Quantitative Methods

Data essay

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Introduction

The main aim of the following analysis is to explore the impact of gender and racial minority status on the number of judicial citations, emphasizing the interaction between these demographic factors. To achieve this goal, the dependent variable of the research will be the frequency of citations received by judicial decisions, reflecting a judge's influence and perceived authority within the legal system. Given these premises, it is important to highlight that the two main independent variables will be related to the gender and ethnic origins of the judge who issued each of the sentences under analysis. By examining the interaction between these variables, the analysis investigates whether female judges from minorities face compounded disadvantages in citation patterns, offering insights into the role of intersectionality in shaping judicial influence.

The variable *citation_5yr_diff_circ_2022* is the dependent variable, measuring the number of times appellate court decisions are cited over five years after publication. Citations are a key indicator of a decision's influence and authority in the legal field, beacuse a higher citation count suggests greater impact and authority. The histogram in *Figure 1* shows a right-skewed distribution, with most decisions receiving few or no citations, while a few have high citation counts. This skewness indicates uneven

influence, with only a minority of cases having significant legal impact. Given this, a negative binomial regression is used, as it is suited for count variables with overdispersion.

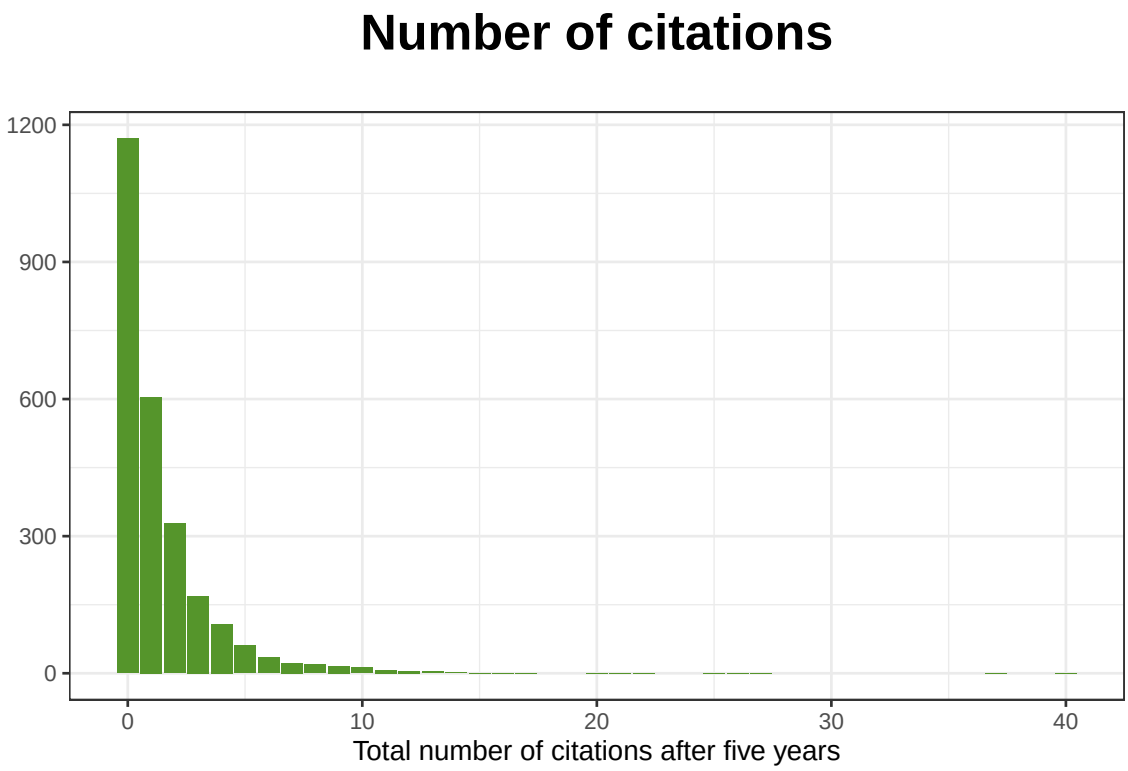

Figure 1: Distribution of the judicial citation

As anticipated in the introduction, the main independent variables used are *femaleOA* and *OAminority*, two dichotomous variables indicating the gender and ethnic origin of the judge who issued the sentence.

The variable *femaleOA* is a dummy variable indicating the gender of the judge who authored each of the decisions in the dataset. It is coded as 1 if the judge is female and 0 if the judge is male. Looking at the values contained in the database, it is possible to observe that there are 2045 male judges and 637 female judges. Considering these values, it is possible to argue that, at least within our data set, the judicial system being analyzed is still mostly composed of men, given their clear predominance.

