STATE OF NORTH CAROLINA
IN THE GENERAL COURT OF JUSTICE
SUPERIOR COURT DIVISION
COUNTY OF WAKE

Common Cause, et al.,	)	
	)	
Plaintiffs,	)	
	)	
v.	)	Docket No. 18 CVS 014001
	)	
Representative David R. Lewis, et al.,	)	
	)	
Defendants.	)	

AFFIDAVIT OF JANET R. THORNTON, Ph.D.

STATE OF FLORIDA)
) ss.
COUNTY OF LEON)

Dr. Janet R. Thornton, affiant, affirms under oath as follows:

1. I am a Managing Director at Berkeley Research Group (BRG), a consulting firm specializing in the application of economic, econometric, and statistical analysis to litigation, regulatory compliance, and risk assessment matters, among other specialties. BRG experts have analyzed data for matters involving firms in many sectors, government entities, as well as institutions of higher education and research. My fields of special interest include computer analysis of large databases, applied econometrics and statistical analysis.

2. I received doctoral and master's degrees in economics from The Florida State University, and a bachelor's degree from the University of Central Florida in economics and political science.

3. I am a member of the American Economic Association and the National Association of Forensic Economics.

4. Prior to my employment at BRG, I was employed at ERS Group for nearly 30 years and held the title of Managing Director. Over the past 30 years, I have prepared analyses for both plaintiffs and defendants, as well as for risk assessment. In the field of labor economics, I have performed research and analyzed data in matters involving allegations of gender, race, ethnicity, religious, and age discrimination in a variety of employment practices including selection, termination, and compensation, and have prepared analyses regarding Fair Labor Standards Act compliance. I have also studied borrower characteristics as they relate to the ability to obtain credit and their effect on the terms of credit transactions.

5. With respect to voting/election rights, I have compared the racial composition of voter turnout including provisional ballots and out-of-precinct ballots by election. I have also examined the incidence of having voter identification and the impact of changes in the number of early voting days. Further, I have provided testimony regarding simulated maps prepared for redistricting.

6. On several occasions I have been asked to design legally defensible sampling/survey methodologies and to serve as an expert witness to critique the validity of samples prepared by others including use of margins of error, sample size, and stratification methods. I have also prepared numerous estimates of economic damages.

7. I have extensive experience working with the decennial Census' Public Use Microdata Sample (PUMS), Summary Files, and EEO files, as well as the American Community Survey (ACS) data, among other types of Census data. My doctoral dissertation used PUMS and Current Population Survey (CPS) data from 1960 and 1980 to examine educational drop-out rates of boys and girls. In the course of my work I utilize these data to address issues raised in credit, insurance, housing, voting/election, and employment discrimination matters. My knowledge of

Census data has resulted in expert testimony regarding the strengths and weaknesses of these data, including the Hispanic surname list. I have also been asked to assess race/ethnicity predictions using different methodologies.

8. As an economist and applied statistician I have experience not only with theory but with the writing of the commands and designing the logic using various computer programs and have designed custom software for clients. This experience has enabled me to develop computer models that assimilate voluminous data and to conduct analyses throughout my over 30 year career.

9. I have provided expert testimony in arbitration hearings and before federal and state courts and regulatory agencies. I testified in the matters of *North Carolina State Conference of the NAACP, et al. v. Patrick Lloyd McCrory, in his official capacity as Governor of North Carolina, et al.*; *League of Women Voters of North Carolina, et al. and Louis M. Duke, et al. v. The State of North Carolina, et al.*; *United States of America v. The State of North Carolina, et al*.; *Barbara H. Lee, et al. v. Virginia State Board of Elections, et al.; Arizona Democratic Party, et al. v. Michele Reagan, et al*.

10. In addition, I provided testimony regarding the computer simulated maps prepared in the *Ohio A. Philip Randolph Institute, et al. vs. Larry Householder, et al.* matter. No court has rejected me as an expert qualified to testify in my fields.

11. As an economist and applied statistician, I examine data, assumptions, and determine if there are patterns in the data or patterns in outcomes that are influenced by the assumptions made. With respect to the projects described above, my work has focused on the review of the underlying data used and the assumptions made. To the extent that there are differences calculated, then I have determined if the differences are statistically significant.

12. I have been an adjunct professor of quantitative methods and statistics at The Florida State University and am a frequent presenter at seminars on the topics of statistical techniques, data and modeling, compensation analysis, and calculating damages. I have published articles in the *Journal of Legal Economics* and the *Journal of Forensic Economics*, and co-authored a chapter in the anthology *Developments in Litigation Economics*, which discusses equal business opportunity programs, among other topics.

13. I have been retained by Counsel for the Defendants to provide expert testimony in the above captioned matter. I manage a team of professionals who have assisted me with this matter and worked under my direction and supervision. All work was vetted and verified by me and my team.[1] My time is billed at the rate of $560 per hour for this matter. My updated curriculum vitae and list of testimony in the past four years are contained in Appendix A.

14. Appendix B lists the materials that I relied upon in preparation of this report. I also relied upon information from public sources as referenced throughout this report.[2]

I. Findings

15. Counsel for the Defendants in the above captioned matter asked me to review and respond to the reports produced by Plaintiffs' experts. In particular, I am responding to Plaintiffs' experts' analyses regarding Plaintiffs' allegation that the current North Carolina State House and Senate districts established in 2017 (hereafter, "enacted map") were drawn for the purpose of providing a Republican advantage. This advantage, Plaintiffs contend, was achieved by manipulating district boundaries in the redrawn map by taking into account prior election results.[3]

[1] Carole Amidon, Ph.D., Jill Fitzpatrick, Ph.D., and Petru Andrei, Ph.D. were the primary researchers who assisted me with this project.
[2] If additional information is obtained that is relevant to this report, it may need to be modified or supplemented.
[3] Amended Complaint, December 7, 2018, page 1.

16. Specifically, I focus on the reports prepared by Plaintiffs' experts, Dr. Jowei Chen, Dr. Jonathan C. Mattingly, and Dr. Wesley Pegden.[4] Based on simulations using different and selected statewide election results and different factor criteria and assumptions, each of Plaintiffs' experts allege that the legislative districts generated by their simulations would have resulted in a higher number of Democratic districts compared to the enacted map.

17. I was asked to review the underlying data and assumptions made by each of the experts. In addition, I was asked to determine how different the simulated maps are from the enacted map.

18. Based upon my review of each of the three Plaintiffs' experts' reports, the results of their simulations are influenced, in part, by:

- the statewide elections that each chose to use to compare the simulated maps to the enacted map, and
- the underlying criteria/assumptions used to select a simulated map to compare to the enacted map.

A researcher's choice of simulation criteria alone will influence the resulting simulations. Additionally, the outcome is influenced by the expert's choice of election data upon which to measure the Democratic two-party vote share used to compare the simulations to the enacted map.

19. Regardless of the simulation method, these political gerrymandering simulations all suffer from the same failure to show that the simulated maps are uniformly distributed from the pool of all possible maps that satisfy the constraints that each expert adopts. In the case of Markov Chain Monte Carlo simulations, it is, in practice, unknown when the equilibrium distribution is reached and when the simulation should begin to sample and it is also difficult to estimate how often the samples should be collected; for this reason, it is almost impossible to prove that the

[4] Expert Report of Jowei Chen, Ph.D. dated April 8, 2019 ("Chen Report"), Expert Report on the North Carolina State Legislature, dated April 8, 2019 by Jonathan C. Mattingly ("Mattingly Report"), and An Analysis of North Carolina's Legislative Districtings: Expert Report dated April 8, 2019 by Wesley Pegden ("Pegden Report").

algorithm randomly samples from the entire space of compliant maps. The large number of precincts (over two thousand) and the usage of several constraints, make it, in practice, impossible to know if all subspaces are adequately covered by the chain of simulations.

20. In addition, the three Plaintiffs' experts fail to apply the same criteria for generating their map simulations and also deviate from the criteria used by the legislature. While each expert states that their simulations show significant deviations from the enacted map, when these assertions are tested statistically the number of Democratic seats estimated from the simulations is not statistically significantly different from the number that each calculates from the enacted map. It is possible that if each expert had followed the actual criteria there would be little to no deviation from the enacted map.

21. With respect to Dr. Pegden's simulated maps, when I compare the average Democratic vote share calculated from his simulations to the enacted map and focus on the non-frozen maps,[5] there are four House and three Senate seats with a difference between the predicted Party of the enacted map and predicted Party from the simulations. I then compared the Party for these districts to the Party held from the 2018 elections. When the actual Party was Republican, the elected candidate was an incumbent and when the actual Party was Democratic, the elected candidate was not an incumbent.

22. To fully evaluate each of Plaintiffs' experts' simulations would require several months, as there are several steps in the evaluation process. First, one has to assess the programming code to determine, in general, the function and purpose of the code in each program, and to determine what files each program is accessing. To actually execute the code requires

[5] Frozen districts include those that the Special Master set and/or the county sets that comprise one district and, therefore, would not deviate from the enacted map. The non-frozen districts are those that Plaintiffs' experts simulated. There is some deviation among the experts as to which are identified as frozen.

making modifications in order for the code to run on a computer other than the expert's computer. Then, to evaluate the simulations requires making further changes to the code to determine how the assumptions applied by each expert influenced the simulation outcomes.

II. Underlying Election Data Are Not Uniform Across the Three Plaintiffs' Experts

23. Each expert relies on statewide election data to compare the Democratic vote share based on the enacted map to the Democratic vote share based on their simulations. With the exception of Dr. Chen, Plaintiffs' experts chose elections that deviate from the elections used by those who prepared the 2017 enacted plan. The table below identifies the statewide elections included by each expert.

