APPENDIX D

Report on Analysis of North Dakota K-12 Public School District Transportation Funding Formulas & Financial Implications

June 2023

Conducted by
Bureau of Evaluation and Research Services (BEARS)
College of Education & Human Development
University of North Dakota
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Funded by
North Dakota State Legislature, Section 16 of SB 2284
In coordination with
Dr. Steven Holen, Superintendent of Schools
McKenzie County Public School District #1

Executive Summary

- The purpose of this analysis and report is to provide insight into current practices regarding K-12 public school transportation funding in North Dakota, and analyze potential alternative models to funding allocation.
- The questions and data analysis strategies were based on the 2012 dissertation by Dr. Steven Holen. On behalf of the state legislature, Dr. Holen commissioned BEARS to replicate the analysis of 2011 data on more current 2022 data, which he provided via the ND Department of Public Instruction (157 of possible 179 districts). Variables analyzed are based off the dissertation and data provided.

1. To what extent does the current K-12 pupil transportation funding system reflect the actual transportation expenditures of North Dakota school districts?

- In 2022, the actual expenditures on transportation from ND schools was $74,798,782.77, whereas the schools received $24,525,772.05 in funding. Districts were under-funded by an average of $320,210.26; however, this number is skewed by some school districts with extreme deficits (e.g., $5,124,960.27 Fargo 1)

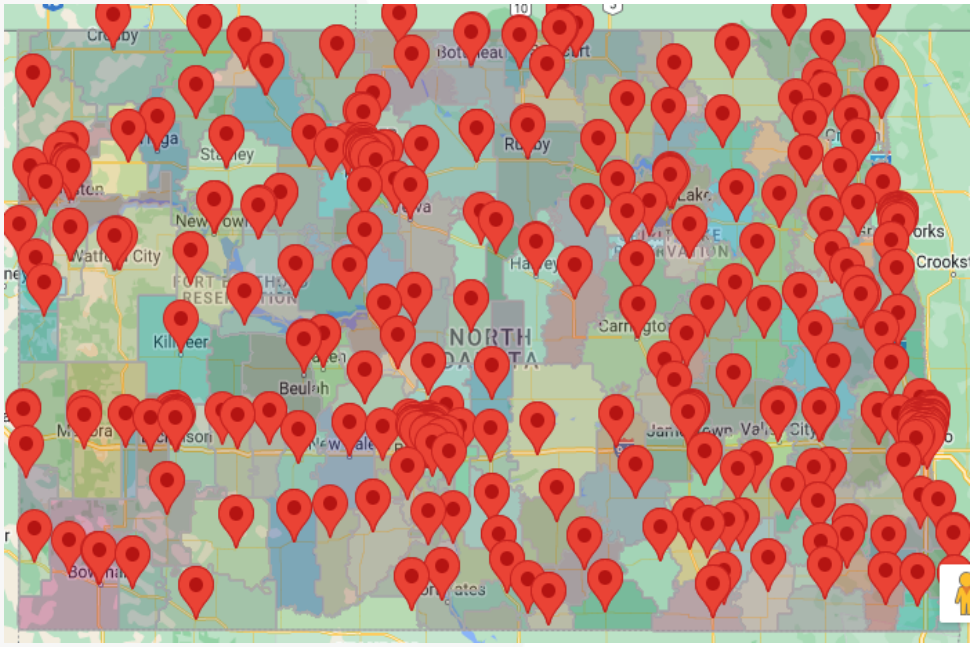
2. Does the Expected Costs model accurately predict the actual transportation expenditures of North Dakota school districts?

- We tested 4 models that ranged in accuracy from 93% to 79%, each having different strengths and weaknesses. Model 1 (based on Holen) explained the largest percent in expenditures, but also was susceptible to the producing outliers.
- Models 2-4 were attempts to explain more variance and eliminate outliers and succeeded to some extent, yet each had their drawbacks (see report).

3. Does a K-12 pupil transportation funding system based on expected costs, rather than a block grant, provide greater equity and adequacy regarding school district transportation funding levels in North Dakota?

- The Expected Cost models provided much more funding to districts and explained more variability in funding, the highest were Models 1 and 2 at about 93%. However, in some cases the models had extreme predictions of expenditures due to outliers in the data.

ND Demographics & Sample



North Dakota

- Schools: 484
- School Districts: 179
  - **Current data: 157**
- Students: 116,639
- Teachers: 9,385
- T:S Ratio: 1:12
- Spending per: $14,242

Comparing ND to USA

	Schools	Districts	Students	Teachers	Teacher-pupil Ratio	Per pupil spending
North Dakota	484	179	116,639	9,385	1:12.4	$14,242
USA	90,323	13,194	47,755,383	2,783,705	1:16	$13,494

The current data set included 157 school districts in North Dakota that reported the five transportation factors identified in this study to the Department of Public Instruction for the 2021-2022 school year. The study includes school districts that offer K-12 services as well as K-8 services.

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Question 1

To what extent does the current North Dakota K-12 pupil transportation funding system reflect the actual transportation expenditures of North Dakota school districts?

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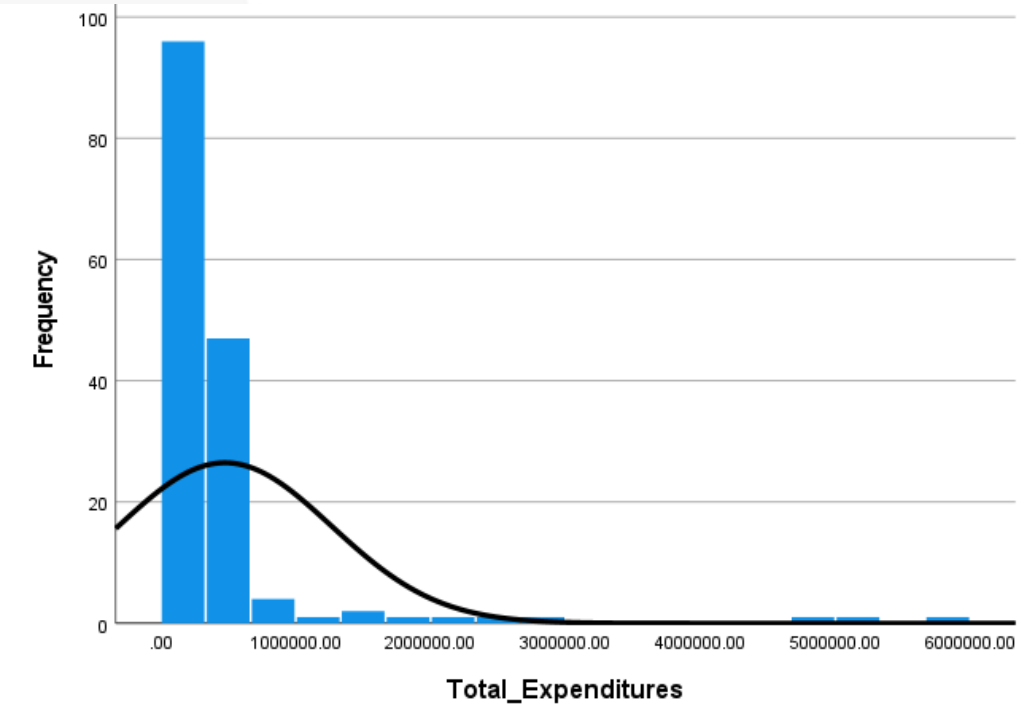
Total Expenditures

Total Expenditures

- The total transportation expenditures (what schools actually spent) for the 157 school districts included in the data set was $74,798,782.77.
- The average expenditures of a North Dakota school district was $476,425.37 (standard deviation $788,504.16).
- The minimum amount of transportation expenditure was $5,981.00 by the Marmarth-12 school district, and the maximum amount was $5,954,770.26 by the Fargo 1 school district.



