources and operational efficiency.

Budget Allocation and Case Load Across Forensic Crime Labs by Agency Type

Agency Type	# of Labs	Average Budget per lab (USD)	Total Budget of Agency Type (USD)	# of Cases	Budget per case (USD)
Federal	41	5.5 M	225.5 M	0.25 M	920.4
State	112	10.9 M	1,220.8 M	2 M	610.49
County	102	4.4 M	448.8 M	0.65 M	685.19
Municipal	71	5.0 M	355.0 M	0.46 M	760.17

Table 1. Summary table showing agency type, number of centers, average budget, total budget, number of cases, and budget per case. **Federal agencies** operate 41 centers with an average budget per case of **\$920.40**, the highest among all agency types. **State agencies**, with 112 centers, have the largest total budget but the lowest budget per case at **\$610.49**. **County and City agencies** have intermediate budgets per case, with **\$685.19** and **\$760.17**, respectively. The table highlights the differences in resource allocation across different agency types, particularly in terms of budget per case.

Methodology

(1) Data Preparation

The dataset was cleaned by filtering for relevant variables, ensuring consistency in data types, and removing missing or invalid entries.

(2) Exploratory Data Analysis

Initial visualizations, such as bar plots and stacked charts, were created to examine the distribution of requests and structural factors across agency types.

(3) Charting

Graphs were used to depict relationships between variables, including budget allocation, oversight, and structural scores, allowing for clear comparisons between agency types.

(4) Linear Regression Fitting

Multiple linear regression models were applied to test the impact of variables like agency type, oversight, and budget per employee on competency test outcomes.

Results

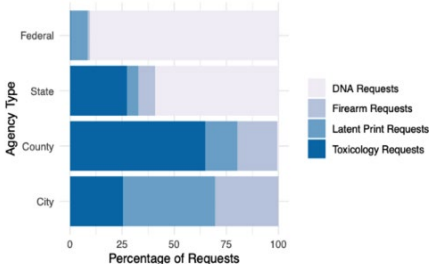


Figure 1. Distribution of requests by agency type, showing a higher proportion of DNA requests for Federal agencies, and a mix of Firearm and Latent Print requests.

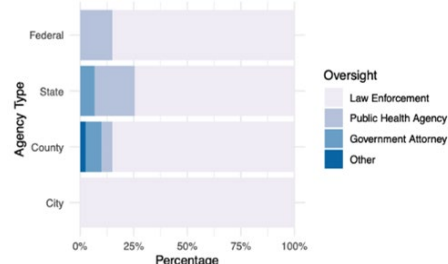


Figure 2. Distribution of agency types by oversight categories, showing Federal primarily under Law Enforcement, while State and County with varied distribution.

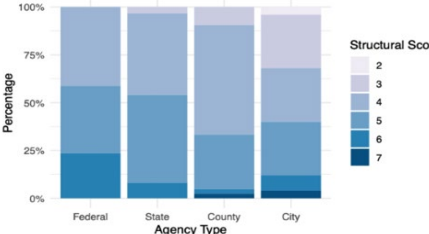


Figure 3. Performance structural scores (Ethics, Training, Verification Checks, Management System, Accreditation, Research Resources, and Random Case Reanalysis) by agency type, showing high scores are more common in Federal and County agencies, while lower scores are more prevalent in City and State agencies.

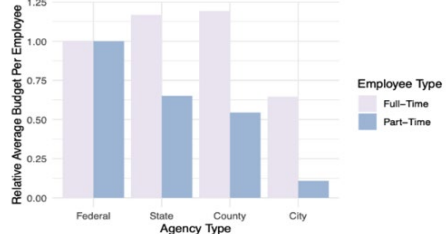


Figure 4. Relative average budget per employee by agency type, comparing full-time and part-time employees. Federal and State agencies allocate relatively higher budgets per full-time employee, while County and City agencies have lower relative budgets for both.

Select Model Performance and Significance Metrics

Variable	p-value	R-Squared	RMSE
Latent Print Requests	0.02	0.05	0.27
Structural Score	0.03	0.17	0.29
Average Budget per Full-Time Employee	0.03	0.03	0.24

Table 2. All three variables are statistically significant (p-values < 0.05), yet the **models have varying levels of explanatory power**. The Structural Score variable explains 17% of the variance ($R^2 = 0.17$), making it the most predictive factor, while the Latent Print Requests and Average Budget per Full-Time Employee explain 5% and 3% of the variance, respectively. The RMSE values, ranging from 0.24 to 0.29, indicate moderate levels of prediction error across the models.

Discussion / Conclusion

Agency type and Oversight do not Significantly Impact Competency Testing Ratings

- For **agency type**, regression models indicated that there were no statistically significant differences in competency test results based on the type of agency (Federal, State, County, or City) as shown by the high p-values for these variables.
- Similarly, the **type of oversight** (Law Enforcement, Public Health Agency, Government Attorney, or Other) did not have a significant impact on competency test outcomes.

Structural Factors and Average Budget-per-Employee Significantly Impact Competency Testing Scores

- A higher **structural score**, which measures performance-supporting structures such as ethics, training, and verification processes, had a significant **negative** impact on competency test results ($p = 0.031$). This suggests that despite the presence of these structures, they may not be as effective in improving outcomes as expected.
- The **budget per full-time employee** was found to have a significant positive impact on competency test scores ($p = 0.003$), indicating that higher funding per full-time staff member correlates with better competency outcomes.

Rate of Latent Print Case Requests Significantly Impact Competency Testing Scores

- Regression analysis results show that the for **Latent Print Requests** (REQ_LTPR_NEW) has a relatively low p-value ($p = 0.019$), suggesting that latent print requests are more closely associated with variations in competency test scores comparatively.
- Interestingly, the chart shows that county-level labs and city-level labs have a higher percentage of the latent print request indicating that there could be a more complex relationship.

References

United States Department of Justice. Office of Justice Programs. Bureau of Justice Statistics. Census of Publicly Funded Forensic Crime Laboratories, 2002. Inter-university Consortium for Political and Social Research [distributor], 2005-09-02. <https://doi.org/10.3886/ICPSR04287.v1>

Brooks, Connor Publicly Funded Forensic Crime Laboratories, 2020. Bulletin. NCJ 306473, Washington, DC: Bureau of Justice Statistics. Anderson, James M., Matthies, Carl, Greathouse, Sarah, Chari, Amalavoyal The unrealized promise of forensic science - A study of its production and use. Berkeley Journal of Criminal Law. 26, (1), 121-180.

Acknowledgements

Thank you to my advisors Professor Matt Hickman (American Society of Criminology) and Matt Durose (Bureau of Justice Statistics) for reviewing and guiding my research project. I'd also like to thank the Office of Justice Programs at the U.S. Department of Justice for hosting the Student Expo opportunity.