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Analysis of Wisconsin's Accountability Report Cards

Statistics 998: Statistical Consulting

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Wisconsin Accountability Report Card Score Analysis

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1. Summary

An analysis of the Wisconsin DPI's district accountability report cards is performed to better understand which school district characteristics are most strongly associated with report card score. In the most recent school year (2018-19), most districts met or exceeded accountability expectations. Using data from the previous four school years, a linear mixed model was fit relating accountability report card score to district funding, % of students with disabilities, % of students with economic disadvantage, % of students with English deficiencies, % of students who moved districts within the school year and interactions between each of these characteristics and funding. The model has an $R^2 = 0.253$ yet the only statistically significant term in the model is % of students with economic disadvantage ($p = 0.047$). A simpler mixed model including only % economically disadvantaged students has a roughly equivalent $R^2 = 0.241$. This suggests that approximately 24% of the variability in the observed accountability scores can be explained by a district's % of economically disadvantaged students alone and that including other district characteristics and funding does not improve the model significantly.

From these results, we hypothesize the following interpretations. First, it appears that % of students with economic disadvantage, % of students with disabilities, and % of students moving districts may capture similar information in regards to accountability score. Next, as % of students with economic disadvantage has a particularly strong association with accountability score while funding does not, economic advantages outside of the classroom may be more impactful than economic advantages inside the classroom. However, we cannot draw causal conclusions as this study is not a causal analysis and we recommend continued monitoring of the relationship between funding and accountability score as it may take some number of years at a particular level of funding for the relationship to become apparent.

2. Introduction

Since the 2011-12 school year, the Wisconsin Department of Public Instruction has produced annual accountability report cards for all publicly funded schools and school districts in Wisconsin. The accountability report cards include data on demographic characteristics of the school/district as well as performance indicators across four priority areas - student achievement, growth, closing gaps, and on-track/post-secondary success. A weighted average of scores in these four priority areas is used to create an overall accountability score which places the district into one of five categories ranging from fails to meet expectations to significantly exceeds expectations (figure 1).

Rating	Score	Stars
Significantly Exceeds Expectations	83-100	*****
Exceeds Expectations	73-82.9	****
Meets Expectations	63-72.9	***
Meets Few Expectations	53-62.9	**
Fails to Meet Expectation	0-52.9	*

Figure 1. Wisconsin DPI school/district accountability rating categories

The accountability report cards serve an important purpose towards the Wisconsin DPI's goal of preparing every student for graduation and further education or a career. The report cards are publicly available - allowing parents to review report cards to make more informed decisions about their child's education. Educators can use the report cards to identify areas of improvement or decline that may lead to further actions to promote continued success or reforms to improve the school/district performance. Furthermore, while the efficacy of performance-based funding is an area of open research[1,2], accountability score performance is ultimately tied to both federal and state funding. Thus, it's of interest to better understand what factors may affect performance within the Wisconsin DPI's accountability rating system.

In this report, accountability report card data at the district level for the previous 4 years is examined to understand factors related to accountability rating. Of primary interest is the relationship between school district funding and accountability score. However, there might be other factors that are associated with both funding and accountability score. Thus, we address three general research questions:

1. Is there an association between school district characteristics and funding?
2. What is the effect of school district funding on accountability score when adjusting for district characteristics?
3. Are any other district characteristics strongly associated with accountability score?

3. Materials and Methods

Data Collection and Experimental Design

The experimental design for this study is a longitudinal observational study. There are two primary data sources included in this study. The first is the annual accountability report card released for each publicly funded school district in Wisconsin. Within the report card, we examine the following school district characteristics:

- Accountability score (0-100) and rating
- % of students with disabilities (disabilities)
- % of students with economic disadvantage (poverty)
- % of students with limited English proficiency (ESL)
- % of students who changed districts in the academic year (mobility)

Note that the report cards don't explicitly state exactly how these percentages are calculated.