			N (School District)= 157
Mean	$476,425.37	**Minimum**	$5,981.00
Mode	$5,981.00	**Maximum**	$5,954,770.26
SD	$788,504.16		

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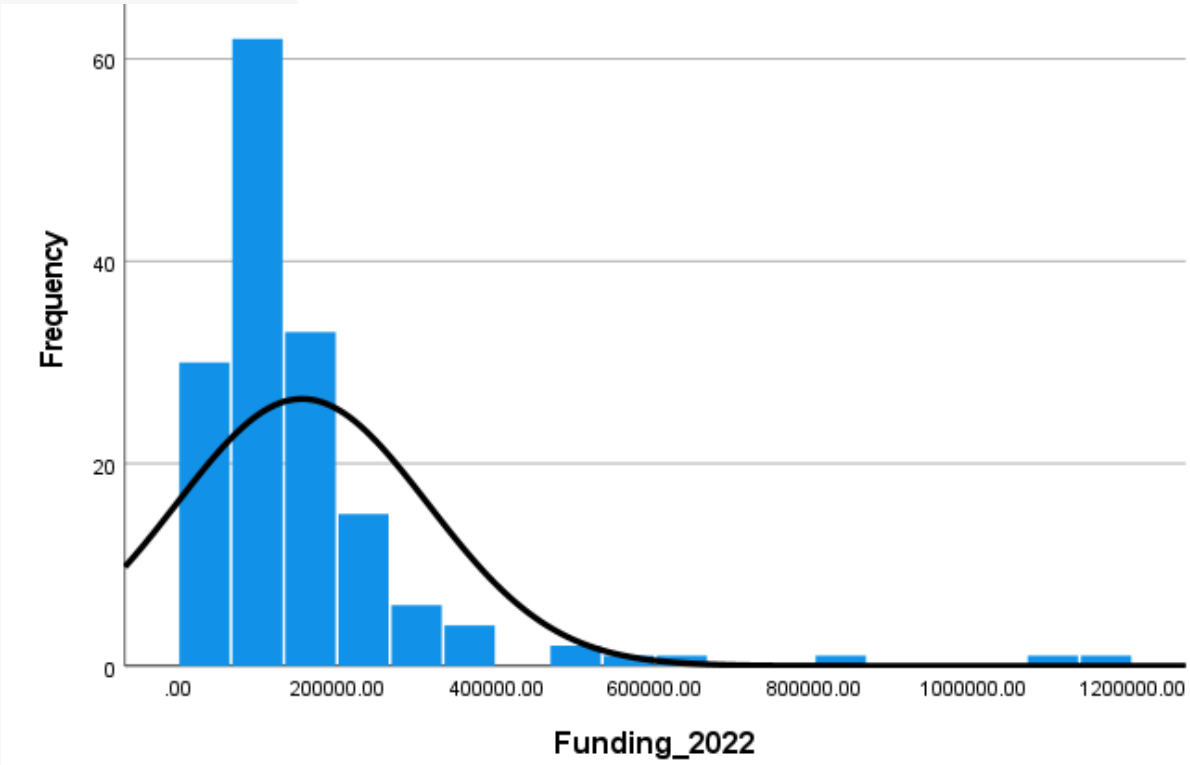
Total Funding

Total Funding

- The total amount of state transportation funding (what schools received based on block grant funding) was $24,525,772.05.
- The average amount of state funding per school district was $156,215.11 (standard deviation $158,194.00).
- The minimum amount of transportation state funding was $4,074.00 for the Little Heart-4 school district., and the maximum was $1,145,994.79 by West Fargo-6 school district.



			N (School District)= 157
Mean	$156,215.11	**Minimum**	$4,074.00
Mode	$4,074.00	**Maximum**	$1,145,994.79
SD	$158,194.00		

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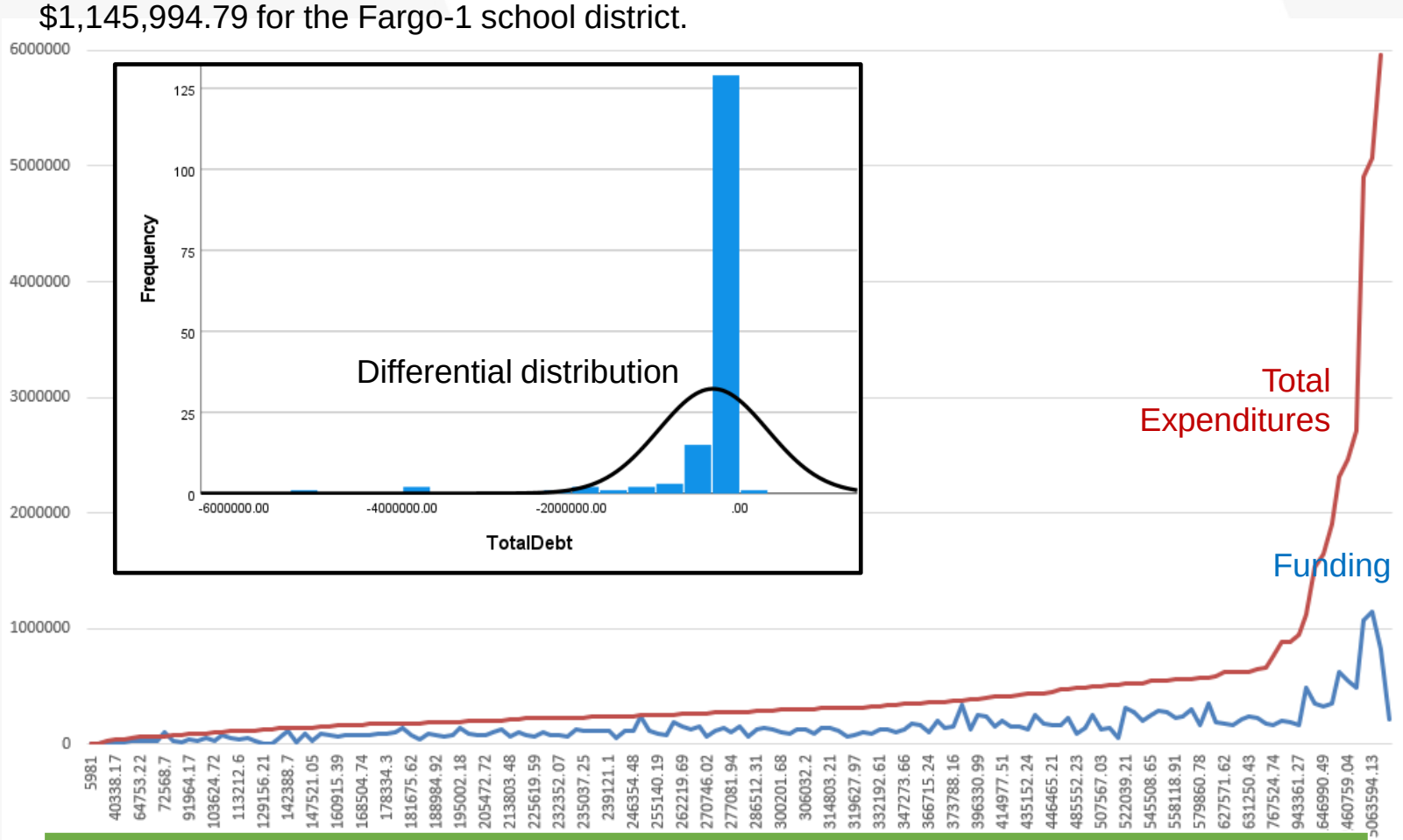
Total Expenditures x Total Funding Differential

Differential

- The amount of state transportation funding awarded minus the amount spent was -$50,273,010.72. That is, schools spent over $50 million more than they were state funded.
- The average difference per school district was -$320,210.26 (standard deviation -$646,635.82). The correlation of funding with expenditures was .92, thus the percentage of variance explained with 85%.
- Only Ft Totten-30 school district had no deficit (+$33,911.02). The minimum difference was -$1,111.00 for the Marmarth-12 school district, while the maximum difference was -$1,145,994.79 for the Fargo-1 school district.