Table 1—North Carolina Statewide Elections Included by Each Expert to Evaluate the Simulation Results

Year	Contest	Democratic Vote Share Assuming Two Parties	Dr. Chen	Dr. Mattingly	Dr. Pegden
2008	Attorney General	61.10%		X	
2008	Commissioner of Insurance	53.62%		X	X
2008	Governor	51.75%		X	
2008	Lieutenant Governor	52.69%		X	
2008	US President and Vice President	50.17%		X	
2008	US Senate	54.37%		X	
2010	US Senate	43.87%	X	X	
2012	Commissioner of Insurance	51.86%		X	
2012	Governor	44.18%	X	X	
2012	Lieutenant Governor	49.92%	X	X	
2012	US President and Vice President	48.97%	X	X	
2014	US Senate	49.19%	X	X	
2016	Attorney General	50.27%	X	X	X
2016	Commissioner of Insurance	49.60%			
2016	Governor	50.11%	X	X	
2016	Lieutenant Governor	46.66%	X	X	
2016	US President and Vice President	48.10%	X	X	
2016	US Senate	47.05%	X	X	

24. Dr. Chen used the statewide elections that were considered when the enacted map was created.[6] Dr. Chen combines 10 statewide elections from 2010 through 2016 to calculate the Democratic vote share. The elections, in aggregate, result in a lower Democratic vote share relative to the combined Democratic vote share among the elections included by Dr. Mattingly and Dr. Pegden. Thus, Dr. Mattingly and Dr. Pegden appear to have inflated the Democratic vote share, in aggregate, compared to the elections used by the legislature for the enacted map.

[6] Chen Report, pages 3, 4, 20. Amended Complaint at paragraph 97.

25. Among the 10 elections Dr. Chen used, and assuming a two-party system, the Democratic vote share for the state is 48% and assuming all who voted regardless of party, the Democratic vote share is 46.9%.

26. Dr. Mattingly appears to have selected most of the statewide elections in terms of the category of offices included by Dr. Chen, but included elections in 2008 while Dr. Chen included elections from 2010 through 2016. Dr. Mattingly does not explain why he chose to include an election year prior to the period of time considered when the 2017 map was enacted.

27. Dr. Mattingly does not provide any explanation for his inclusion of the 17 elections listed in Table 1, nor does he explain why he chose to exclude the Commissioner of Insurance election in 2016, even though he included this office in prior years, 2008 and 2012. The year that he excluded has a lower Democratic vote share for this office compared to the earlier years. The year that he included prior to the period of time considered when the 2017 map was enacted has the highest Democratic vote share compared to the other years.

Table 2—Democratic Vote Share for Commissioner of Insurance

Year	Contest	Democratic Vote Share Assuming Two Parties	Dr. Mattingly
2008	Commissioner of Insurance	53.62%	X
2012	Commissioner of Insurance	51.86%	X
2016	Commissioner of Insurance	49.60%	

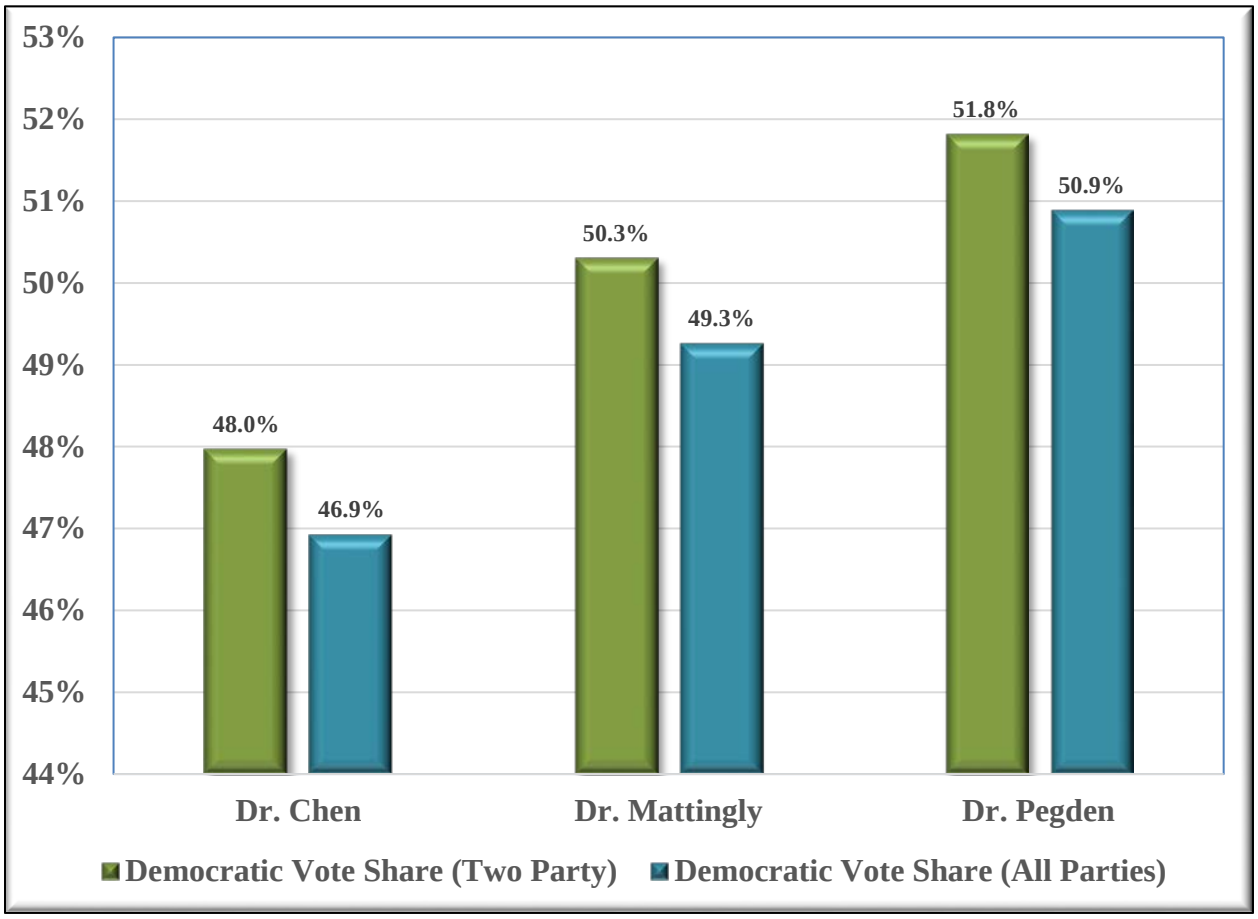
28. Among the 17 elections Dr. Mattingly used, and assuming a two-party system, the Democratic vote share for the state is 50.3%; assuming all who voted regardless of party, the Democratic vote share is 49.3%.

29. Dr. Pegden chose to use one election from 2008, Commissioner of Insurance, and one election from 2016, Attorney General, which he claims are reflective of base partisanship.[7] However, the Attorney General election had the highest Democratic vote share among the 2016 elections considered by the other two experts. The Commissioner of Insurance election had the third highest Democratic vote share among the six 2008 elections used by Dr. Mattingly. Assuming a two-party system, the Democratic vote share for the state is 51.8% based on the two elections that Dr. Pegden considered. The Democratic vote share is lower, at 50.9%, when all who voted regardless of party are included for these two elections.

30. It is clear from reviewing the results of each expert's simulations, even with their different simulation approaches, the results are impacted by the inclusion or exclusion of particular elections used to compute the two-party Democratic vote share and the benchmark used to assess partisan bias between the simulations and the enacted map. Figure 1 shows the difference in the Democratic vote share among the elections included by each of the three Plaintiffs' experts to assess the results of their simulated maps compared to the 2017 enacted map.

[7] Pegden Report, page 35.

Figure 1—Average Democratic Vote Share Among Statewide Elections Included by Each Expert Preparing Simulations



III. Assumptions/Criteria Utilized by the Three Plaintiffs' Experts Deviate from the Actual Criteria Relied Upon for the 2017 Enacted Map

31. Each of the three Plaintiffs' experts deviate from the criteria utilized when constructing the 2017 enacted map. As a consequence, one should not expect that their simulations would contain a map identical to the enacted map or even be "close" to the enacted map. If the simulations had used the exact criteria of the 2017 enacted map, then we would anticipate that if the space of compliant maps was properly sampled, the enacted map or something close to it would have been among the simulations. Only then can one properly evaluate the simulated maps

compared to the enacted map. The results of the simulations are not informative because the premise of their simulated maps is incomplete and inaccurate. Each expert has added error to his results by not following the actual criteria used in constructing the enacted map.

32. The following summarizes the actual criteria utilized by the legislature in constructing the enacted map:[8]

> **Equal Population**. The Committees shall use the 2010 federal decennial census data as the sole basis of population for drawing legislative districts in the 2017 House and Senate plans. The number of persons in each legislative district shall comply with the +/- 5 percent population deviation standard established by *Stephenson v. Bartlett*, 355 N.C. 354, 562 S.E. 2d 377 (2002).
>
> **Contiguity**. Legislative districts shall be comprised of contiguous territory. Contiguity by water is sufficient.
>
> **County Groupings and Traversals**. The Committees shall draw legislative districts within county groupings as required by *Stephenson v. Bartlett*, 355 N.C. 354, 562 S.E. 2d 377 (2002) (*Stephenson I*), *Stephenson v. Bartlett*, 357 N.C. 301, 582 S.E.2d 247 (2003) (*Stephenson II*), *Dickson v. Rucho*, 367 N.C. 542, 766 S.E.2d 238 (2014) (*Dickson I*) and *Dickson v. Rucho*, 368 N.C. 481, 781 S.E.2d 460 (2015) (*Dickson II*). Within county groupings, county lines shall not be traversed except as authorized by *Stephenson I*, *Stephenson II*, *Dickson I*, and *Dickson II*.
>
> **Compactness**. The Committees shall make reasonable efforts to draw legislative districts in the 2017 House and Senate plans that improve the compactness of the current districts. In doing so, the Committees may use as a guide the minimum Reock ("dispersion") and Polsby-Popper ("perimeter") scores identified by Richard H. Pildes and Richard G. Neimi in *Expressive Harms, "Bizarre Districts," and Voting Rights: Evaluating Election-District Appearances After Shaw v. Reno*, 92 Mich. L. Rev. 483 (1993).
>
> **Fewer Split Precincts**. The Committees shall make reasonable efforts to draw legislative districts in the 2017 House and Senate plans that split fewer precincts than the current legislative redistricting plans.
>
> **Municipal Boundaries**. The Committees may consider municipal boundaries when drawing legislative districts in the 2017 House and Senate plans.
>
> **Incumbency Protection**. Reasonable efforts and political considerations may be used to avoid pairing incumbent members of the House or Senate with another incumbent in legislative districts drawn in the 2017 House and Senate plans. The

[8] Bates Number LDNC1883.