The second data source used is the Wisconsin DPI survey of revenue limit formula components provided by the Adams-Friendship area school district administrator Tom Wermuth. The survey includes substantial information about revenue and expenses for each Wisconsin school district in each school year. While the survey includes substantial information about district funding, we choose to utilize a relatively simple summary measure of district funding; the amount of funding per pupil (FPP).

Data Processing

District accountability report card data files for the previous four school years (2015-16, 2016-17, 2017-18, and 2018-19) were pulled from the Wisconsin DPI website. Districts lacking an accountability score or those not serving grades K-12 were removed (however, districts serving preK-12 were kept). Accountability ratings towards the extreme (significantly exceeds expectations and fails to meet expectations) were found to be relatively sparse. Thus, these categories were merged with the closest ratings (exceeds expectations and meets few expectations respectively).

Funding information from the Wisconsin DPI survey of revenue was provided by Tom Wermuth and the amount of funding per pupil was joined to the accountability report card data using district code and school year. The resulting data set contained 366 school districts each of which had complete, non-missing data for all variables for all four school years (2015-16 to 2018-19). A summary of the school district characteristics averaged by district across school years for those districts analyzed in this report is shown in table 1.

Table 1. Summary of school district characteristics averaged over school years 2015-16 to 2018-19.

Characteristic	Meets Few Expectations	Meets Expectations	Exceeds Expectations	**Overall**
Count	14	156	196	**366**
Accountability Score	61.09 (2.31)	69.7 (3.7)	76.7 (4.44)	**73.71 (7.2)**
FPP (thousands, $)	9.77 (0.88)	9.69 (0.9)	9.72 (0.89)	**9.7 (0.9)**
Disabilities (%)	14.88 (4.5)	14.39 (3.6)	12.89 (3.51)	**13.66 (3.79)**
Economic Disadvantage (%)	53.04 (18.33)	43.62 (15.42)	30.21 (19.56)	**37.29 (22.09)**
English Deficiency (%)	0.45 (4.9)	1.14 (4.13)	1.57 (2.33)	**1.46 (2.8)**
Moved Districts (%)	5.61 (1.99)	3.99 (1.72)	2.76 (1.43)	**3.31 (1.77)**

[1] Fails to meet expectations was grouped with meets few expectations and significantly exceeds expectations was grouped with exceeds expectations.
[2] Characteristics are summarized by median (inter-quartile range).

Statistical Analysis and Modeling Results

A longitudinal study is one in which each study subject has multiple measurements. For example, we have four sets of accountability scores, district characteristics, and funding for each school district for each of the four school years included in the study. There are numerous methods to analyze longitudinal data - in this report we utilize two different methods, averaging across years for each school district and mixed modelling.

For constructing visualizations, we choose to average by district across school years to reduce the amount of data shown in the visualization. For example, the average % of students with disabilities over the previous four years in a particular district provides an accurate summary of the expected % of students with disabilities in that district in any particular year.

Meanwhile, to formally assess assocations and to report effect sizes, we construct linear mixed models. Linear mixed models are similar to least squares regression models except that subject-specific random effects are included to account for correlation between different observations (for example, results for the same district across school years). Thus, a mixed model is able to account for subtle relationships in the data that may be lost whenever data is averaged by district across multiple years.

Association Between District Characteristics and Funding

To address our first research aim, a scatterplot and correlation matrix between district funding and characteristics was constructed (figure 2). Additionally, locally estimated scatterplot smoothing (LOESS) lines were fit to each scatterplot to help highlight trends in the data. First, we notice that funding has a weak to non-existent relationship with each of the school district characteristics. Funding is most strongly correlated with % of students with disabilities, but even that correlation is weak ($r = 0.0631$). This suggests that these characteristics likely do not affect funding and that there are no underlying processes that affect both funding and these characteristics in the same manner.

Meanwhile, it appears that some school district characteristics are at least moderately correlated. Specifically, % of students with economic disadvantage, english deficiency, and moving districts all have correlations between 0.466 and 0.738. The remaining district characteristic, % of students with English deficiencies, is only weakly correlated with % of students with economic disadvantage but does not exhibit any substantial correlation with other characteristics.