N (School District)= 157			
Mean	-$320,210.26	**Minimum**	-$5,124,960.27
Mode	-$5124960.27	**Maximum**	-$1111.00
SD	-$646,635.82		

Question 2

Does the Expected Costs model accurately predict the actual transportation expenditures of North Dakota school districts?

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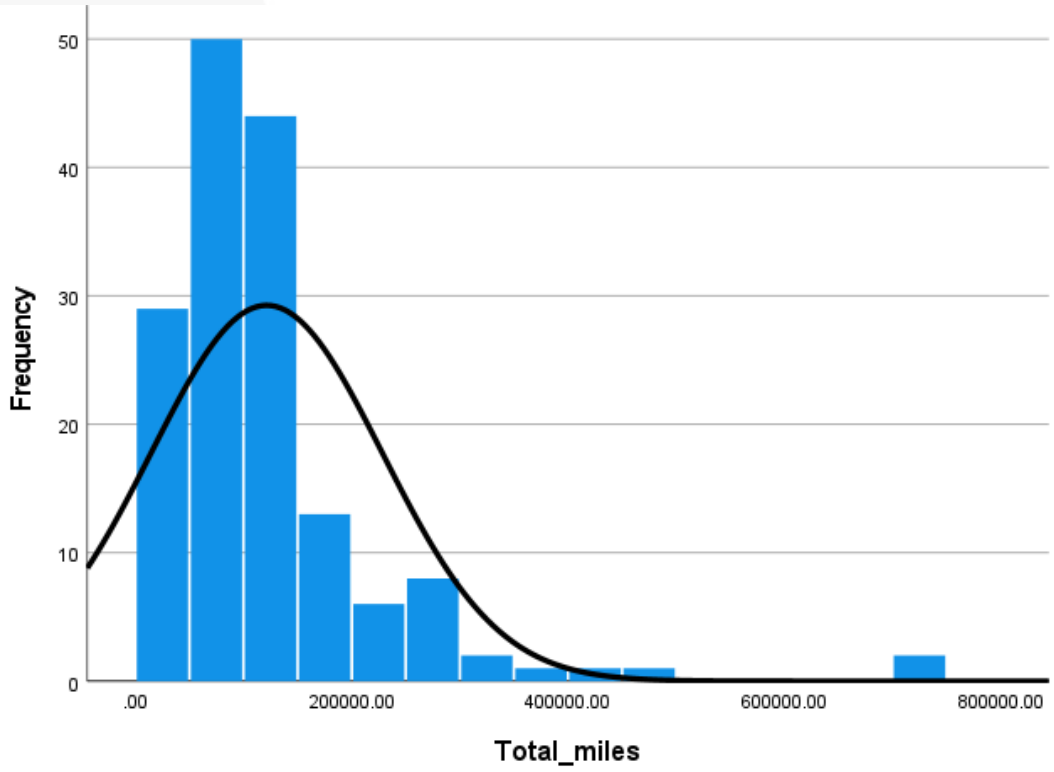
Predictor Variable: Total Miles

Based on an analysis by the Oregon Department of Education (ECONortwest, 2008), an **expected cost model(s)** was developed with multiple regression that generates an average cost of transporting students under local site characteristics. This analysis replicated the Holen dissertation using **five predictor variables** from the North Dakota DPI.

Total Miles

The total number of miles traveled by school district transportation for the 2022 school year.

- This factor can include miles traveled by school district buses for rural or in-city services offered by the school district. It can also include mileage traveled by families receiving family transportation payments from the school district.



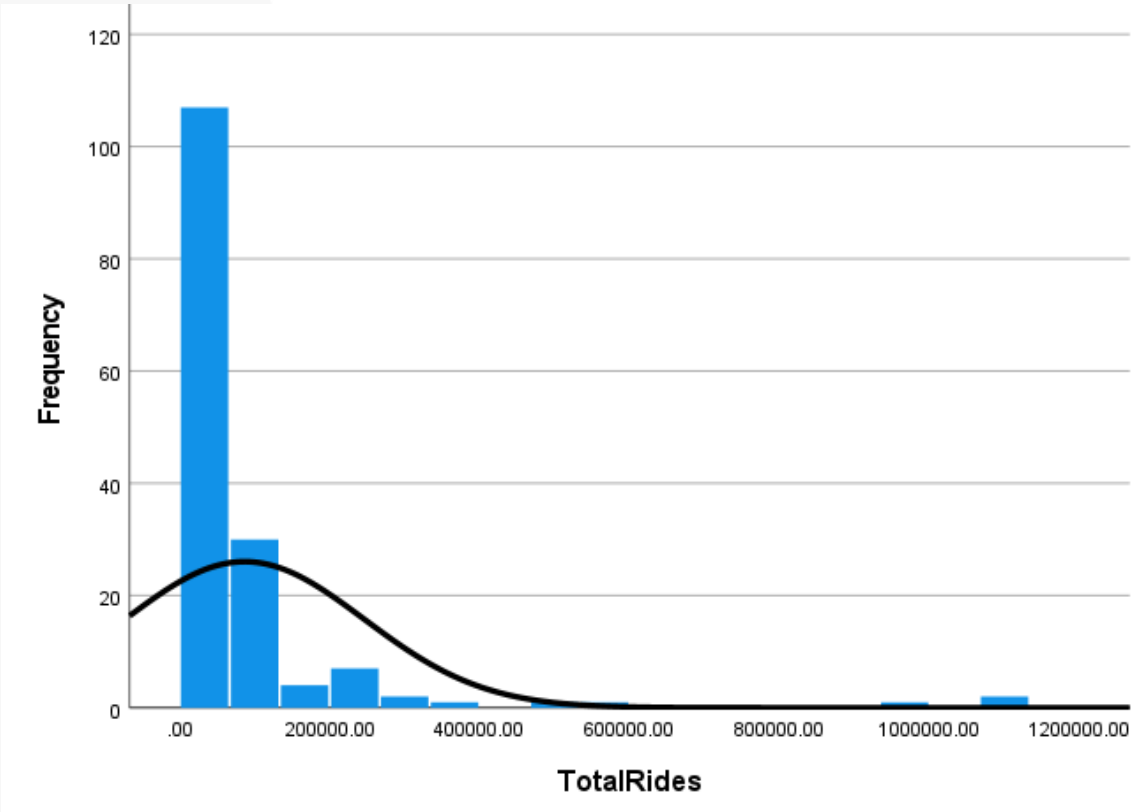
			N (School District)= 157
Mean	121434.09	**Minimum**	326.00
Mode	326.00	**Maximum**	741264.21
SD	107008.66	**Outlier**	West Fargo 6

Predictor Variable: Total Riders

Total Riders

The number of students transported from home to school, school to home, or both.

- Total Riders represents actual students using school district transportation services of any form; either rural, in-city, or family transportation services for the 2022 school year.



			N (School District)= 154
Mean	87461.02	**Minimum**	342.00
Mode	342.00	**Maximum**	1128326.00
SD	160193.15	**Outlier**	Fargo 1