The variable *OAminority* is a dummy variable indicating whether the judge belongs to an ethnic minority. It is coded as 1 if the judge is non-white and 0 if the judge is white. Examining the values present in the dataset, it is possible to observe that there are 2426 white judges and 478 non-white judges. Taking these values into consideration, it is possible to observe how the judicial system appears to be composed of a clear prevalence of white judges rather than judges belonging to ethnic minorities.

Consequently, by observing the values reported in *Figure 2* below it is possible to verify the distribution of the number of citations for both the main independent variables, namely gender and ethnic group. Looking at the graph it is possible to notice the high presence of white-male judges, who are more than all the other three categories added together. On the contrary, the group that appears to be at the center of the analysis, namely women belonging to ethnic minorities, appears to be the one with the least representation within the data set.

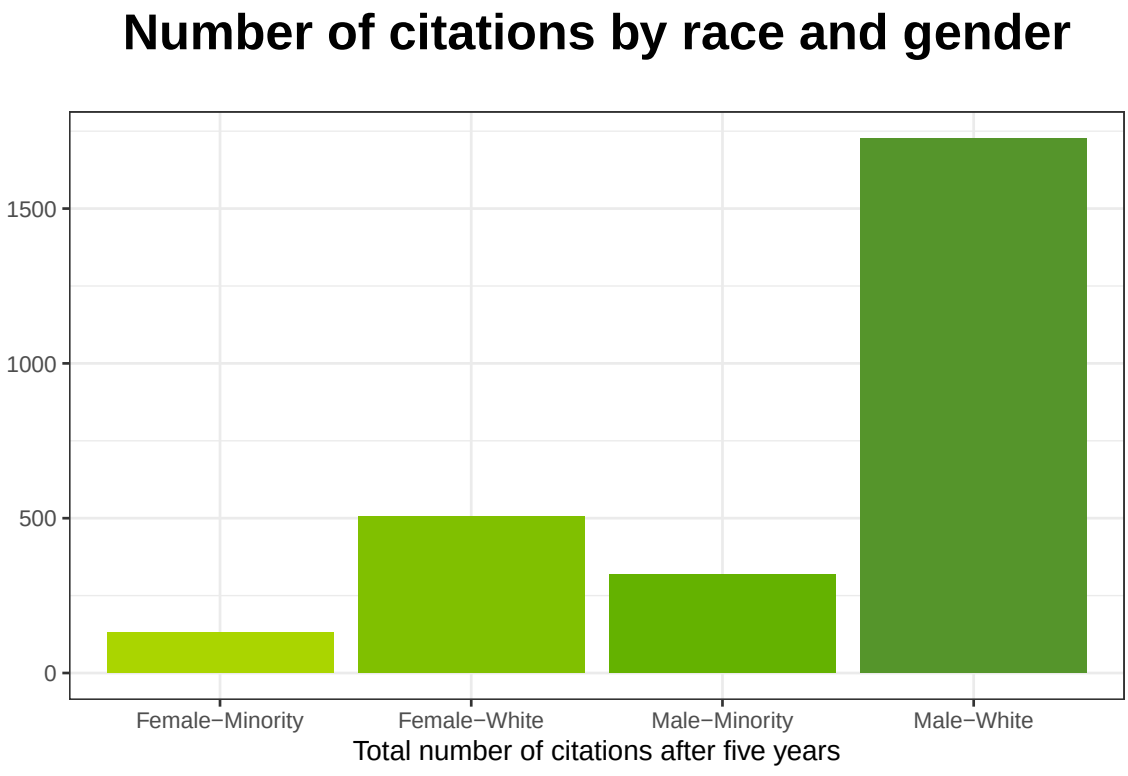

Figure 2: Distribution of race and gender

In addition to these two variables, the decision made was to include their interaction in order to capture the combined effect of gender and minority status on judicial citations. This approach is crucial because the intersection of these characteristics can lead to unique challenges or biases that are not accounted for by their individual effects. Including this interaction allows for a more nuanced analysis of whether these overlapping identities create distinct patterns of influence, ensuring that the model accurately reflects the complexity of demographic impacts on legal authority and perceived judicial credibility.

Moreover, with the purpose of ensuring robust and unbiased results, the decision made was to include some key control variables, namely *OAls_elite*, *authorities_deep*, and *OAtenure_ln*, that address the factors that could influence court citations.