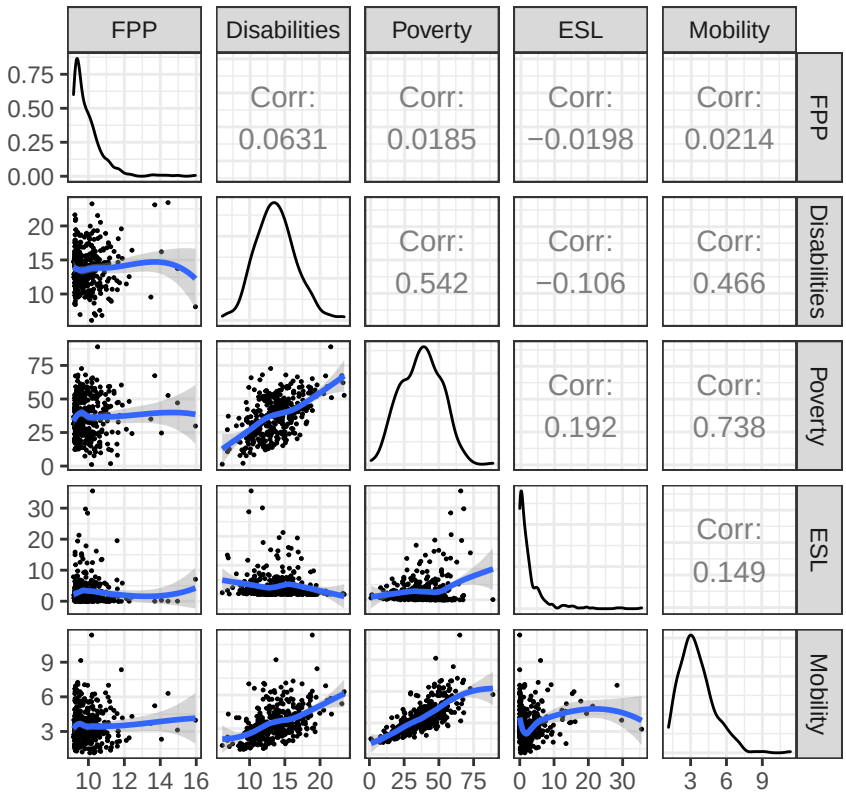

Figure 2. A scatterplot and correlation matrix of district funding and characteristics averaged over all years.

Effect of Funding on Accountability Score

The relationship between funding and accountability score is the primary focus of this report. First, the distribution of accountability score and funding per pupil was explored by plotting histograms of the number of in each rating averaged across school years (figure 3). The figures suggest that accountability scores are fairly symmetric and appear to follow a relatively normal distribution. Only a few districts met few expectations and no districts fail to meet expectations. In fact, the median school district exceeds expectations. The plot of funding per pupil reveals that district funding is highly right skewed. Most districts receive less than $10,000 per student while few receive much more funding (up to $16,000 per student). We choose to leave funding as-is rather than apply a transform intended to reduce skew in order to make our results easier to interpret.