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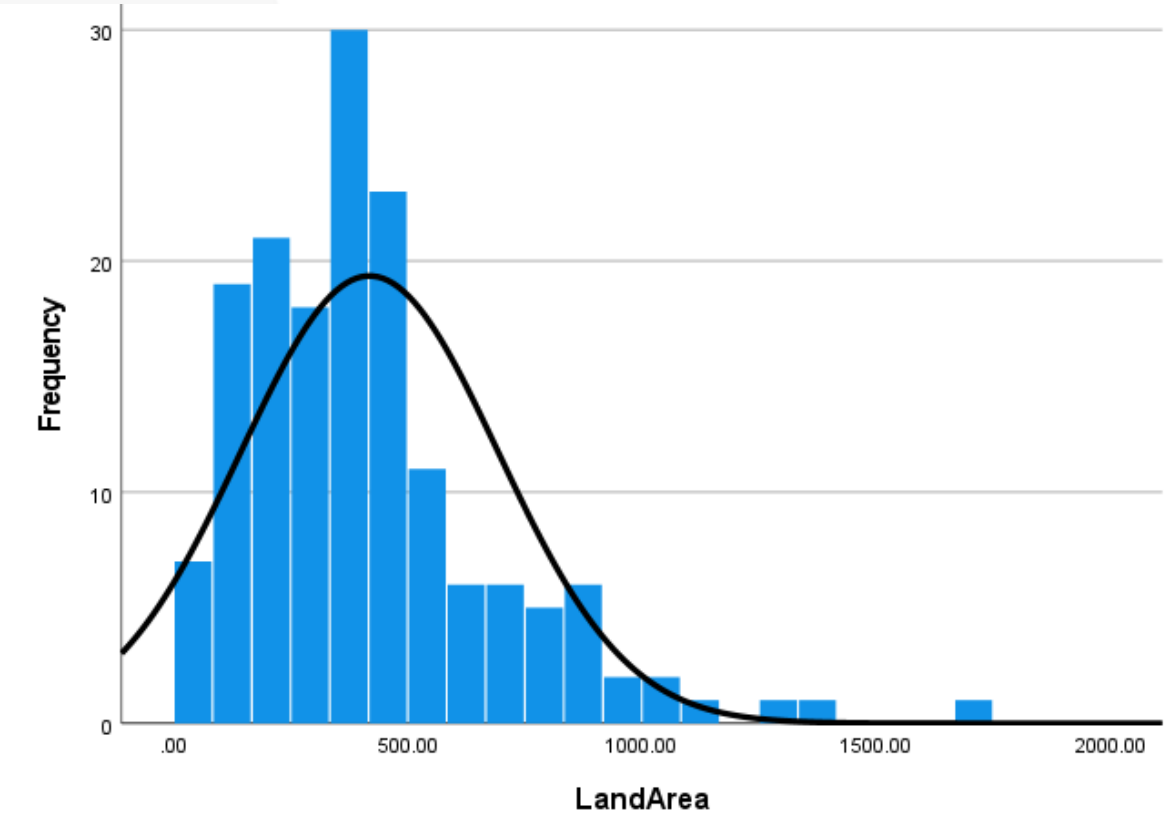
Predictor Variable: Land Area

Land Area

The reported school district physical size as measured in total square miles.

- The actual raw distance the school district boundaries cover for the 2022 school year.



			N (School District)= 157
Mean	421.05	**Minimum**	30.04
Mode	243.00	**Maximum**	1679.00
SD	275.04	**Outlier**	McKenzie Co 1

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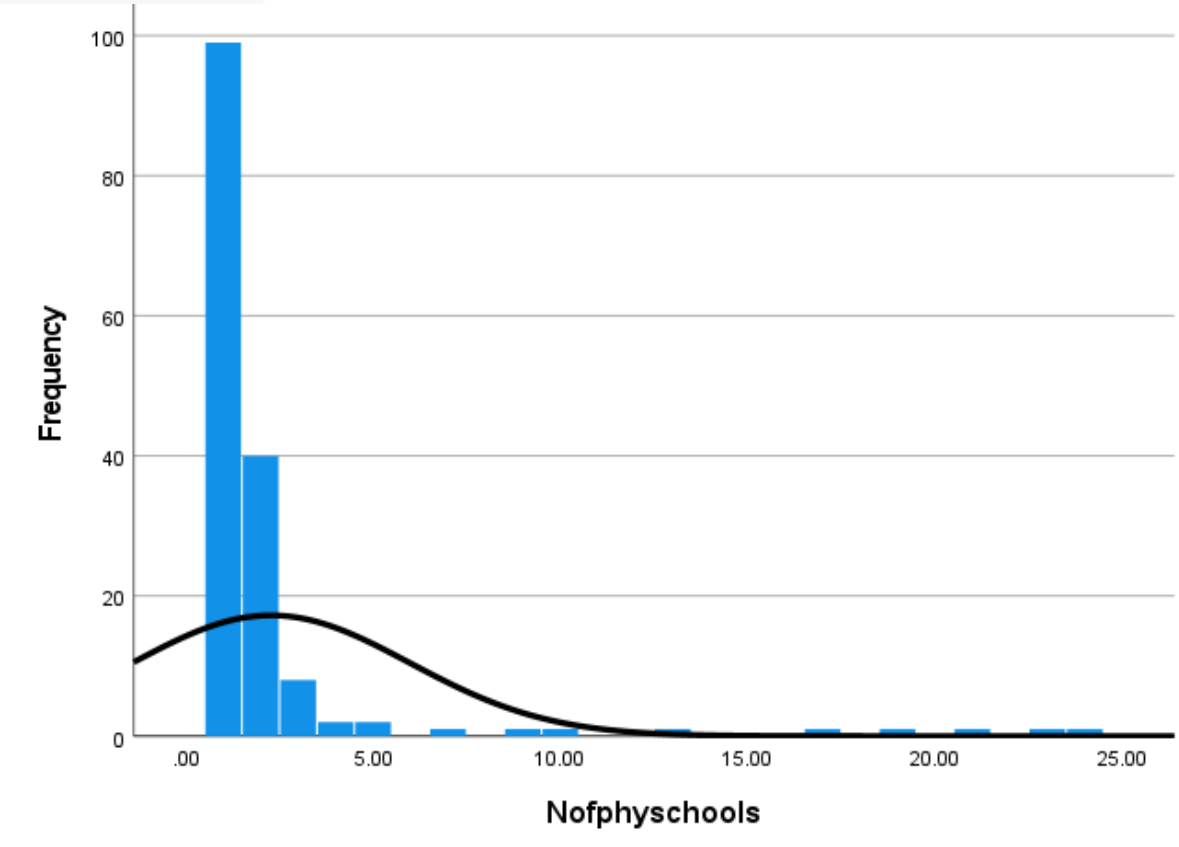
Predictor Variable: Number of Schools

Number of Schools

The number of school buildings located within the school district that provides educational services for students ranging from Kindergarten to Grade 12.

- This factor represents the simple number of school buildings within the school district that provide educational services to its students.



			N (School District)= 157
Mean	2.29	**Minimum**	1.00
Mode	1.00	**Maximum**	24.00
SD	3.74	**Outlier**	Bismarck 1

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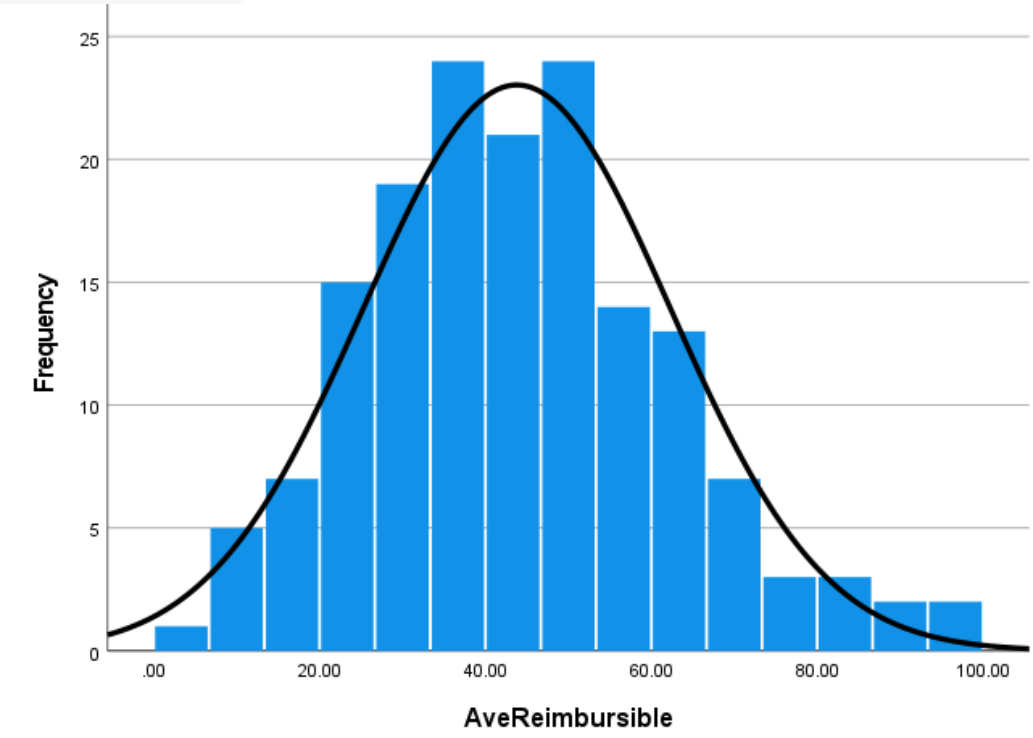
Predictor Variable: Average Mileage to School

Average Mileage to School

The Average Mileage to School factor is calculated by averaging the length in miles of each route reported to the Department of Public Instruction.