> Committees may make reasonable efforts to ensure voters have a reasonable opportunity to elect non-paired incumbents of either party to a district in the 2017 House and Senate plans.
>
> **Election Data**. Political considerations and election results data may be used in the drawing of legislative districts in the 2017 House and Senate plans.
>
> **No Consideration of Racial Data**. Data identifying the race of individuals or voters shall not be used in the drawing of legislative districts in the 2017 House and Senate plans.

Dr. Pegden's Deviations from the Actual Criteria:

33. Dr. Pegden deviates from the population and compactness guidelines established for the 2017 enacted map. Rather than requiring a district to meet the ±5% population deviation, Dr. Pegden applies a less clear requirement: "I require comparison districtings to have district populations within the same range as the enacted House or Senate plan, respectively."[9] In addition, Dr. Pegden does not apply the guide of the minimum Reock ("dispersion") score and Polsby-Popper score ("perimeter") that was used as a minimum threshold for the enacted map. Instead, Dr. Pegden requires the simulated maps to be at least as compact as the enacted map up to an error of 5%.[10] A review of Dr. Pegden's simulation code suggests that in reality, he did not actually apply a compactness criterion. Thus, Dr. Pegden could accept simulated maps that do not meet the minimum thresholds of the enacted map and could have failed to include simulated maps that meet these minimum thresholds.

34. As a consequence of these deviations, Dr. Pegden will accept and reject simulated maps that do not meet the same criteria as the enacted map, resulting in yet another apples and oranges comparison.

[9] Pegden Report, page 7.
[10] Pegden Report, page 8.

35. Dr. Pegden also does not adjust for incumbency protection in accordance to the enacted plan. Thus, he does not apply a weight for the party of the incumbents, which would change his partisanship outcomes.

36. With respect to the simulations prepared by each of Plaintiffs' experts, none follow the guidelines used to construct the 2017 enacted map. As a consequence, the set of maps resulting from the simulations that are used to compare the Democratic Districts to that of the enacted map are faulty because, in each case, the foundation of the comparison is not the same as the enacted map.

Dr. Chen's Deviations from the Actual Criteria:

37. With respect to compactness the guidelines state, "The Committees shall make reasonable efforts to draw legislative districts in the 2017 House and Senate plans that improve the compactness of the current districts. In doing so, the Committees may use as a guide the minimum Reock ("dispersion") and Polsby-Popper ("perimeter") scores identified by Richard H. Pildes and Richard G. Neimi."[11] The minimum dispersion or Reock score is 0.15 and the minimum perimeter or Polsby-Popper score is 0.05 according to this article.[12]

38. Dr. Chen did not apply the compactness guidelines as they were described in the legislative record. Instead, Dr. Chen applies more stringent compactness criteria to accept maps by essentially keeping only those simulated maps with a better score. Thus, it is not surprising that he writes that all of his simulated maps have a higher Reock and Polsby-Popper score than the enacted map.[13]

[11] Richard H. Pildes and Richard G. Neimi in *Expressive Harms, "Bizarre Districts," and Voting Rights: Evaluating Election-District Appearances After Shaw v. Reno*, 92 Mich. L. Rev. 483 (1993).
[12] Richard H. Pildes and Richard G. Neimi in *Expressive Harms, "Bizarre Districts," and Voting Rights: Evaluating Election-District Appearances After Shaw v. Reno*, 92 Mich. L. Rev. 483 (1993), Table 3 and cited in Cromartie v. Hunt, 133 F.Supp. 2d 407 (2000), at 415.
[13] Chen Report, page 16.

39. Dr. Chen's code for acceptance of a map states, "save this plan if it has the lowest t-score."[14] The t-score is only a mathematically convenient criterion introduced by Dr. Chen to generate his maps.

40. In addition to including compactness to construct the t-score, Dr. Chen also included a measure for the splitting of precincts and municipalities as part of the score. The criteria established for the 2017 enacted plan do not state that the goal is to avoid the splitting of precincts and municipalities. Instead, the 2017 enacted plan was constructed to have fewer precinct splits than the prior plan in the districts that were to be redrawn and stated that municipal boundaries could be taken into consideration.

41. A t-score evaluation was not among the actual criteria relied upon for the creation of the 2017 enacted map. To create the t-score that he uses to evaluate a map, Dr. Chen subtracts the Reock and Polsby-Popper scores from 1.75. Dr. Chen does not explain why he decided to use 1.75, but were he to change the 1.75 to another number, he would derive a different t-score by which to evaluate each simulated map. As a consequence, Dr. Chen is able to influence the simulated maps that he accepts and rejects.

42. If Dr. Chen had applied the actual criteria utilized by those who constructed the enacted map, he presumably would have generated a different set of maps. The resulting maps would have been the more relevant simulations to compare to the enacted map to assess partisan bias. Dr. Chen's modification of the actual criteria results in making apples and oranges

[14] See for example code from Dr. Chen's file, NCU_BASE_SET1.JAVA:
double t_score = (1+tmcdfrags-ALLmcds.size()+ tvtdfrags-ALLvtds.size()) * (new Double(1.75)-reock-polsby); //lower is better
if(t_score<low_score){ low_score=t_score; Dpcts=makeCopy(districts, t_Dpcts); Dpops=(int[])t_Dpops.clone(); } //**save this plan if it has the lowest t_score**
System.out.println("tctyfrags: "+tctyfrags+" tmcdfrags: "+tmcdfrags+" tvtdfrags: "+tvtdfrags+" reock: "+reock+" polsby: "+polsby+" t_score: "+t_score+" try: "+t);
System.out.println("============"); break; //System.exit(0);

comparisons. It should not be surprising to have maps with "better" scores, although only slightly better based on a review of Tables 5 and 6 of his report, compared to the enacted map. To properly evaluate the enacted map would require using the same, not modified, criteria. Dr. Chen could have accepted maps with the same or fewer splits as the enacted map.

43. Dr. Chen's Set 2 simulations are an attempt to include incumbency protection among his criteria. He states that he prepared another set of simulations "that intentionally protect exactly as many incumbents as is mathematically possible within each county grouping while otherwise adhering to the same traditional districting criteria."[15] This approach appears to focus on the first criterion used to prepare the enacted plan, that "Reasonable efforts and political considerations may be used to avoid pairing incumbent members of the House or Senate with another incumbent in legislative districts drawn in the 2017 House and Senate plans."[16]

44. However, Dr. Chen does not take into account the additional criterion used with respect to incumbency protection: "The Committees may make reasonable efforts to ensure voters have a reasonable opportunity to elect non-paired incumbents of either party to a district in the 2017 House and Senate plans."[17] Dr. Chen ignores this piece of the 2017 enacted map criteria which was to allow for incumbents to win, not to just consider the pairing. He could have modified his criterion to weight the vote share for the political party of the incumbent, but chose not to.

45. A review of the current political party representation in districts that are not frozen and in which non-incumbents were elected reveals a higher proportion of Democratic Party House and Senate members elected to these seats.[18]

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[15] Chen Report, page 43.
[16] Bates Number LDNC1883.
[17] Bates Number LDNC1883.
[18] Among the frozen House Districts, half of the Districts (or 9 of 18) were Democratic Party candidates. Among the frozen Senate Districts, one-third (or 7 of 21) were Democratic Party candidates. See the North Carolina House of Representatives website, https://www.ncleg.gov/House, and the North Carolina Senate website, https://www.ncleg.gov/Senate.

46. Among the 24 House Districts that are not frozen and had individuals elected in 2018 who were *not* incumbents (i.e., individuals with 1 or 1.5 terms), 70.8% (or 17 of 24) were Democratic Party candidates.[19] On the other hand, among the 78 House Districts that are not frozen and had individuals elected in 2018 who *were* incumbents (i.e., individuals with 2 or more terms), 37.2% (or 29 of 78) were Democratic Party candidates. If Dr. Chen had accounted for the party of the incumbents, he would have perhaps generated a different outcome regarding partisanship.

47. The same pattern exists when I examine the Senate Districts. Among the 9 Senate Districts that are not frozen and had individuals elected in 2018 who were *not* incumbents (i.e., 1 term), 66.7% (or 6 of 9) were Democratic Party candidates. On the other hand, among the 20 Senate Districts that are not frozen and had individuals elected in 2018 who *were* incumbents (i.e., 2 or more terms), 40.0% (or 8 of 20) were Democratic Party candidates.

48. These statistics show that if Dr. Chen had controlled for not only the pairing of incumbents but also the party of the incumbents, he would have estimated fewer Democratic seats, because the majority of seats were held by incumbents, of whom a lower proportion were Democratic.

49. Dr. Chen also performs a counterfactual analysis of his simulated maps in which he reviews the simulated maps under 25 different scenarios of the percent Democratic vote share where the vote share is increased and decreased by 6 percentage points. From my review, this counterfactual analysis does not provide useful information because the simulations themselves do not accurately reflect the criteria used to produce the 2017 enacted map. As a consequence,

[19] There were four districts with elected individuals with 1.5 terms all of whom were Democratic Party candidates. If these four are removed from the calculation, then the percentage is 65% (or 13 of 20).

adding or subtracting 6 percentage points from a faulty set of simulations results in a faulty range on which to base the counterfactual analysis.

Dr. Mattingly's Deviations from the Actual Criteria:

50. Dr. Mattingly scores each simulated map from his Markov Chain Monte Carlo simulation[20] and applies constraints. However, he does not apply the enacted map's specific criteria overall.

51. Dr. Mattingly's score function includes a weight for a population score, Polsby-Popper score (i.e., compactness), and municipality score. This score impacts which simulated maps are considered.