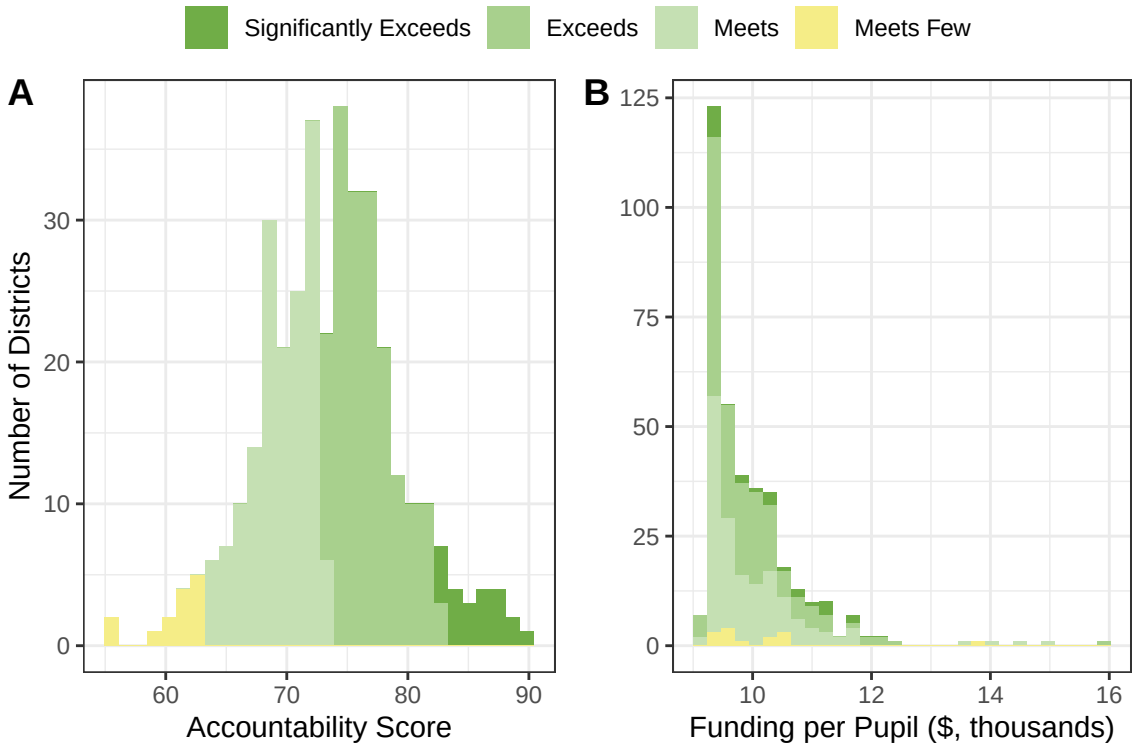

Figure 3. Distributions of district accountability score (A) and funding (B) averaged across school years.

Next, the relationship between district characteristics, funding, and accountability rating (collapsed into only 3 rating groups) was explored visually (figure 4). From the figure, there appears to be a clear trend between % of students with disabilities, economic disadvantage, and between district mobility. That is, as each of these percentages increase the median accountability rating decreases. There appears to be a modest positive relationship between students with english deficiency and accountability rating. There does not appear to be

any discernible relationship between funding and accountability rating. However, unexpectedly, the rating with the highest median funding actually contains districts which meet few expectations.