- School districts are to report the length of each transportation route in miles; these reported values were used by the researcher to calculate an Average Mileage to School factor.



			N (School District)= 160
Mean	43.45	**Minimum**	0.50
Mode	24.17	**Maximum**	94.00
SD	18.14	**Outlier**	Fordville-Lankin 5

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Preliminary Analysis

Normality

- Skewness, a measure of symmetry, ideally is 0 or between +1 and -1 suggests a normal distribution; whereas values from ±1.0-2.3 indicate moderate and greater than ±2.3 severe non-normality. Kurtosis, a measure of peakedness, ideally is 0 or between +1 and -1, where severely non-normal is > 7.0.
- All model variables were moderately to severely non-normal, except Average Mileage.

	Total Miles	Total Rides	Land Area	N of Schools	Avg Mileage	Funding 2022	Total Expenditure
Skew	3.13	4.89	1.49	4.41	0.40	3.72	4.98
Kurt	13.86	26.67	3.43	19.96	0.01	18.03	27.74

Correlations

- The correlations among predictor variables in the model was a potential issue. High "multi-collinearity" makes it difficult to determine the individual effect of each predictor on the outcome. In general, a correlation (*r*) greater than .70 and/or a Variable Inflation Factor (VIF) greater than 5 suggests multi-collinearity in the model.
- The correlation between Total Miles and Total Riders was 0.82; between Total Miles and Number of Schools was 0.73, and between Total Riders and Number of Schools was 0.81. The Variable Inflation Factor (VIF) of the five independent variables is the following: Total Miles = 5.27, Total Riders = 5.48, Land Area = 1.46, Number of Schools = 3.14, and Average Mileage = 1.37.

	1	2	3	4	5	6
1. Total Miles	-					
2. Total Rides	0.82**	-				
3. Land Area	0.26**	-0.06	-			
4. N of Schools	0.73**	0.81**	-0.07	-		
5. Avg Mileage	0.00	-0.31**	0.30**	-0.28**	-	
6. Funding 2022	0.98**	0.91**	0.17*	0.78**	-0.07	-
7. Total Expenditure	0.86**	0.93**	0.05	0.87**	-0.24**	0.92**

Regression Analysis: Model 1

Model 1

- The first regression model analyzed included five predictor variables: Total Miles, Total Riders, Land Area, Number of Schools, and Average Miles to School. The outcome variable was Total Expenditures
- The regression formula for Model 1 explained 93% of the expenditures and was:

Expenditures = -123,100+ 1.071 (Total Miles) + 2.779 (Total Riders) + 200 (Land Area) + 67110 (Number of Schools) + -135.1 (Average Miles).

R-squared: 0.9302, *p*= <0.001

Example of estimate:

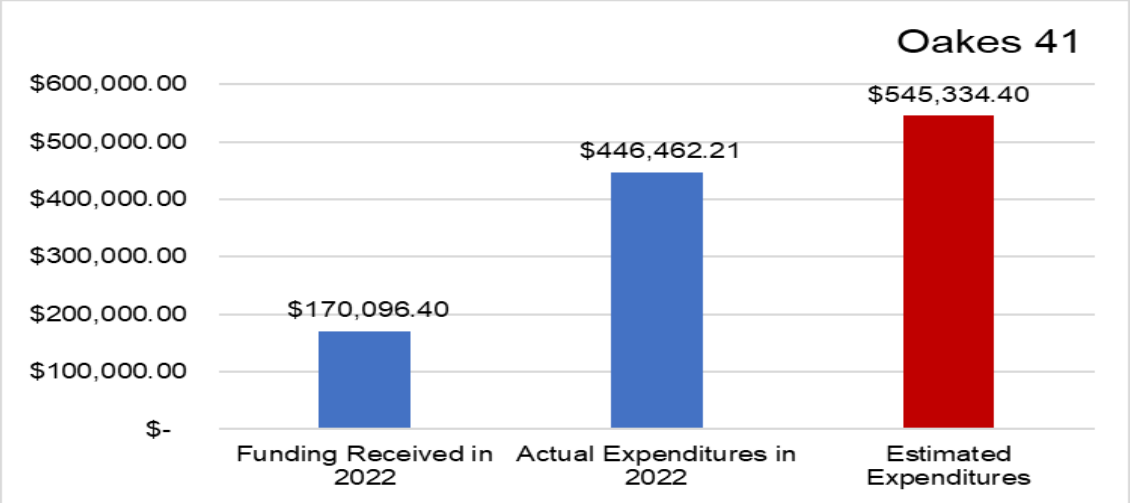
District = Oakes 41

Funding received in 2022 = $170,096.40

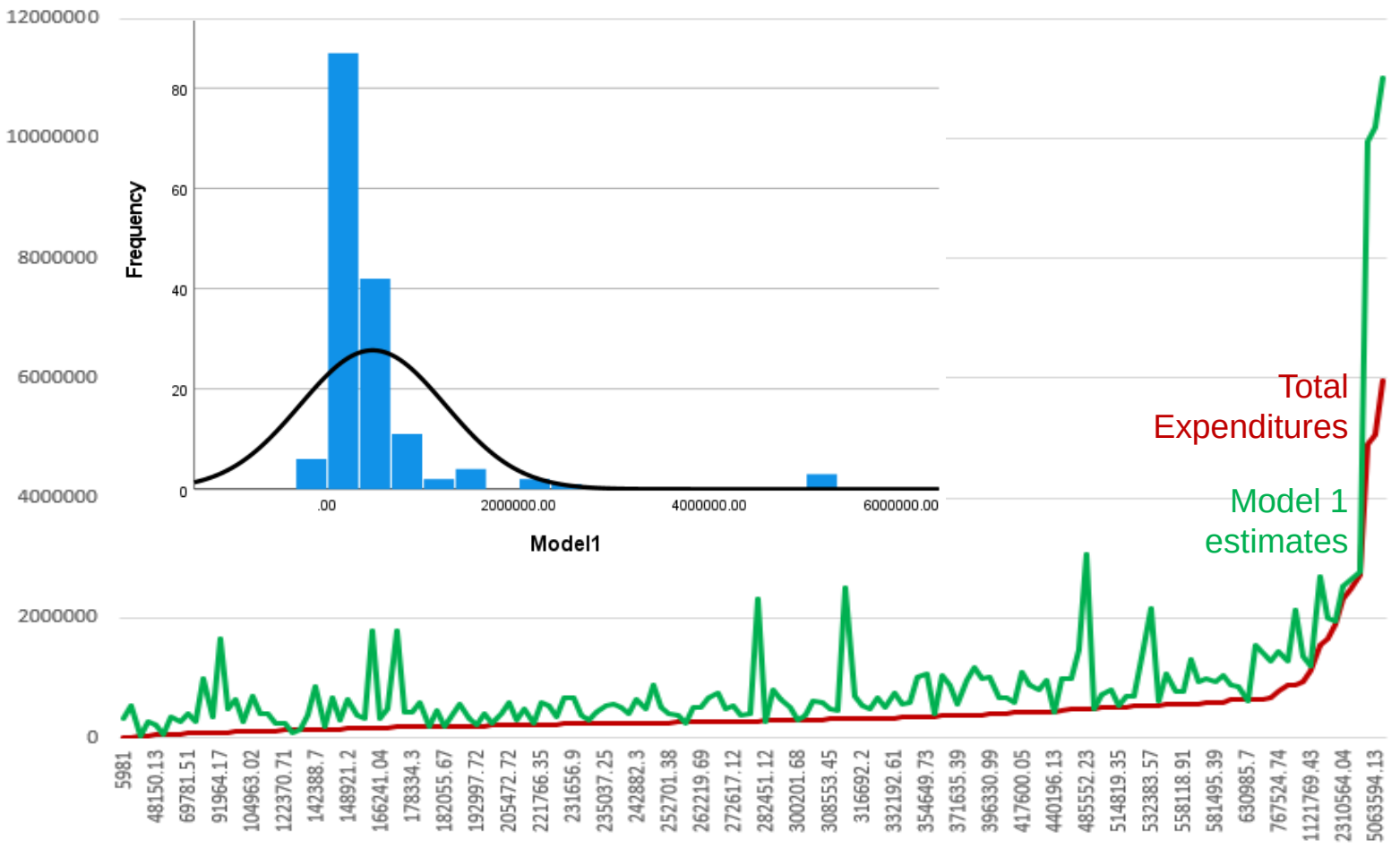
Actual expenditures in 2022 = $446,462.21