52. The population score rates how the population from the simulated maps compares to the ideal. This is a deviation from the enacted plan's criteria which is that the "number of persons in each legislative district shall comply with the +/- 5 percent population deviation standard established by *Stephenson v. Bartlett*, 355 N.C. 354, 562 S.E. 2d 377 (2002)."[21]

53. Dr. Mattingly's score function also weights his measure of compactness. Specifically, he ignores the minimum Reock ("dispersion") and Polsby-Popper ("perimeter") scores identified by Richard H. Pildes and Richard G. Neimi for accepting a simulated map. Instead, Dr. Mattingly focuses solely on the Polsby-Popper score[22] but does not compare a simulated map's score to the minimum established by Pildes and Neimi. As a consequence, Dr. Mattingly could accept maps that do not conform to the Pildes and Neimi criteria adopted by the 2017 enacted plan.

[20] Dr. Mattingly's starting point is the algorithm described by Dr. Chen and Dr. Jonathan Rodden to which he applies his Markov Chain Monte Carlo simulation. (Mattingly Report, page 86; see also: Jowei Chen and Jonathan Rodden. *Unintentional Gerrymandering: Political Geography and Electoral Bias in Legislatures*, Quarterly Journal of Political Science, (2013) Vol. 8, pages 239–269.)
[21] Bates Number LDNC1883.
[22] Mattingly Report, page 50.

54. Dr. Mattingly's score function also weights for municipality splits. Dr. Mattingly describes his municipality score function as a measure of "how many people in a given municipality have been separated from the district(s) that best represents their municipality."[23] Again, this is not how the 2017 enacted map was constructed, because the criteria were 1) to have fewer precinct splits and 2) that municipal boundaries could be considered when drawing the districts.

55. Dr. Mattingly does not use uniform weights for each component of his score (population, compactness, and municipality) for each county cluster. Further, he does not apply the consistent population threshold of ±5% that was required for the enacted plan. Indeed, he states that he cannot generate plans with all districts between ±5% population deviation.[24] For example, the Wake House cluster has a population threshold used in his simulations that is ±12%, not ±5%.[25] By changing the weights and/or changing the threshold, Dr. Mattingly is changing the group of simulated maps that he is selecting. Dr. Mattingly's efforts to create simulated maps do not optimize the criteria used by the legislature, but instead optimize based on his own varied thresholds and score functions.

56. Further, Dr. Mattingly does not consider incumbency protection as defined in the 2017 enacted map criteria. Dr. Mattingly writes that "Our primary ensemble does not preserve incumbents. ... Finally, some of our sampled plans are less compact, split more municipalities, and split more people out of municipalities than the enacted plan."[26] Even when he attempts to test more strict redistricting criteria, he does not simultaneously control for *all* of the criteria used to

[23] Mattingly Report, page 50.
[24] Mattingly Report, page 54.
[25] Mattingly Report, pages 55-56.
[26] Mattingly Report, page 81.

establish the 2017 enacted map. Thus, Dr. Mattingly's simulated maps do not reflect the same criteria used for the enacted map, resulting in another apples and oranges comparison.

IV. It Is Not Known if the Simulated Maps Are Representative of the Distribution of Possible Maps

57. Regardless of the simulation, these political gerrymandering simulations all suffer from the same failure to show that the simulated maps are uniformly distributed in the pool of all possible maps that satisfy the constraints that each expert adopts. For instance, in the case of Markov Chain Monte Carlo simulations, it is, in practice, unknown when the equilibrium distribution is reached and the simulation should begin to sample. It is also difficult to estimate how often the samples should be collected; for this reason, it is almost impossible to prove that the algorithm randomly samples from the entire space of compliant maps. The large number of precincts (over two thousand) and the multiple constraints imposed by each of the three experts, make it, in practice, impossible to know if all subspaces are adequately covered by the chain of simulations.

58. Researchers have found that "though these algorithms generate or 'simulate' electoral maps, whether the set of maps that they identify is a uniform sample of the set of all feasible maps has never been shown by its authors. Moreover, skepticism has been raised by several scholars that this process does not uniformly sample from the full set of feasible maps even though it has stochastic components."[27] Further, researchers have found that their empirical evidence supports these suspicions. "Though these methods have some stochastic components and are able to identify maps satisfying particular criteria, they do not uniformly sample the

[27] Wendy K. Tam Cho and Yan Y. Liu. *Sampling from Complicated and Unknown Distributions Monte Carlo and Markov Chain Monte Carlo Methods for Redistricting.* Physica A 506 (2018), page 173; referencing the 2013 article authored by Dr. Chen and Dr. Rodden, and cited by Dr. Mattingly.

underlying population and thus do not produce a representative sample of the underlying population of interest."[28] The more constraints that are added make it even less plausible that the set of maps represents a uniform sample of all possible maps for a given number of constraints and geographic areas to move, which in this case are the voting tabulation districts which are proxies for precincts.

59. As a consequence, it is quite possible that there are areas of the space of compliant maps that are not explored in these simulations that may have characteristics more like the 2017 enacted map.

V. The Enacted Map Is Not Statistically Significantly Different from the Simulated Maps with Respect to the Number of Democratic Districts

60. Each of the three Plaintiffs' experts uses language suggesting that the enacted map is an outlier or is significantly different from the simulated maps. However, none of the three experts conduct a statistical test to determine if the number of Democratic Districts that each calculates for their simulations statistically significantly deviates from the enacted map. This is particularly relevant when none of the experts applied each of the criteria used to construct the enacted map. As a consequence, some deviation would be expected between the simulated maps and the enacted map. The question then becomes, how different statistically is the enacted map from the simulated maps, when the same criteria as the enacted map were not applied.

61. Moreover, a review of the many graphics prepared by Plaintiffs' experts typically shows that the enacted map is on the continuum of simulated maps. For example, at page 16 of his report, Dr. Mattingly graphs the enacted plan using different election data and the simulated

[28] Wendy K. Tam Cho and Yan Y. Liu. *Sampling from Complicated and Unknown Distributions Monte Carlo and Markov Chain Monte Carlo Methods for Redistricting.* Physica A 506 (2018), page 173;174.

maps. The enacted map is either more Democratic or is within the range of possibilities given by the simulated map, referred to as the ensemble. This appears to be the case in nearly every instance.

62. Similarly, at page 169 of his report, Dr. Chen provides a chart that compares the enacted map using his composite of elections for his simulations to the enacted map for each named Plaintiff. In nearly every instance, the enacted map is within the range of simulated maps.

63. Throughout my career I have regularly relied upon statistical testing to determine if there are differences, statistically speaking, in the rates of selection between different groups such as men and women, African-Americans and non-African-Americans, etc. The statistical testing provides a basic understanding to the court of whether a reported difference in selection rates is, in fact, more than, less than, or the same as a zero difference in the selection rate. I have provided assessments of selection rates in numerous matters in state and federal court, before the OFCCP, the EEOC, and in consulting arrangements.

64. In the current matter, the question is whether the selection of Republican legislators by the voters is statistically similar to the selection rate of Republican legislators predicted by the various simulation procedures. This question is identical to the questions asked in labor economics based matters where the decision is about promotion, hiring, or termination. The standard statistical test, given the available information, is the binomial. In this matter, we have an unknown pool of potential Republicans and Democrat legislators to be chosen based on an approximation of the percent of the voters who would vote Democratic and, thereby, presumably elect a Democratic legislator. I tested this hypothesis using the results of the simulations by the Plaintiffs' experts and found that the simulations produced statistically similar numbers of Republican and Democratic legislators as that which occurred in the elections. Therefore, the actual number of Republican and Democratic legislators that were elected is not statistically different from the

simulated number of Republican and Democratic legislators in any scenario. Using this metric, the enacted map does not appear to have statistically significantly different results in the outcome of the elections of Republican and Democratic legislators.

65. The counterfactual analyses provided by the Plaintiffs' experts through their analyses incorporating uniform swing adjustments (i.e., adding/subtracting a percentage of Democratic voters by assumption) fails to mitigate the basic underlying assumptions of the Plaintiffs' experts. Therefore, the incorporation of hypothetical vote tallies does not mitigate my basic statistical finding that there is not a statistically significant difference in the number of Republican and Democratic legislators than would be predicted by the various simulations.

66. To test how different the enacted map is from the simulated maps statistically, I compared the expected number of Democratic districts based on the simulations as reported by each expert to the number based on the enacted map. I then determined if the difference was statistically significant. I would not expect the number of Democratic districts from the enacted plan to perfectly match the simulations. None of the simulations apply the exact same guidelines/criteria as the 2017 enacted plan and we do not know if the simulations are representative of the entire space of compliant maps.

67. To illustrate, if we toss a coin 100 times, we would expect 50 heads and 50 tails. However, there could be deviations from 50 heads and 50 tails that would seem possible, i.e., close, to 50 heads and 50 tails. However, if there were 10 heads and 90 tails, we may conclude that the coin could be biased or the manner in which the coin is tossed is not being done uniformly. When the outcomes are so extreme, then the difference between what we expect (i.e., 50 heads and 50 tails) and what occurred (i.e., 10 heads and 90 tails), is statistically significant.

68. We can apply the same type of comparison between the enacted plan's number of Democratic districts and the number predicted by the simulated maps, even though they are not reflective of the actual guidelines. I determined the number of standard deviations associated with the difference between the enacted plan and simulated number of Democratic districts. Generally, social scientists and the courts conclude that differences between two groups (e.g., enacted and simulated plan Democratic districts) are statistically similar when the difference, in terms of the number of standard deviations, is less than approximately two (or three) standard deviations.[29] A difference that is less than two (or three) standard deviations is consistent with a greater than 5% (or 1%) probability of that difference occurring by chance. When the differences are smaller than two (or three) standard deviations, then they are typically considered to be "statistically insignificant." Conversely, social scientists and the courts typically conclude that differences are statistically dissimilar when the number of standard deviations of the difference is greater than approximately two (or three) standard deviations [or the probability of chance occurrence is less than or equal to 5% (or 1%)]. When the differences are as large as two (or three) standard deviations, or larger, they are considered to be "statistically significant."[30]

69. Courts adopted this standard in voting rights cases (e.g., *Castaneda v. Partida*) and carried the standard over to other issues including equal employment issues in cases such as *Hazelwood School District v. U.S.*, 433 U.S. 299, 308 n.14 (1977) and *Teamsters v. U.S.*, 431 U.S. 324; 97 S. Ct. 1843 (1977). I used the binomial distribution to determine if the difference between

[29] This analysis was prepared using the binomial distribution. Social scientists and statisticians have used criteria of less than 5% or less than 1% probability of occurring by chance ("greater than two or three standard deviations") to categorize a result as "statistically significant" for over 75 years. See, for example, Statistics by Freedman, Pisani, and Purves. See also EEOC v. Federal Reserve Bank of Richmond, 698 F.2d 633 (4th Cir. 1983), where the Court indicated that only a difference greater than 3 standard deviations confirms an inference of adverse disparity.