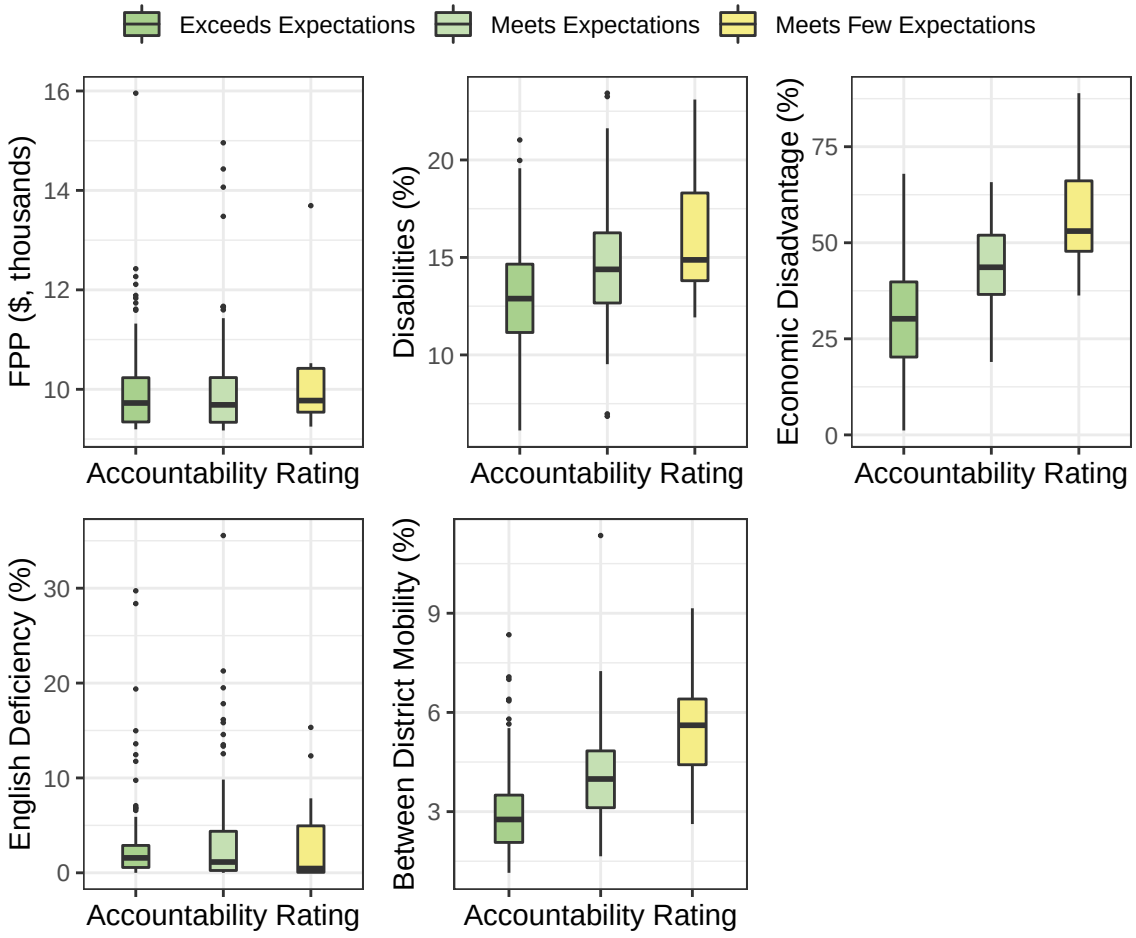

Figure 4. District characteristics vs. accountability rating averaged by district across school years.

To formally test for relationships between the variables of interest, a mixed linear regression model relating accountability score to school district characteristics with district-specific random effects was fit. Additionally, because funding is the variable of primary interest, interaction effects between funding and each characteristic were included in the model. The coefficients of the model, with confidence intervals and p-values are reported in table 2. The only variable which has a statistically significant (at the $\alpha = 0.05$ level) association with accountability score is % economically disadvantaged students ($p = 0.047$). Funding appears to have a positive relationship with accountability score but the association is insignificant when adjusting for the other characteristics of the district. Additionally, all of the interaction effects are statistically insignificant. The R^2 for this model is 0.253, indicating that the terms included in the linear mixed effects model are able to explain approximately 25% of the observed variability in accountability score.[3]

Term	Estimate	95% CI	p-Value
Main Effects			
(Intercept)	70.09	(52.78, 87.32)	-
Funding per Student (thousands, $)	1.22	(-0.48, 2.94)	0.161
% Disabilities	0.69	(-0.4, 1.8)	0.219
% English Deficient	-0.26	(-1.7, 1.18)	0.722
% Economically Disadvantaged	-0.33	(-0.66, -0.01)	0.047
% Moved Districts	4.23	(-4.36, 12.82)	0.336
Interaction Effects			
Disabilities x Funding	-0.08	(-0.19, 0.03)	0.154
English Deficient x Funding	0.03	(-0.12, 0.17)	0.709
Economically Disadvantaged x Funding	0.01	(-0.02, 0.05)	0.420
Moved Districts x Funding	-0.47	(-1.37, 0.43)	0.311

Table 2. Results of the linear mixed model relating accountability score to district characteristics ($R^2 = 0.253$).