Estimated Expenditures = -123,100+ 1.071 (123,420) + 2.779 (110,334) + 200 (497.5) + 67,110 (2) + -135.1 (29.54)

Estimated Expenditures by Model 1 = $545,334



Regression Analysis: Model 1



			N (School District)= 157
Mean	477,504.93	**Minimum**	-24554.19
Mode	-24554.19	**Maximum**	5116857.91
SD	759841.34		

Model 1 strengths:

- Most schools' estimates were closer to their transportation expenses.

Model 1 limitations:

- Average Miles predictor variable was non-significant (didn't contribute to explanation).
- Some outlier estimates were generated; that is, much higher or lower than expenditures
- Model doesn't account for data non-normality

Regression Analysis: Model 2

Model 2

- The second regression model **did not include Average Miles** (a non-significant predictor in Model 1), thus was based on four predictor variables: Total Miles, Total Riders, Land Area, and Number of Schools. The outcome variable was Total Expenditures
- The regression formula for Model 1 explained 93% of the expenditures and was:

Expenditures = -128,200+ 1.055 (Total Miles) + 2.789 (Total Riders) + 199.6 (Land Area) + 67,280 (Number of Schools).

R-squared: 0.9302, p= <0.001

Example of estimate:

District = Oakes 41

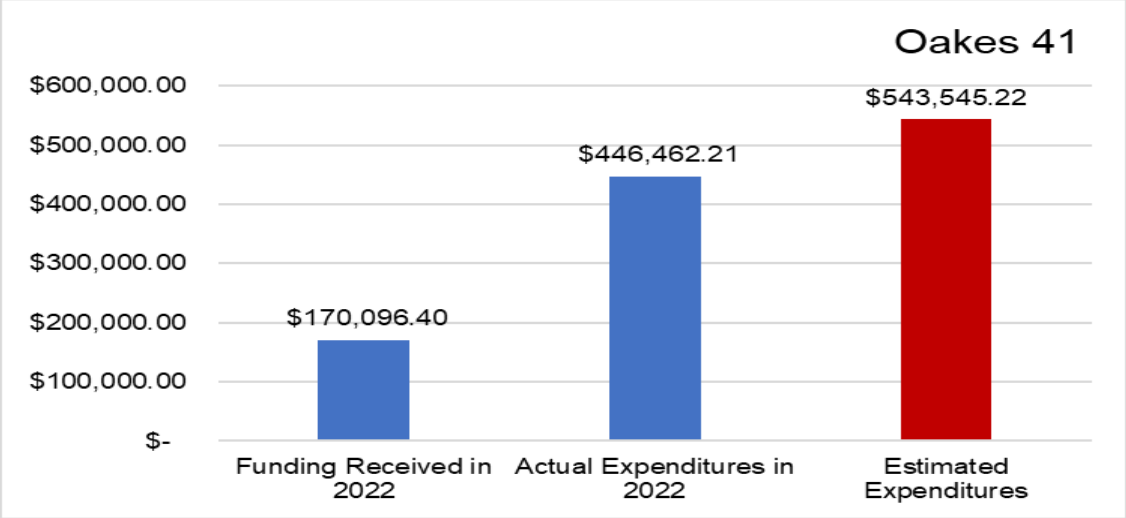
Funding received in 2022 = $170,096.40

Actual expenditures in 2022 = $446,462.21

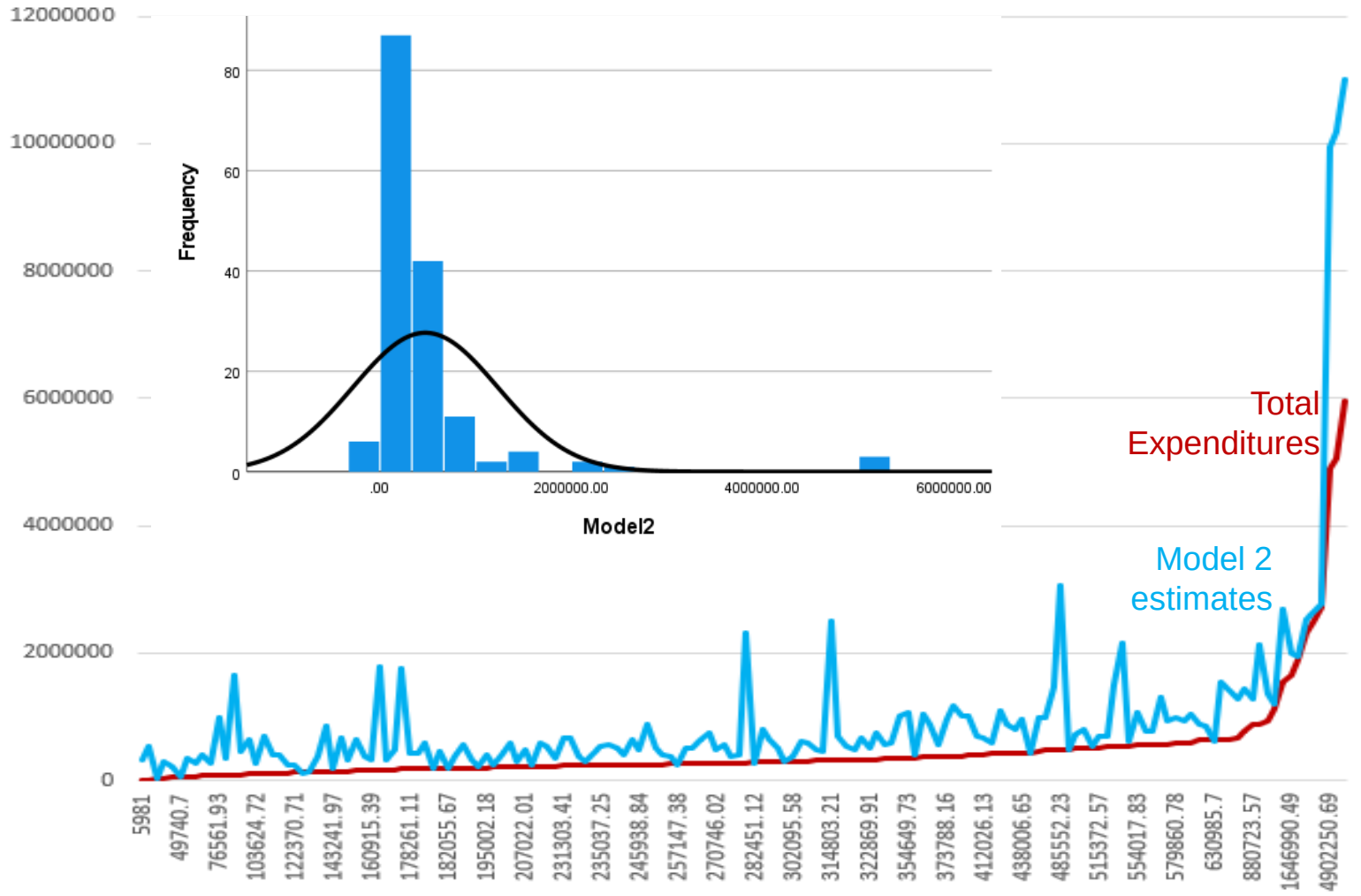
Estimated Expenditures = -123,100+ 1.055 (123,420) + 2.789 (110,334) + 199.6 (497.5) + 67280 (2)

Estimated Expenditures by Model 1 = $545,334

Estimated Expenditures by Model 2 = $543,545.22



Regression Analysis: Model 2



			N (School District)= 157
Mean	477453.15	**Minimum**	-26734.62
Mode	-26734.62	**Maximum**	5116878.77
SD	759873.45		

Model 2 strengths:

- Most schools' estimates were closer to their transportation expenses.