Reliance on precedent is a key indicator of legal quality, with decisions based on precedent often seen as more rigorous. The variable *authorities_deep* controls for the extent of reliance on precedent, helping researchers distinguish between citations driven by legal reasoning and those influenced by a judge's demographics. It captures the depth of decision-making, as well-founded decisions are typically more persuasive and cited more. By controlling for precedent reliance, analyses avoid skewing results, allowing for a clearer understanding of how demographic factors affect citation patterns.

Judges from elite law schools are often seen as more authoritative, influencing how frequently their decisions are cited due to the prestige of their education. The *OAls_elite* variable helps account for this citation advantage, separating it from the quality of their decisions or demographic factors. By controlling for educational background, the analysis can better assess how demographic traits, such as the main independent variables, impact citation patterns without the influence of perceived educational prestige.

Judicial tenure influences a judge's experience and authority, often making their decisions more likely to be cited. The *OAtenure_ln* variable accounts for the effect of professional experience, represented by the logged years a judge has served on the Court

of Appeals. This control separates the impact of tenure from demographic factors, ensuring that citation patterns reflect experience, not just demographic characteristics. Including tenure reduces bias and provides a clearer understanding of how demographics influence citation rates, independent of a judge's expertise and seniority.

Including these variables ensures the model accounts for factors influencing citation patterns beyond demographics, minimizing omitted variable bias, strengthening causal inference, and providing a more accurate assessment of how gender and minority status impact judicial influence. This approach isolates the hypothesized effects, ensuring observed differences are attributable to the judges' demographics, not other factors. Based on this, the model presented in the following pages is designed as follows:

$$citation = \beta_0 + \beta_1 * female + \beta_2 * minority + \beta_3 * female * minority + \beta_4 * authorities + \beta_5 * elite + \beta_6 * tenure$$

Negative binomial models

Before presenting the models, it is necessary to explain why the chosen regression type is *Negative Binomial* and not *Poisson*. After testing both models, a Likelihood Ratio Test (overdispersion test) was applied to decide between the two hypothesized specifications. The results show that the *Negative Binomial* regression is more efficient in representing the data used in the regression. Consequently, the decision was made to apply two models: a simple one, containing only the two independent variables and the interaction term, and a more complex one, with all the control variables, as previously represented.

The results of *Model 1* indicate that being a female judge or belonging to an ethnic minority individually has no statistically significant effect on the number of citations for judicial decisions. However, the interaction term for female judges from ethnic minority backgrounds is statistically significant, suggesting that their decisions are cited

Table 1: Results of the negative binomial models

	Dependent variable:	
	Number of citation	
	(1)	(2)
Constant	0.409***	0.0004
	(0.038)	(0.105)
Female	−0.046	−0.153*
	(0.080)	(0.079)
Ethnic minority	0.112	0.060
	(0.094)	(0.092)
Reliance on precedent		0.065***
		(0.006)
Years in Court		−0.001
		(0.034)
Elite school		0.100
		(0.061)
Female*Ethnic minority	−0.433**	−0.285
	(0.187)	(0.183)
Observations	2,373	2,373
Log Likelihood	−3,939.913	−3,878.208
θ	0.642*** (0.032)	0.717*** (0.038)
Akaike Inf. Crit.	7,887.826	7,770.415
Note:		*p<0.1; **p<0.05; ***p<0.01

less frequently compared to others. This finding highlights a potential compounded disadvantage based on intersecting demographic characteristics. The constant term is highly significant, reflecting the baseline citation rate. Overall, the results suggest that while individual identity factors may not always impact citations, their interaction does in a meaningful way.

Looking at the results of *Model 2* is possible to notice that variable gender has a negative, statistically significant coefficient, indicating that decisions by female judges receive fewer citations than those by male judges, suggesting potential gender bias. At the same time, the ethnic minority variable has a positive but insignificant coefficient, showing no clear evidence that minority status alone affects citation patterns. Also, the interaction term is not significant, suggesting that the combined effect of being an ethnic minority and being a woman is not statistically significant and therefore does not influence the total number of citations obtained in the five years following the issuance of the sentence. The first control variable, reliance on precedent, has a positive and significant effect, showing that adherence to precedent increases citation frequency and enhances judicial rulings' perceived value and quality. In parallel, the other control variables are not significant: elite school attendance has a positive but insignificant coefficient, and years of service on the Court of Appeals have a negative but similarly insignificant coefficient, suggesting these factors do not strongly influence the number of citations made by other judges.