Effect of Student Poverty on Accountability Score

From figure 4 and the results of the linear mixed model summarized in table 2, it appears that student poverty is negatively associated with accountability score. A scatterplot of % of students with economic disadvantage vs. accountability score was constructed (figure 5). Additionally, a mixed effects model relating only % of students with economic disadvantage to accountability score with district-specific random effects was fit to the data. From the plot, it's clear that % of sudents living in poverty is strongly correlated with accountability score performance. The results of the mixed model suggest that for each 1% increase in students living in poverty, the accountability score decreases by approximately 0.21. Furthermore, the model has an $R^2 = 0.241$, suggesting that approximately 24% of the variability in observed accountability score can be explained by % of economically disadvantaged students alone.

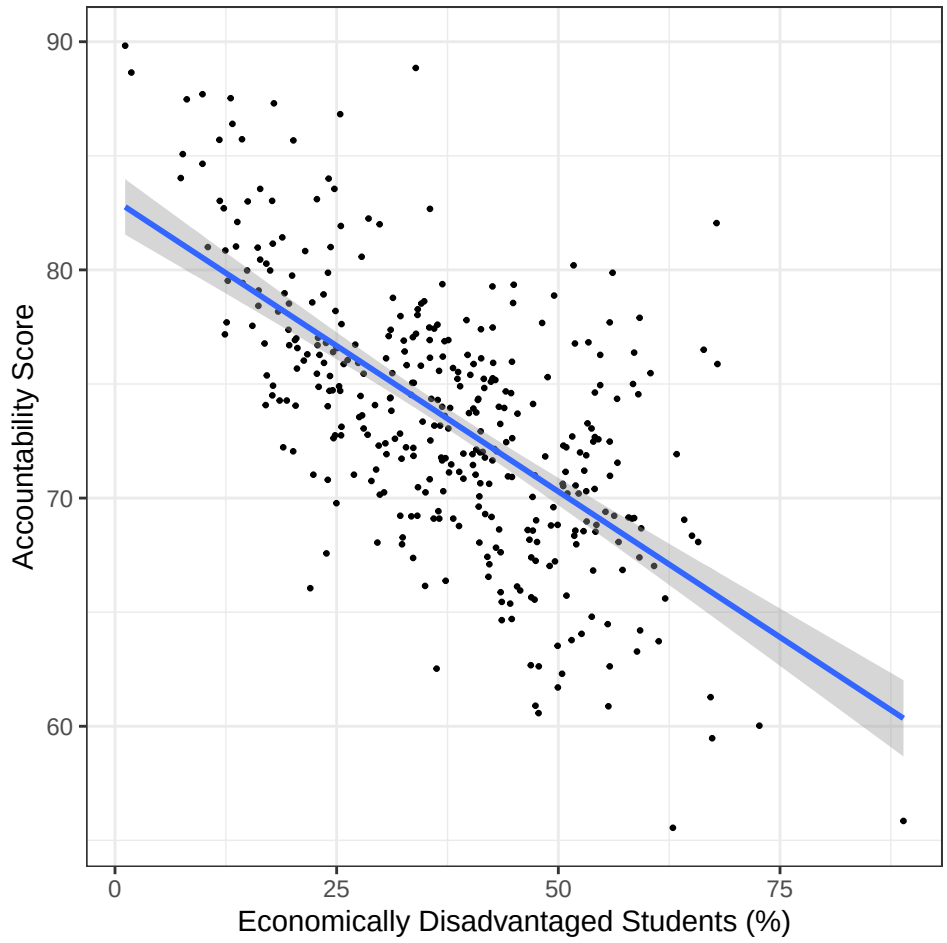

Figure 5. Scatterplot of student poverty vs. accountability score averaged by district across school years.