Model 2 limitations:

- Removing Average Miles predictor variable made little difference to results.
- Some outlier estimates were generated; that is, much higher or lower than expenditures
- Model doesn't account for data non-normality

Regression Analysis: Model 3

Model 3

- The third regression model included the original five variables from Model 1 (Total Miles, Total Riders, Land Area, Number of Schools, Average Miles to School); however, **using the natural logarithmic function** three highly skewed predictor variables were transformed (Total Miles, Total Riders, Land Area). The outcome variable was Total Expenditures.
- The regression formula for Model 3 explained 80% of the expenditures and was:

Expenditures = -2,192,053 + 314,596(Log Total Miles) + 88,669(Log Total Riders) – 18,414(Log Land Area) + 152,963(Number of Schools) -1,836(Average Miles).

R-squared: 0.8008, p= <0.001

Example of estimate:

District = Oakes 41

Funding received in 2022 = $170,096.40

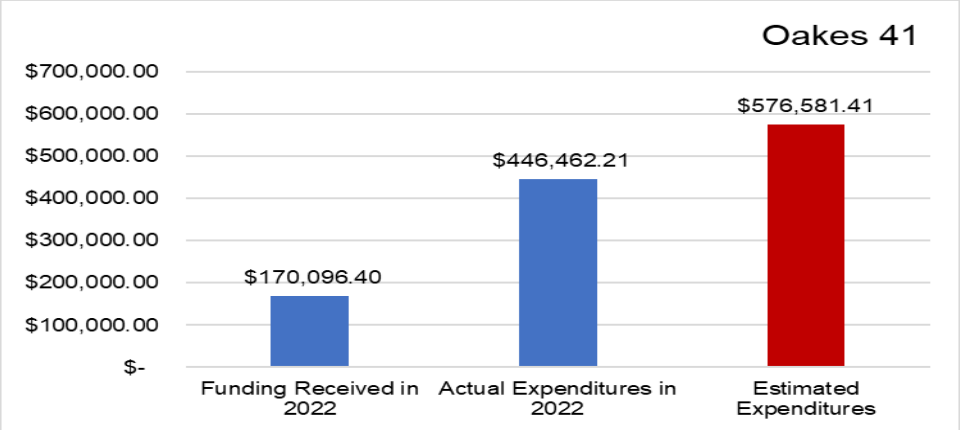
Actual expenditures in 2022 = $446,462.21

Estimated Expenditures = -2,192,053 + 314,596(5.09) + 88,669(11.61) – 18,414(6.21) + 152,963(2) -1,836(29.54).

Estimated Expenditures by Model 1 = $545,334

Estimated Expenditures by Model 2 = $543,545.22

Estimated Expenditures by Model 3 = $576,581.41



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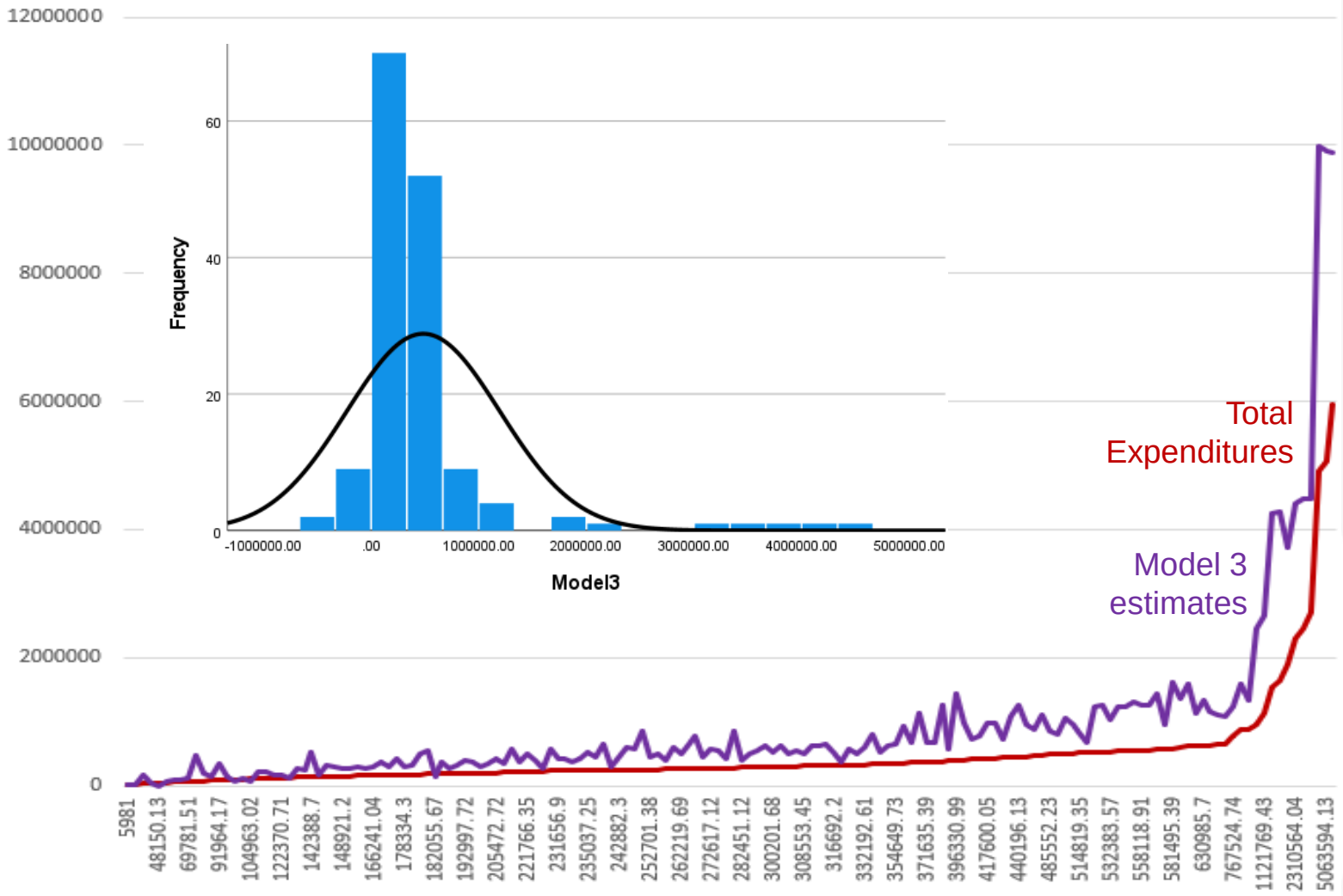
Regression Analysis: Model 3



			N (School District)= 157
Mean	485339.58	**Minimum**	-469360.75
Mode	-469360.75	**Maximum**	4413875.66
SD	710156.27		

Model 3 strengths:

- Some extreme outlier predicted values were reduced.

Model 3 limitations:

- Overall model explained less variance in expenditures than model 1 or 2
- Generally, over-estimates expenditures

Regression Analysis: Model 4

Model 4

- The fourth regression model included the original five variables from Model 1; however, **outliers in all the variables** were identified (values greater than 97.5% of the sample) and removed. The outcome variable was Total Expenditures.
- 10 schools were eliminated from the analyses if they exceeded one or more of the following criteria: total miles > 398,381.6, total riders > 508,002, land area > 1,045.94, number schools > 17, total expenditures > $2,497,304
- The regression formula for Model 4 explained 79% of the expenditures and was:

Expenditures = 4,406.54 + 1.37(Total Miles) + 0.98(Total Riders) + 160.40(Land Area) + 65,648(Number of Schools) -1,070.64(Average Miles).