[30] Statistical significance cannot provide a cause for a difference as there may be other factors that explain the difference. Ramona L. Paetzold and Steven L. Willborn (2016). The Statistics of Discrimination, Using Statistical Evidence in Discrimination Cases. Thomson Reuters, §2.5 and §4.13.

the number of Democratic seats from the enacted map is statistically significantly different from the number based on the simulated maps. The binomial distribution, which is utilized to test for determining disparate impact, has long been recognized by the Supreme Court (e.g., *Hazelwood School District v. United States*, 433 U.S. 299, 308 n. 14 (1977) *citing Castaneda v. Partida*, 430 U.S. 482, 496-97 n. 17 (1977)).

Dr. Pegden's Simulations

70. In Dr. Pegden's "first level analysis" he uses a computer algorithm to "randomly select a geographical unit (e.g., a voting precinct) on the boundary of two districts, and check: "if I change which district this geographic unit belongs to, will the resulting districting still satisfy the districting criteria" adopted by the North Carolina General Assembly in 2017, omitting the partisan considerations.[31] If the criteria are met, the hypothetical districting change is made. Dr. Pegden then uses voting data "as a proxy for partisan voting patterns" to "evaluate the partisanship of the districting" as a result of changing the district.[32] Dr. Pegden repeats this process "many times," "resulting in a sequence of districtings, each produced by a small random change to the districting preceding it, with the enacted map I am evaluating as the starting point for the sequence." [33]

71. Dr. Pegden uses the Markov Chain Monte Carlo method by starting with the enacted map. Rather than providing a histogram of his results similar to those prepared by Dr. Chen and Dr. Mattingly, Dr. Pegden only provides a percentage of generated maps that are less Republican than the enacted map. He does not provide any measure of how different the enacted map is from his simulated maps in terms of the estimated number of Democratic House and Senate Districts.

[31] Pegden Report, page 5.
[32] Pegden Report, page 5.
[33] Pegden Report, page 5.

72. In order to assess this difference, Dr. Pegden's simulation was modified to generate the histogram. I determined that the average number of Democratic House Districts generated from his simulations is 48 compared to the enacted map of 44. Similarly, I determined that the average number of Democratic Senate Districts generated from his simulations is 23 compared to the enacted map of 20.[34]

73. The question to then ask is whether or not the difference between the 44 Democratic House Districts under the enacted plan that Dr. Pegden calculates is statistically significantly different from the 48 that he estimates from his simulations. Similarly, we ask the question of whether or not the difference between 20 Democratic Senate Districts under the enacted plan that Dr. Pegden calculates is statistically significantly different from the 23 that he estimates from his simulations.

74. One should not be surprised that the number of Democratic districts does not exactly mirror the simulated maps because the criteria used to generate the simulated maps are not the same as the enacted map. As a consequence, then I would expect to find some differences. As described above, Dr. Pegden failed to apply the same criteria used to generate the enacted map. In addition, he relied on the Attorney General election from 2016 for his comparisons, an election that had a higher Democratic vote share.

75. As shown below, using Dr. Pegden's simulations, there are approximately 4 more Democratic House Districts and 3 more Democratic Senate Districts based on the simulations as compared to the enacted plan. I determined that these differences are *not* statistically significant with numbers of standard deviations that are less than one.

[34] The enacted map Democratic District share is based on the enacted map information from Dr. Chen with respect to the 2016 Attorney General election used by Dr. Pegden.

Table 3—Comparison of the Democratic House and Senate Districts of the Enacted Plan and the Simulated Maps Prepared by Dr. Pegden

Elections	Number of Districts	Average Democratic District Share Among Simulated Maps	Number of Democratic Districts Based on Enacted Map	Average Number of Democratic Districts from Simulations	Difference between Enacted and Simulated Map Democratic Districts	Number of Standard Deviations Associated with the Difference
House	120	39.96%	44	47.96	-3.96	-0.74
Senate	50	45.80%	20	22.90	-2.90	-0.82
The Average Number of Democratic Districts from Simulations is calculated by rerunning Dr. Pegden's simulations and retaining the histogram information.						

76. I also prepared tests of two proportions to determine if the proportion of Democratic House and Senate Districts based on the enacted map and the simulated maps are statistically significantly different. I determined that they are not. [35]

77. I also compared the average simulated Democratic vote share by district across Dr. Pegden's simulations as compared to the enacted map for the non-frozen districts. The following charts illustrate that there are few deviations between the direction of the Democratic vote share across the simulations compared to the enacted map.

[35] The following are the results of the tests of two proportions based on Dr. Pegden's results:

Elections	Democratic District Share Estimated by Dr. Pegden from Enacted Map	Democratic District Share Estimated by Dr. Pegden from Simulations	Percentage Point Difference In Democratic District Share	Number of Standard Deviations
House	36.67%	39.96%	-3.30%	-0.53
Senate	40.00%	45.80%	-5.80%	-0.59

Figure 2—Comparison of the Enacted Map and the Average Across Dr. Pegden's Simulations for Each non-Frozen House District

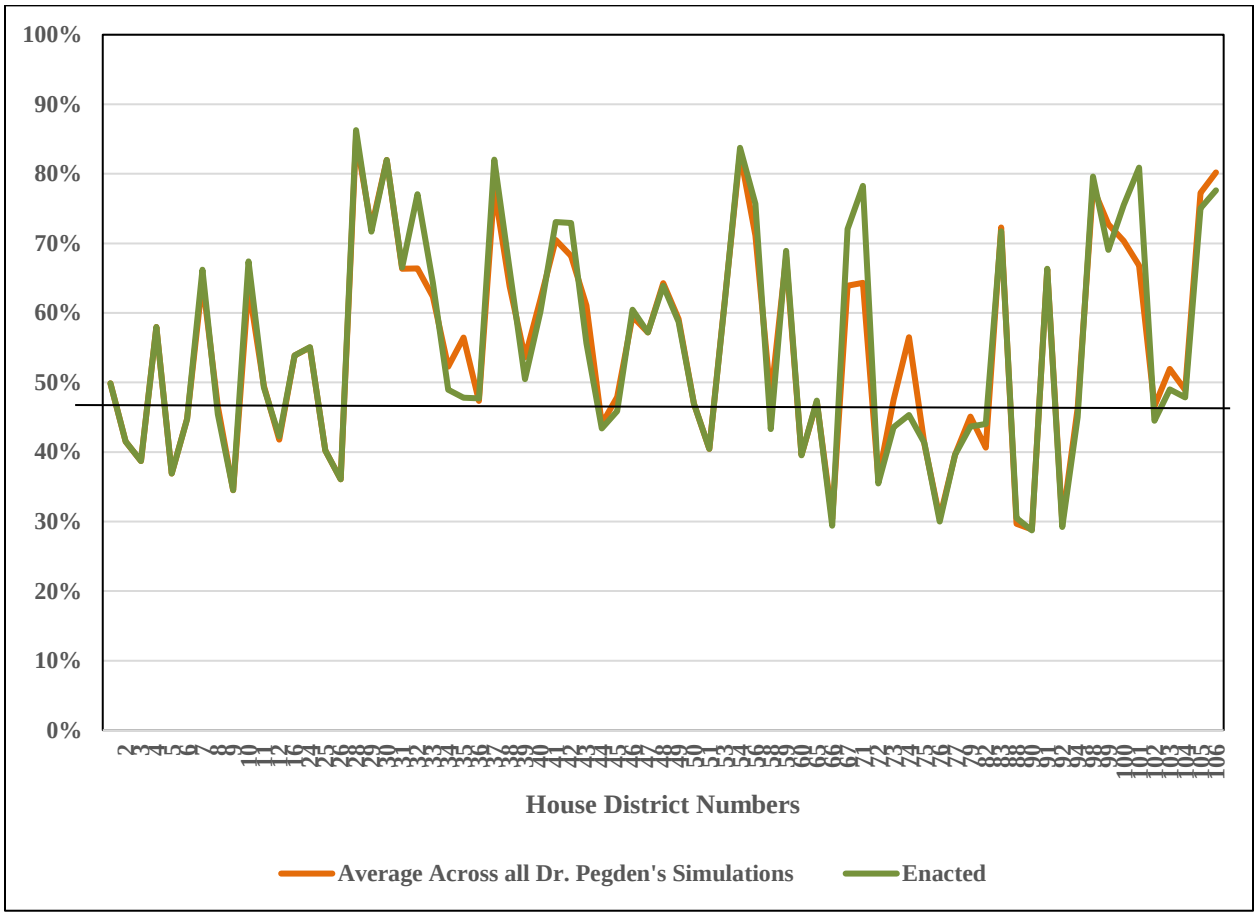
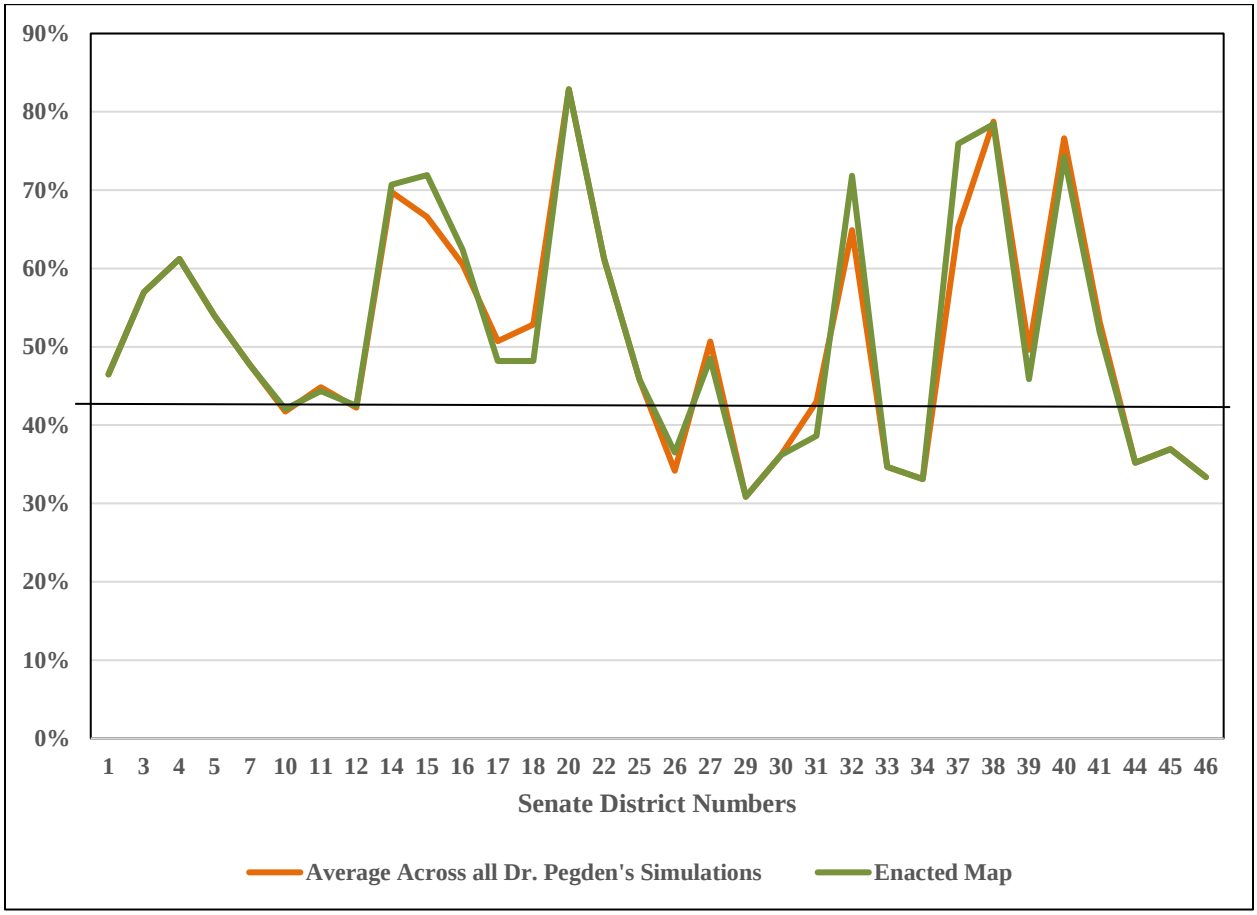