Lastly, we seek to better understand the interaction between poverty and funding in regards to accountability score. Using the data averaged by district across school years, poverty was split into four quartiles each containing roughly 25% of the total number of districts. That is, the first quartile, Q1, contains roughly 25% of districts serving the lowest percentage of students with economic disadvantage. Then, a scatterplot of accountability score vs. funding was constructed with colors coded according to the district's poverty quartile (figure 6). For the first three quartiles, including the districts within the 75th percentile of % of economically disadvantaged students, there appears to be no interaction between funding and poverty. That is, as funding increases, the accountability score appears to increase at the same rate for each poverty quartile. However, for the students serving the poorest students, we observe that increased funding is actually associated with lower accountability scores.

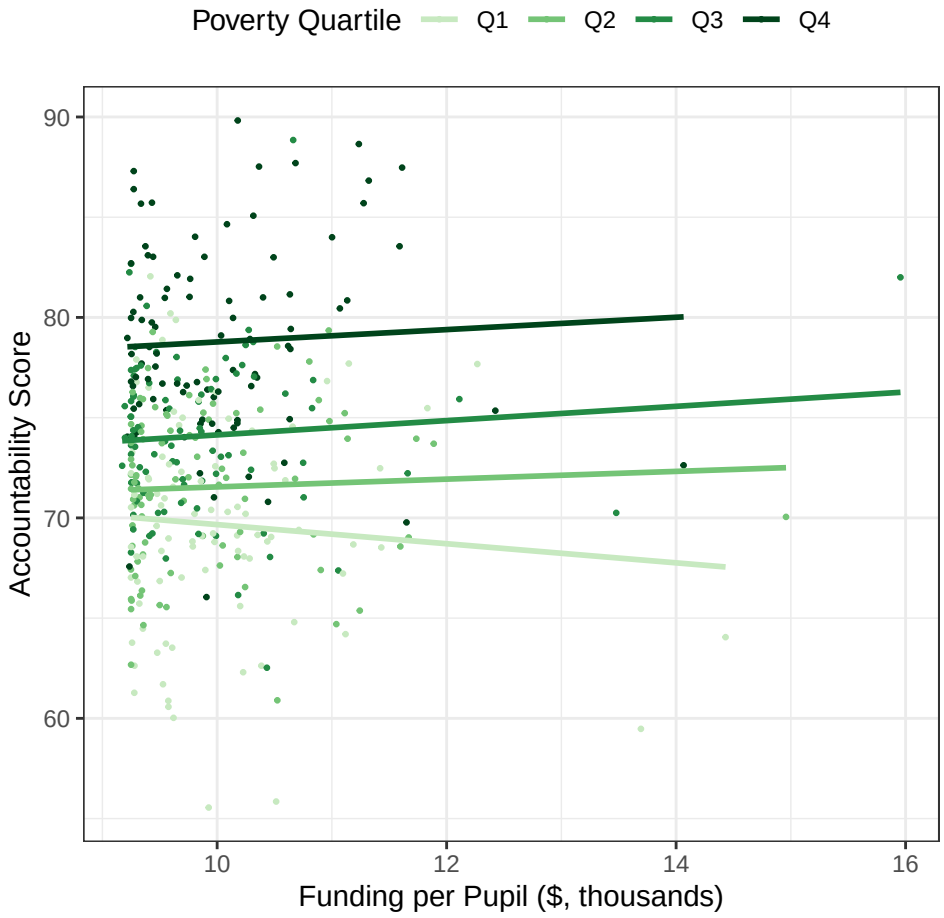

Figure 6. Interaction plot of funding and student poverty averaged by district across school years.

4. Discussion

Association Between District Characteristics and Funding

One might expect that districts with different demographic characteristics might require and receive different levels of funding. However, for the demographic data available to us, our analysis suggested that there is no association between district characteristics and funding. However, as association between % of students with disabilities, economic disadvantage, and between district mobility were all found to have at least moderate correlation. This result suggests that there may be some underlying quality of school districts that affects each of these characteristics. For example, it might be the case that being located in more urban areas of Wisconsin may lead to school districts with higher numbers of students with disabilities, economic disadvantage, and may facilitate easier movement between districts. However, just because these characteristics are correlated does not mean that they are related to or affect funding or accountability score in the same way.