R-squared: 0.7933, p= <0.001

Example of estimate:

District = Oakes 41

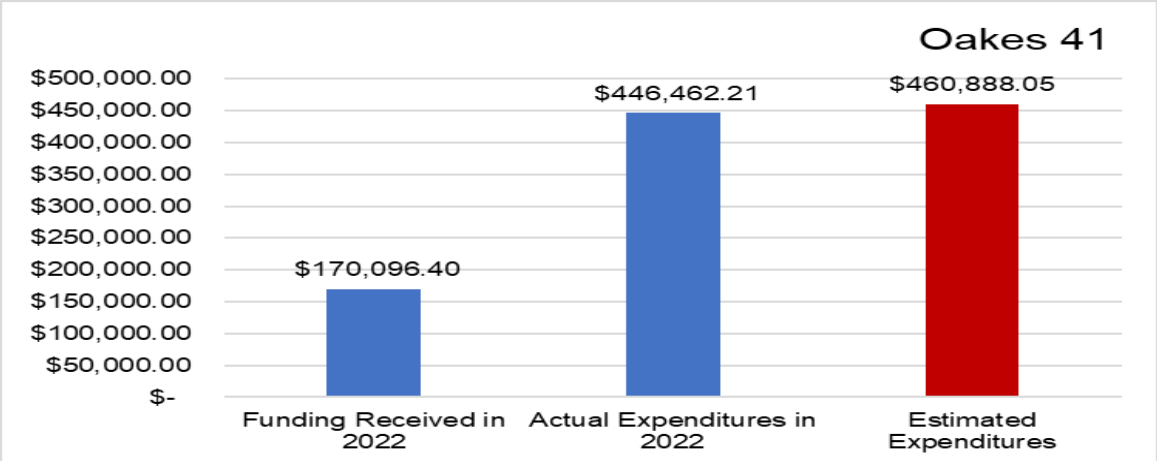
Funding received in 2022 = $170,096.40

Actual expenditures in 2022 = $446,462.21

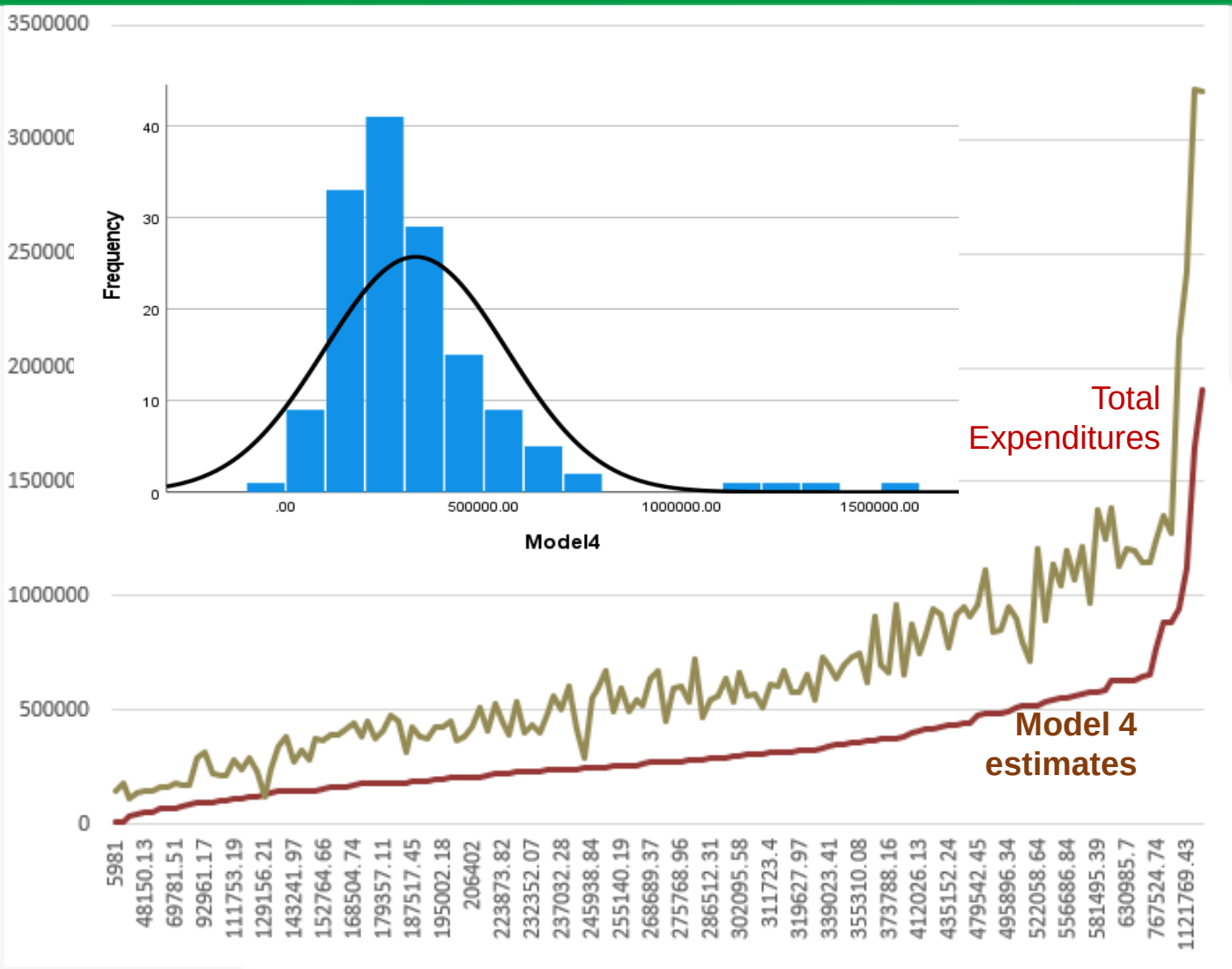
Estimated Expenditures = 4,406.54 + 1.37(123,400) + 0.98(110,334) + 160.40(497.50) + 65,648(2) -1,070.64(29.54).

Estimated Expenditures by Model 1 = $545,334; Estimated Expenditures by Model 2 = $543,545.22; Estimated Expenditures by Model 3 = $576,581.41

Estimated Expenditures by Model 4 = $460,888.05



Regression Analysis: Model 4



			N (School District)= 157
Mean	331658.22	**Minimum**	48024.90
Mode	48024.90	**Maximum**	1576010.23
SD	228790.19		

Model 4 strengths:

- Some extreme outlier predicted values were reduced.

Model 4 limitations:

- Overall model explained less variance in expenditures than models 1-3
- Generally, over-estimates expenditures

Question 3

Does a K-12 pupil transportation funding system based on expected costs, rather than a block grant, provide greater equity and adequacy regarding school district transportation funding levels in North?

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Funding Model Comparison

- With the block grant allocation method, North Dakota school districts in the data set were underfunded, but the variability in expenditures aligned with funding amount at about 85% (variance explained).
- The Expected Cost models provided much more funding to districts and explained more variability in funding, the highest were Models 1 and 2 at about 93%. However, in some cases the models had extreme predictions of expenditures due to outliers in the data.

	Average District Funding	% Expenses Explained
Actual Expenditures	$476,425.37	
Current Block Grant Funding	$156,215.11	85%
Model 1 (Expected cost)	$477,504.93	93%
Model 2 (Non-sign removed)	$477,453.15	93%
Model 3 (Natural Log)	$485,339.58	80%
Model 4 (Outliers removed)	$331,658.22	79%

- The expected cost models should be interpreted with caution because they produced outliers (dramatically higher or lower expected funding amounts) and regularly over-estimated expenditures.
- Further research to fine-tune models to provide reliable and reasonable estimates is recommended.

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