Figure 3—Comparison of the Enacted Map and the Average Across Dr. Pegden's Simulations for Each non-Frozen Senate District



78. I then identified the non-frozen districts with differences between the Party that Dr. Pegden would have estimated based on his simulations compared to the enacted map. I identified the four House and three Senate districts as listed below. I also determined if the current Party within these districts was consistent with the enacted map and found that in all but two instances they were not. In three of the four House districts, Dr. Pegden estimated a Democratic Party candidate and currently these districts are held by a Democrat. The one difference is a Republican Party candidate who has been in office for four terms. Similarly, in two of the three Senate districts, Dr. Pegden estimated a Democratic Party candidate and currently these districts are held

by a Democrat. The one difference is a Republican party candidate who has been in office for three terms.

Table 4—Non-Frozen Districts with a Difference between the Estimated Party Based on the Simulations of Dr. Pegden and the Enacted Map

House/ Senate District Grouping (county names)	House/Senate District	Estimated Party Based on Average District Simulation	Estimated Party Based on Enacted Map	Actual Party of Elected in 2018	House/ Senate Terms of Elected
House Districts					
Wake	35	Democrat	Republican	Democrat	1
Wake	36	Democrat	Republican	Democrat	1
Forsyth and Yadkin	75	Democrat	Republican	Republican	4
Mecklenburg	104	Democrat	Republican	Democrat	1
Senate Districts					
Wake and Franklin	17	Democrat	Republican	Democrat	1
Wake and Franklin	18	Democrat	Republican	Republican	3
Randolph, Guilford, and Alamance	27	Democrat	Republican	Democrat	1

79. These results illustrate the importance of determining where the deviations are and the impact of the election data used for the comparisons. They further show the importance of considering the incumbency protection as it was used by the legislature.

Dr. Chen's Simulations

80. Using a computer algorithm, Dr. Chen generates 1,000 simulations for the House and 1,000 simulations for the Senate, with an additional 1,000 simulations for each that he purports incorporate incumbency. The maps optimize the criteria that Dr. Chen chose by calculating a t-score that incorporates his thresholds for equalizing population, compactness, contiguity, and preserving political boundaries/subdivisions which, as described above, do not mirror the enacted

map. The computer simulations are then used to assess partisan bias by constructing the two-party Democratic vote share using elections Dr. Chen selected during the 2010-2016 time period.

81. At Tables 5 and 6 of his report, Dr. Chen provides the number of Democratic Districts using the 2010-2016 composite election data as described for the enacted plan and then for each of the simulated maps using his criteria with and without incumbency protection. Across his simulations, Dr. Chen estimates an average of 46.52 House Democratic Districts without incumbency protection and an average of 47.075 with incumbency protection included as a constraint in his simulations. With respect to the Senate Democratic Districts, his simulations average 19.85 Democratic Senate Districts without incumbency protection and 19.858 with incumbency protection. Dr. Chen further states that using the 2010-2016 composite election data, he estimates that 42 of the 120 House and 18 of the 50 Senate districts would have been Democratic under the enacted plan.

82. The question to then ask is whether or not the difference between the 42 Democratic House Districts under the enacted plan that Dr. Chen calculates is statistically significantly different from either the 46.52 or 47.075 that he estimates from his simulations. Similarly, we ask the question of whether or not the difference between 18 Democratic Senate Districts under the enacted plan that Dr. Chen calculates is statistically significantly different from either the 19.85 or the 19.858 that he estimates from his simulations.

83. Again, one should not be surprised that the number of Democratic districts does not exactly mirror the simulated maps because the criteria used to generate the simulated maps are not the same as the enacted map. As a consequence, then I would expect to find some differences. As described above, Dr. Chen failed to apply the same criteria used to generate the enacted map.

84. As shown below, using Dr. Chen's simulations, there are approximately 5 more Democratic House Districts and 2 more Democratic Senate Districts based on the simulations as compared to the enacted plan. These differences are *not* statistically significant with numbers of standard deviations associated with the differences that are between -0.53 and -0.95.

Table 5—Comparison of the Democratic House and Senate Districts of the Enacted Plan and the Simulated Maps Prepared by Dr. Chen Using the 2010-2016 Composite Statewide Elections

Simulation Set	Number of Districts	Average Democratic District Share Among Simulated Maps	Number of Democratic Districts Based on Enacted Map	Average Number of Democratic Districts from Simulations	Difference between Enacted and Simulated Map Democratic Districts	Number of Standard Deviations Associated with the Difference
Simulated House Districts						
Set 1	120	38.77%	42	46.52	-4.52	-0.85
Set 2	120	39.23%	42	47.08	-5.08	-0.95
Simulated Senate Districts						
Set 1	50	39.70%	18	19.85	-1.85	-0.53
Set 2	50	39.72%	18	19.86	-1.86	-0.54

Set 1 reflects the simulations without incumbency protection and Set 2 reflects the simulations with incumbency protection.
The Average Number of Democratic Districts from Simulations is calculated from the distribution of simulation results at Tables 5 and 6 of Dr. Chen's report.

85. I also prepared tests of two proportions to determine if the proportion of Democratic House and Senate Districts based on the enacted map and the simulated maps are statistically significantly different. I determined that they are not.[36]

86. Dr. Chen did not begin with the enacted map as did Dr. Pegden. As a consequence, it is difficult to make the same comparisons between the simulated maps and enacted map districts. However, Dr. Chen estimates, on average, 46 to 47 Democratic House seats and 20 Democratic Senate seats. The current map consists of 46 Democratic House seats and 21 Democratic Senate seats. Again, the data used, the criteria assumed, and the manner in which incumbency protection is considered in the simulation influence the outcomes.

Dr. Mattingly's Simulations

87. Dr. Mattingly prepares simulated maps which he compares to the enacted map using the Markov Chain Monte Carlo method. At pages 8 and 12 of his report, using his 17 selected statewide elections, Dr. Mattingly reports deviations between the enacted plan and simulated number of Democratic Senate and House Districts. Across the 17 statewide elections, the average of the median number of Democratic House Districts that he calculates from his

[36] The following are the results of the tests of two proportions based on Dr. Chen's results:

Simulation Set	Democratic District Share Estimated by Dr. Chen from Enacted Map	Democratic District Share Estimated by Dr. Chen from Simulations	Percentage Point Difference In Democratic District Share	Number of Standard Deviations
Simulated House Districts				
Set 1	35.00%	38.77%	-3.77%	-0.60
Set 2	35.00%	39.23%	-4.23%	-0.68
Simulated Senate Districts				
Set 1	36.00%	39.70%	-3.70%	-0.38
Set 2	36.00%	39.72%	-3.72%	-0.38

simulations is 53.94 which can be compared to the average of the median number of Democratic House Districts that he calculates from the enacted plan of 50.59. The difference between the simulations (53.94) and the enacted plan (50.59) is 3.35 Democratic House Districts.

88. Across the 17 statewide elections, the average of the median number of Democratic Senate Districts that he calculates from his simulations is 23.06 which can be compared to the average of the median number of Democratic Senate Districts that he calculates from the enacted plan of 20.82. The difference between the simulations (23.06) and the enacted plan (20.82) is 2.24 Democratic Senate Districts.