Effect of Funding & Poverty on Accountability Score

We first examine the distribution of district accountability score and funding per pupil. In fact, most schools appear to be performing quite well according to their accountability score rating. Furthermore, accountability score appears to be normally distributed which allows us to fit linear models which are more commonly used and may be more familiar to those without a statistical background.

Most publicly funded school districts in Wisconsin receive funding around $11,000 per pupil or less. Approximately 1/3 of districts receive around $9,500 per pupil. A small number of districts receive substantially more funding than this amount, however, our analysis suggests that this increased funding is not significantly associated with accountability score when adjusting for other school district characteristics. Visual analysis and a linear mixed model fit to the data suggest that % of students with disabilities, economic disadvantage, and between district mobility are negatively associated with accountability score. Of these characteristics, % of economically disadvantaged students is the only characteristic which is significantly associated with accountability score when adjusting for other characteristics. While the full model containing terms for each district characteristic and funding (including interactions) explains around 25% of the variability in observed accountability scores, a much simpler model containing only % economically disadvantaged students explaind around 24% of the variability in observed accountability scores. This result, accompanied with the correlations between characteristics seen in figure 2, suggests that the measure of % economically disadvantaged students is actually capturing much of the same information as the other district characteristics and funding in regards to their relationship with accountability score.

While % of students with economic disadvantage appears to have a particularly strong association with accountability score, we are still interested in the effect of funding and particularly the interaction between poverty and funding. For example, it's plausible that school districts with a high percentage of students living in poverty might receive more benefit from funding than those districts with lower poverty. Our preliminary analysis in figure 6 suggests that this is not the case. Most districts appear to be affected similarly regardless of the districts underlying poverty. However, for the districts serving the highest percentage of economically disadvantaged students, increased funding is actually associated with lower accountability score. We hypothesize that rather than increased funding having a negative effect, as it appears from the data, increased funding has little or no effect. It's possible that money is being brought into underperforming districts in an attempt to improve their outcomes but that, while funding is increasing, the accountability score is not. It's also possible that the effect of funding on accountability score is delayed. Thus, we recommend continued monitoring over additional years to see if those districts which are underperforming but receiving higher funding do experience better performance in the future.

5. Conclusion

Accountability report cards produced for each publicly funded school district in Wisconsin are a valuable source of information for parents and educators to better serve the needs of the students of Wisconsin. In this report, we've explored the relationships between district demographic characteristics, funding, and accountability score. Of the factors analyzed in this study, we've found that % economically disadvantaged students is most strongly associated with accountability score. We hypothesize that this characteristic is likely capturing much of the same information included in other district characteristics in regards to accountability score. When adjusting for district poverty and other characteristics, funding does not have a statistically significant association with accountability score. In fact, we observe that increased funding is actually associated with lower accountability score for districts serving more students in poverty. One interpretation of these results is that economic advantages outside of the classroom are more impactful than economic advantages within the classroom in regards to performance in the four priority areas - student achievement, growth, closing gaps, and on-track/post-secondary success - measured by the accountability score. Due to the relatively short time-span of this study (the most recent 4 years), we recommend continued monitoring of accountability score and its relationship with funding.

References

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2. Callahan, K., Meehan, K., Shaw, K. M. (2017) *Summary of OBF Impact on Student Outcomes in Tennessee and Indiana* **Research for Action**
3. Nakagawa, S., Schielzeth, H. (2012) *A general and simple method for obtaining R^2 from generalized linear mixed-effects models* **Methods in Ecology and Evolution**

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UniverCity Year is a three-phase partnership between UW-Madison and one community in Wisconsin. The concept is simple. The community partner identifies projects that would benefit from UW-Madison expertise. Faculty from across the university incorporate these projects into their courses, and UniverCity Year staff provide administrative support to ensure the collaboration's success. The results are powerful. Partners receive big ideas and feasible recommendations that spark momentum towards a more sustainable, livable, and resilient future. Join us as we create better places together.

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