First difference by race and gender

To assess gender and ethnic differences as outlined in the hypotheses, it is necessary to control for the expected values from previous models based on the same personal characteristics. This requires four simulations to evaluate the differences across the three hypotheses. The results presented in the graph show the first differences in citation likelihood between minority female judges and three other groups: white males, white females, and minority males. The red vertical line at zero represents no difference in

citation rates. Positive values indicate higher citation likelihood for the comparison group relative to minority female judges, while overlapping the red line suggests no statistically significant difference.

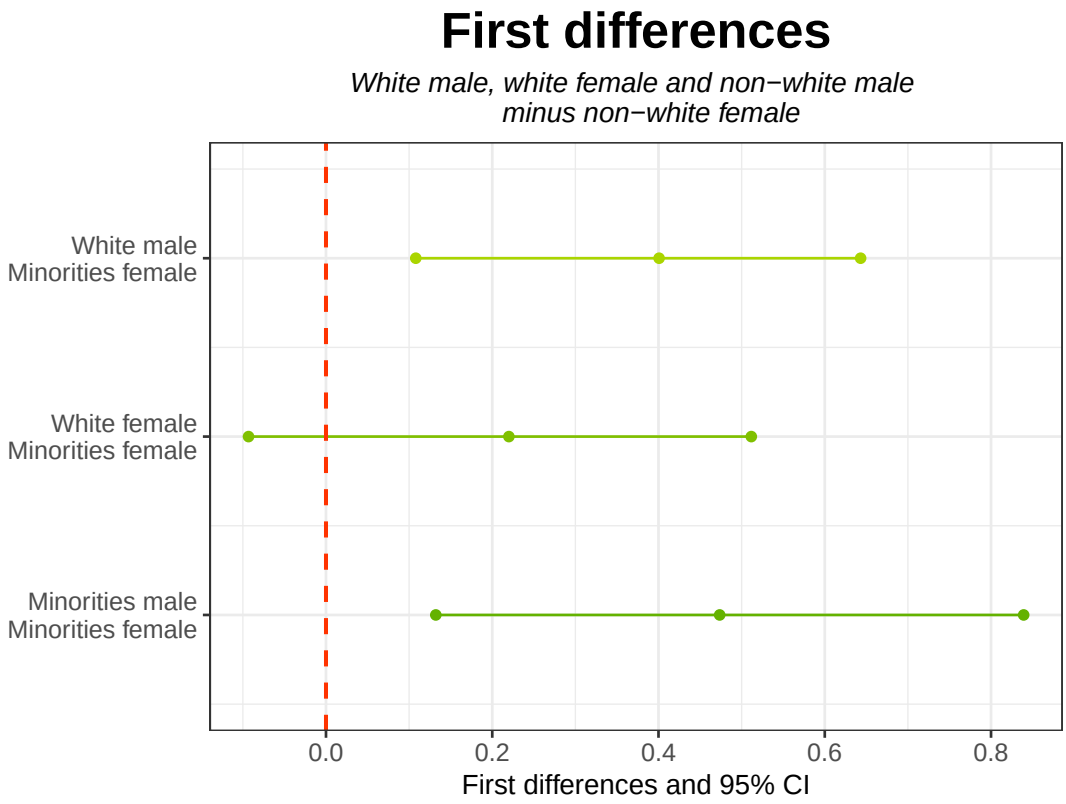

Figure 3: First difference

White male judges show a significant positive difference in citation rates compared to minority female judges. The confidence intervals do not overlap with zero, indicating that white male judges are cited more frequently. This supports the hypothesis that demographic biases favor white male judges in citation patterns. Minority male judges also demonstrate a citation advantage over minority female judges, with their confidence intervals similarly above zero. This suggests that if there is a bias towards ethnic minorities, it is most evident only in the case of female judges. In contrast, the comparison between white female judges and minority female judges reveals a first difference where the confidence intervals overlap the red line at zero. This indicates that the

difference in citation likelihood between these two groups is not statistically significant. This result suggests that while gender and race biases are evident when comparing minority women to male judges, the race difference within gender groups may not be as pronounced. Overall, the results underscore the compounded disadvantages faced by minority female judges, aligning with intersectionality theories, while also highlighting variability in the effects of gender and race across groups.