89. As with the other experts, one should not be surprised that the number of Democratic districts does not exactly mirror the simulated maps because the criteria used to generate the simulated maps are not the same as the enacted map. As a consequence, then I would expect to find some differences. As described above, Dr. Mattingly failed to apply the same criteria used to generate the enacted map. In addition, he included elections from 2008 and removed an election in 2016, resulting in a higher Democratic vote share.

90. Similar to the analyses prepared comparing Dr. Chen's simulations to the enacted plan's Democratic Districts, I prepared an analysis to determine if the 3.35 difference in the number of Democratic House Districts and 2.24 difference in the number of Democratic Senate Districts between Dr. Mattingly's simulations and the enacted plan are statistically significant. I determined that these differences are *not* statistically significant with numbers of standard deviations that are less than one.

Table 6—Comparison of the Democratic House and Senate Districts of the Enacted Plan and the Simulated Maps Prepared by Dr. Mattingly Across the Different Statewide Elections that He Included

Elections	Number of Districts	Average Democratic District Share Among Simulated Maps	Number of Democratic Districts Based on Enacted Map	Average Number of Democratic Districts from Simulations	Difference between Enacted and Simulated Map Democratic Districts	Number of Standard Deviations Associated with the Difference
House	120	44.95%	50.59	53.94	-3.35	-0.62
Senate	50	46.12%	20.82	23.06	-2.24	-0.63
The Average Number of Democratic Districts from Simulations is calculated from the distribution of simulation results at pages 8 and 12 of Dr. Mattingly's Report.						

91. I also prepared tests of two proportions to determine if the proportion of Democratic House and Senate Districts based on the enacted map and the simulated maps are statistically significantly different. I determined that they are not.[37]

92. I also examined the difference between the median Democratic House districts based on Dr. Mattingly's simulated maps and the enacted map for the 17 elections he included compared to the 10 elections that were considered when the enacted map was constructed. Across the 17 elections, Dr. Mattingly estimates a shortfall of 3.35 Democratic House districts. This shortfall is reduced to 1.5 when the 10 elections considered by the legislature are included. In addition, Dr. Mattingly's estimates reveal that there is an excess of Democratic House seats when

[37] The following are the results of the tests of two proportions based on Dr. Mattingly's results:

Elections	Democratic District Share Estimated by Dr. Mattingly from Enacted Map	Democratic District Share Estimated by Dr. Mattingly from Simulations	Percentage Point Difference In Democratic District Share	Number of Standard Deviations
House	42.16%	44.95%	-2.79%	-0.44
Senate	41.65%	46.12%	-4.47%	-0.45

two of the elections are considered. These data illustrate the relevance of the input data that is used to assess the simulations relative to the enacted map. While the average seat shift does not change for the Senate Democratic seats when the 10 elections are considered, the relevance of the input data is still pertinent as shown by the two elections for which Dr. Mattingly estimates neither an excess or shortfall in the number of Senate Democratic seats.

Table 7—Estimated Democratic House Seats Calculated by Dr. Mattingly When the Elections are Restricted to Those Considered by the Legislature

Election	Simulated Maps	Enacted Map	Difference	Simulated Maps	Enacted Map	Difference
USS10	36	39	-3	36	39	-3
GV12	39	43	-4	39	43	-4
LG16	43	42	1	43	42	1
USS16	43	42	1	43	42	1
PR12	46	43	3	46	43	3
USS14	47	45	2	47	45	2
PR16	48	45	3	48	45	3
PR08	49	44	5			
LG12	50	48	2	50	48	2
AG16	50	44	6	50	44	6
GV16	51	47	4	51	47	4
CI12	56	51	5			
LG08	63	56	7			
IC08	65	57	8			
GV08	66	62	4			
USS08	71	60	11			
AG08	94	92	2			
Overall	**53.9**	**50.6**	**3.35**	**45.3**	**43.8**	**1.5**

VI. Conclusion

93. None of the three Plaintiffs' experts apply the same criteria that were used to construct the enacted map. A researcher's choice of simulation criteria alone will influence the resulting simulations. Additionally, the outcome is influenced by the expert's choice of election

data upon which to measure the Democratic two-party vote share used to compare the simulations to the enacted map.

94. Further, it is unknown when the simulation should begin to sample and how often the samples should be collected, because it is almost impossible to prove that each expert's algorithm samples from the entire space of compliant maps.

95. Regardless of the simulation criteria, technique, and the data used to evaluate the maps, none of the three Plaintiffs' experts' findings statistically significantly deviate from the enacted map with respect to the number of Democratic House and Senate districts. It is possible that if each had followed the actual criteria used by the legislature there would be little to no deviation from the enacted map.

I have read the foregoing statement consisting of 95 paragraphs and swear that it is true and accurate to the best of my knowledge and belief.

FURTHER THE AFFIANT SAYETH NOT.

Janet R. Thornton

Janet R. Thornton, Ph.D.

Subscribed and sworn to before me this 7TH day of May, 2019.

Diana R. Bryson

DIANA R. BRYSON
Commission # GG 296050
Expires March 1, 2023
Bonded Thru Troy Fain Insurance 800-385-7019

Appendix A

Curriculum Vitae and Testimony List

Janet R. Thornton, Ph.D.
BERKELEY RESEARCH GROUP, LLC
2457 Care Drive, Suite A-200, Tallahassee, FL 32308

Direct: 850-402-5105
jthornton@thinkbrg.com

EDUCATION

Ph.D., Florida State University, Economics, 1992.
M.S., Florida State University, Economics, 1985.
B.A., University of Central Florida, Economics and Political Science, 1981

ACADEMIC EXPERIENCE

FLORIDA STATE UNIVERSITY
Instructor, Quantitative Methods for Business Decisions (2010)
Instructor, Quantitative Methods and Statistics (2000-2001)
Instructor, Economics (1984-1985)
Instructor and Teaching Assistant, Economics (1982-1984)

GEORGIA SOUTHWESTERN COLLEGE
Part-time Instructor (1985-1986)

UNIVERSITY OF CENTRAL FLORIDA
Research Assistant (1981)

PRESENT EMPLOYMENT

Managing Director, Berkeley Research Group, LLC (2015)

Dr. Thornton specializes in analyzing employment, insurance, and credit decisions. She has testified as an expert witness in federal court, state court, and administrative hearings regarding allegations of discrimination and the calculation of economic damages, and has been retained by both plaintiffs and defendants.

Dr. Thornton has prepared economic and statistical analyses involving allegations of gender, race, ethnicity, religious, and age discrimination in a variety of employment practices including selection, termination, and compensation. She has prepared analyses for employers both proactively and in response to litigation and OFCCP audits.

Dr. Thornton estimates economic damages and provides analysis of wage and hour claims as they relate to overtime (including misclassification), calculation of the regular rate of pay, and off-the-clock work issues including donning and doffing time. She has provided expert

witness testimony in wage and hour matters including a class action involving a large restaurant/retail chain.

Dr. Thornton has provided expert witness testimony regarding simple and complex random sampling designs, has analyzed survey data, and has calculated and incorporated statistical error rates associated with sampling designs. This expertise and her knowledge of complex databases has been used to help organize, manage, and process data for litigation including the use of sampling to identify anomalies in the organizations data processes.

Dr. Thornton's expertise in the analysis of lending practices has led her to design monitoring software specifically tailored to meet her clients' needs. She has prepared several reports and testified in class action lawsuits related to credit pricing issues.

Dr. Thornton has provided expert witness testimony regarding voting rights issues including the analysis of voter ID match rates and voting patterns among demographic groups.

PREVIOUS POSITIONS

Managing Director, ERS Group (2011 – 2015)
Director, ERS Group (2004-2011)
Vice President and Senior Research Economist, ERS Group (1998-2004)
Senior Research Economist, ERS Group (1997-1998)
Research Economist, ERS Group (1986-1997)
Research Assistant, ERS Group (Summer 1985)
Research Assistant, ERS Group (Summer 1984)

HONORS AND AWARDS

Omicron Delta Epsilon (Economics)
Omicron Delta Kappa (National Leadership)
Pi Sigma Alpha (Political Science)
Phi Kappa Phi Honor Society
Scholarship to attend the Conference on Public Choice at the Center for Public Choice in Blacksburg, Virginia, 1983

SPECIALIZATION

Labor and Natural Resource Economics

PUBLICATIONS AND PRESENTATIONS

ARTICLES

"A Labor Economist's View of the Pay Gap: Approaches for Identifying Firm-Specific Wage Disparities and Enhancing Diversity in Light of Fair Pay Laws." Prepared for the American Employment Law Council's Twenty-Third Annual Conference, October 2015.

"New Tools for the Calculation of Infringement Damages," (with Roy Weinstein and Paul White). Prepared for The Center of American and International Law, Plano, TX, October 2010.

"Weathering the Economic Downturn: Economic and Statistical Analysis for Layoffs," (with Fredrick Holt), EEO Insight, Vol. 1, Issue 3, 2009.

"Recent Developments in the Analysis of Employment Practices," (with Joan Haworth and Paul White), Developments in Litigation Economics, Eds. Patrick Gaughan and Robert Thornton. Vol. 87 of Contemporary Studies in Economic and Financial Analysis. Amsterdam: Elsevier, 2005.

"Minority and Female Owned Business Opportunity in Atlanta," (with Joan G. Haworth). Prepared for the City of Atlanta, October 2000.

"Cohort Analysis and the Determination of Economic Damages Resulting from Employment Discrimination," (with Michael J. Piette). Journal of Forensic Economics, Vol. VIII, No. 1, Winter 1995.

"Using New Labor Force Participation Rates When Computing Economic Damage and Loss: A Methodological Note," (with Michael J. Piette). Journal of Legal Economics, Vol. 4, No. 2, Summer 1994.

"A Human Capital Approach to School Retention," Ph.D. Dissertation, Department of Economics, Florida State University, April 1992.

"The Use of Cohort Analysis in the Litigation Context," (with Michael J. Piette). Presented at the American Economic Association Meeting, New Orleans, LA, January 1992.

"Changes in Labor Force Participation Rates Over Time: Some New Evidence from Census Data," (with Michael J. Piette). Presented at the Southern Economic Association Meeting, Washington, D.C., November 1992.

PRESENTATION AND TRAINING ENGAGEMENTS

"Equal Pay for Comparable Work: How to Make It Work in Massachusetts" (with Ellen Kearns), a webinar for Constangy, Brooks, Smith & Prophete, LLP, April 2018.

"Pay Equity" (panel with Lori Bowman, Zev J. Eigen, Ph.D., Genie Harrison and Susannah Howard), presented at the Daily Journal Employment Law Forum, July 2017.

"Deep Diving Pay Equity" (panel with Hon. Charlotte A. Burrows, Adam T. Klein and Nancy E. Rafuse), presented at the American Bar Association National Conference on Equal Employment Opportunity Law, March 2016.

"From the Labor Economists' Perspective – Class Certification Statistical Modeling Post-Walmart and How the Employer May Improve its Chances of Prevailing in Discrimination Cases," presented with Mary Baker, Ph.D. at the American Employment Law Council's Twenty-Third Annual Conference, October 2015.

"Economic and Statistical Analyses of Common Employment Issues" (with Bo Shippen, Ph.D.), presented at Fisher & Phillips, November 2014.

"Shoot First, Ask Questions Later: Managing through the EEOC's Strategic Priorities" (with Shay Hable and Nancy Rafuse), presented at the Corporate Counsel Institute Program, December 2013.

"How to Prepare for an OFCCP Compensation Audit" (with Steve Greene), a webinar for World at Work, September 2013.

"Compensation Analysis for Federal Contractors/Sub-Contractors," presented at the Jacksonville, Florida, Industry Liaison Group Conference, July 2012.

"WHO SAID LIFE WAS FAIR: Successfully Analyzing and Defending Fair Lending Claims" (with Eric Taylor), presented at the American Conference Institute's 13th National Forum on Consumer Finance Class Actions & Litigation, January 2012.

"Compensation Analyses," presented at the Space Coast Florida Industry Liaison Group Conference, October 2011.

"Compensation Analyses and Pay Equity," presented at the Central/Space Coast Florida Industry Liaison Group Conference, March 2010.

"Basic Statistics and Applications in AA Plan Development, Adverse Impact and Compensation," a course for the American Association for Affirmative Action's PDTI training 2010, February 2010.

"Demystifying Compensation Analysis: Concepts & Challenges, Part II," a webinar for the American Association for Affirmative Action's PDTI 2009 Webinar Series, September 2009.

"Tools for Analyzing and Monitoring Compensation," presented at the Jacksonville Industry Liaison Group Conference, May 2009.

"Tools for Analyzing and Monitoring Compensation," presented at the Central/Space Coast Florida Industry Liaison Group Conference, April 2009.

"Demystifying Compensation Analysis: Concepts & Challenges," a webinar for the American Association for Affirmative Action's PDTI 2009 Webinar Series, March 2009.

"Weathering the Economic Downturn: Economic and Statistical Analysis for Layoffs," presented at the Jacksonville Industry Liaison Group Conference, "Preparing for Change: Hot Topics for 2009 and Beyond," February 2009.

"Tools for Analyzing and Monitoring Compensation," presented at the Southwest and Rocky Mountain Regional Industry Liaison Group Conference, "Fairness and Inclusion in a Changing Workforce," November 2008.

Presented at the Proskauer Rose LLP seminar "Navigating Wage and Hour Issues in California," April 2008.

SEMINAR PRESENTATIONS

"Employment Discrimination: Economic and Statistical Evidence," an ERS Group seminar. Presented the following topics: "Commonly Used Statistical Techniques" and/or "Advanced Statistical Techniques: Compensation Analysis" and/or "Statistical Concepts: Modeling & Data Issues" and/or "Exposure and Liability: Calculating Damages." Orlando, 2012 and 2014; Washington, D.C. and New York, 2009; Washington, D.C. and New York, 2006; Washington, D.C. and New York, 2004; Washington, D.C. and New York, 2003; Chicago and New York, 2002; Dallas, 2001; New York and Los Angeles, 2000; Atlanta, Chicago, San Francisco, 1999; and Los Angeles, 1998.

"2010 Compensation Tune-up: Are Your Pay Practices Ready for Challenges?" an ERS Group webinar, January 2010.

"Weathering the Economic Downturn: Economic and Statistical Analysis for Layoffs," an ERS Group webinar, January 2009 and December 2008.

"Compensation Tune-Up for 2007: Tools for Analyzing and Monitoring Compensation," an ERS Group webinar, February 2007.

"Analyzing and Monitoring Compensation in Today's Regulatory Environment," an ERS Group seminar, Washington, D.C. and San Francisco, 2005.

PROFESSIONAL ASSOCIATIONS AND MEMBERSHIPS

American Economic Association
National Association of Forensic Economics
North Florida Committee on Foreign Relations

Janet R. Thornton, Ph.D.
BERKELEY RESEARCH GROUP, LLC
2457 Care Drive, Suite A-200, Tallahassee, FL 32308

Johnny Reynolds, et al. v. Alabama Department of Transportation, et al.; Case No. CV-85-T-665-N, U.S. District Court, Middle District of Alabama, Northern Division. [affidavits, deposition]

Roxie Sibley, et al. v. Sprint Nextel Corporation and Sprint/United Management Company; Case No. 02:08-CV-02063-KHV/JPO, U.S. District Court, District of Kansas. [affidavits, deposition]

North Carolina State Conference of the NAACP, et al. v. Patrick Lloyd McCrory, in his official capacity as Governor of North Carolina, et al. (Case No. 1:13CV658); League of Women Voters of North Carolina, et al. and Louis M. Duke, et al. v. The State of North Carolina, et al. (Case No. 1:13CV660); and United States of America v. The State of North Carolina, et al. (Case No. 1:13CV861), U.S. District Court, Middle District of North Carolina. [declarations, depositions, trial testimony]

Charles M. Bingham v. Raytheon Technical Services Co., LLC; Case No. 1:13-CV-00211-TWP-DKL, U.S. District Court, Southern District of Indiana, Indianapolis Division. [declaration]

Alberta Currie, et al. v. The State of North Carolina and the North Carolina State Board of Elections; Case No. 13-CVS-1419, State of North Carolina General Court of Justice, Superior Court Division, County of Orange. [affidavit]

Barbara H. Lee, et al. v. Virginia State Board of Elections, et al.; Case No. 3:15-CV-357, U.S. District Court, Eastern District of Virginia. [deposition, declaration, trial testimony]

Sheree Steele and Momina Ansoralli, et al. v. CVS Pharmacy, Inc.; Case No. 15-CV-04261, U.S. District Court, Southern District of New York. [deposition]

United States of America v. South Dakota Department of Social Services; Case No. 5:15-cv-05079-JLV, U.S. District Court, District of South Dakota, Western Division. [deposition]

Arizona Democratic Party, et al. v. Michele Reagan, et al.; Case No. CV-16-01065-PHX-DLR, U.S. District Court, District of Arizona. [deposition, trial testimony]

Stacy Tebo v. City of DeBary, Florida, and Leo Daniel Parrott; Case No. 6:16-cv-01599-31-DAB, U.S. District Court, Middle District of Florida, Orlando Division. [deposition]

Betsy Ackerson v. The Rector and Visitors of the University of Virginia; Case No. 3:17-cv-00011-GEC, U.S. District Court, Western District of Virginia, Charlottesville Division. [deposition]

Cherie Noelle Maness v. City of High Point, North Carolina; Case No. 1:17-cv-384, U.S. District Court, Middle District of North Carolina. [deposition]

Sandra B. Johnson v. Alabama Department of Transportation and State Personnel Department; Case No. CV-85-T-665-N, U.S. District Court, Middle District of Alabama, Northern Division. [affidavit]

Mary Buckhanna v. Alabama Department of Transportation and State Personnel Department; Case No. CV-85-T-665-N, U.S. District Court, Middle District of Alabama, Northern Division. [affidavit]

Nial Benton and Hutton Graham, et al. v. Deli Management, Inc. d/b/a Jason's Deli; Case No. 1:17-cv-00296-WSD, U.S. District Court, Northern District of Georgia, Atlanta Division. [deposition]

Ohio A. Philip Randolph Institute, et al. v. Ryan Smith, Speaker of the Ohio House of Representatives, et al.; Case No. 1:18-cv-00357-TSB-KNM-MHW, U.S. District Court, Southern District of Ohio. [deposition, trial testimony]

Roy M. Holston v. Alabama Department of Transportation and State Personnel Department; Case No. CV-85-T-665-N, U.S. District Court, Middle District of Alabama, Northern Division. [affidavit]

Alfred L. McQueen v. Alabama Department of Transportation and State Personnel Department; Case No. CV-85-T-665-N, U.S. District Court, Middle District of Alabama, Northern Division. [affidavit]

Appendix B

Materials Relied Upon

Materials Relied On

- Amended Complaint, dated December 7, 2018
- Expert Report of Jowei Chen, Ph.D., dated April 8, 2019, with supporting materials
- Expert Report on the North Carolina State Legislature, by Jonathan C. Mattingly, Ph.D., dated April 8, 2019, with supporting materials
- An Analysis of North Carolina's Legislative Districtings: Expert Report, by Wesley Pegden, Ph.D., dated April 8, 2019, with supporting materials
- Expert Report on North Carolina's General Assembly Districts, Christopher A. Cooper, Ph.D., dated April 8, 2019, with supporting materials
- 2017 House and Senate Plans Criteria; Bates Number LDNC1883.
- Maps for the 2011 plans and maps used in the 2018 election, including data and shape files
- Wendy K. Tam Cho and Yan Y. Liu. *Sampling from Complicated and Unknown Distributions Monte Carlo and Markov Chain Monte Carlo Methods for Redistricting.* Physica A 506 (2018), pages 170-178.
- Ramona L. Paetzold and Steven L. Willborn (2016). The Statistics of Discrimination, Using Statistical Evidence in Discrimination Cases. Thomson Reuters, §2.5 and §4:13.
- North Carolina election data downloaded from the North Carolina State Board of Elections website https://www.ncsbe.gov referenced herein