Robustness check

To increase the validity of the inferences and to see if the estimated effects of interest are sensitive to changes in the model specifications, a robustness check will be applied which will consist in the removal of the outliers present within the *Model 2* previously exposed. To verify if this check is significant, the simulation results using the values obtained with the new model without outliers are proposed in *Figure 4*.

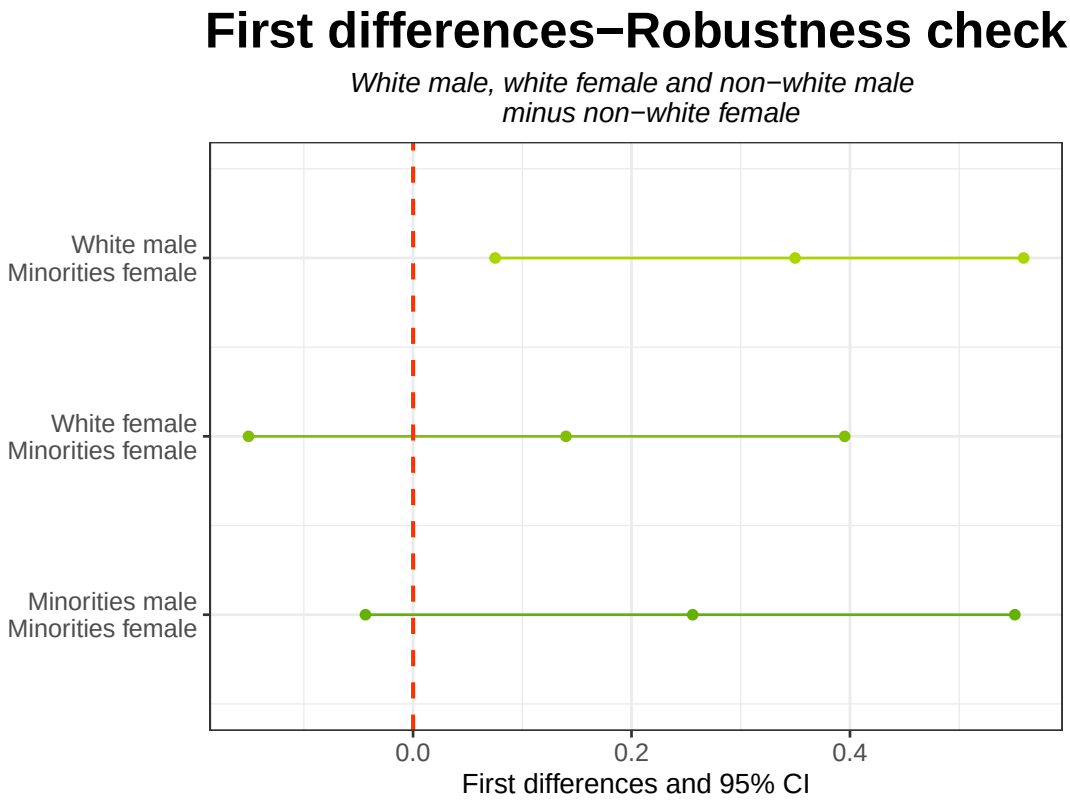

Figure 4: First difference - Robustness check

The robustness check refines the analysis of citation disparities between minority female judges and other demographic groups. While the positive first difference for white male judges remains statistically significant, as its confidence interval does not overlap with zero, the differences for white female judges and minority male judges do overlap with the zero line. This indicates that their citation advantages relative to minority female judges are not statistically significant when outliers are excluded. The persistence of a significant advantage for white male judges highlights the substantial bias associated with both race and gender. Meanwhile, the reduced significance of the other comparisons suggests that outliers may have influenced the earlier results for these groups. Overall, the robustness check reinforces the conclusion that intersectional biases impact citation patterns, particularly disadvantaging minority female judges.

Conclusion

The analysis highlights significant disparities in judicial citations based on gender and racial minority status, with compelling evidence of intersectional biases. The initial results reveal that minority female judges receive fewer citations compared to the other groups, with statistically significant differences for white males and minority males. These findings suggest compounded disadvantages for minority female judges, reflecting both gender and racial biases. However, the robustness check, excluding outliers, reveals a more nuanced picture: while white male judges retain a significant citation advantage, the differences between minority females and white females or minority males are no longer statistically significant. This indicates that outliers may have inflated the perceived disadvantages faced by minority female judges relative to these groups. Overall, the results confirm that intersectionality shapes citation patterns, with minority female judges experiencing the greatest barriers. The robustness of white male advantages underscores the persistence of structural inequalities in the legal system.