Poverty Factors and Educational Outcomes in Metropolitan Detroit School Districts

Abstract

A statistical model is developed relating scores on a state-administered standardized test to underlying socioeconomic factors for school districts in the Metropolitan Detroit area. Outcomes for basic educational performance are indicated by the Pass/Fail rate of the Michigan Educational Assessment Program (MEAP) administered to 9th-grade students. A conventional linear regression model is used in this analysis. By employing demographic factors to accurately model basic educational outcomes, a means is provided for analyzing the performance of school districts within context of the socioeconomic challenges they face. The Detroit Public School District is *not* included in the development of the model, allowing the model to predict test score performance in Detroit based the ability of many comparable school districts to address similar challenges. While other local public school districts show a strong tendency to match the model closely, scores in the Detroit Public Schools are 37% above the model prediction, a result statistically significant at a 95% confidence level. This indicates Detroit as an over-performing school district given its socioeconomic context. Consequences of this assessment are discussed.

Objective

The objectives of the analysis are restricted to basic educational outcomes − essentials, not enrichment. Schools with vastly different socioeconomic contexts are often compared with a single metric, such as an average test score for the State as a whole. These *absolute* measures may fall short in providing appropriate metrics for the performance of highly challenged schools within their socioeconomic context: *relative* measures are needed to assess school districts' performance in addressing the socioeconomic challenges they face.

Data

Only publicly available has been used in the development of the model. The benchmark used in the study to measure basic education outcomes is the Pass/Fail rate of the MEAP test given at the 9th grade level. These scores are available from the Michigan Department

of Education (www.michigan.gov/meap). All other data used in the development and assessment of this model consists of demographic and socioeconomic information from the United States Census Bureau. These data may be obtained directly from the Census Bureau web sites, especially http://factfinder.census.gov.

Census bureau data examined in this study includes Per Capita Income, Population, Population Density (per sq mi land area), % of Households with Children Present, % of Population Below the Poverty Line and the % of Households with Single Mothers. It is important that the factors used in the final model are independent, i.e., not saying the same thing as something else already in the model. However, much of the Census Bureau data are *not* independent: per capita income is correlated to the percent of population below the poverty line and the % of households with single mothers; population density is correlated to the % of households with children. However, per capita income is independent of population density. Accordingly, these two factors by themselves make an appropriate basis for the statistical model.

A plot of demographics factors such as per capita income for individual school districts may appear to show a clear trend (Figure 1). However, since some school districts are much larger than others, it is important to used weighted averages rather than values for individual school districts. In this study, income data has been binned in $2,000 ranges. The MEAP Pass / Fail rate used in the model for each income range is composed of a weighted average of all the school districts in each income range. The average is weighted by both population and by the specific per capita income in each school district. Thus, larger school districts having greater weight in the average and school districts with a per capita income near one end of an income range have this factored in as well.
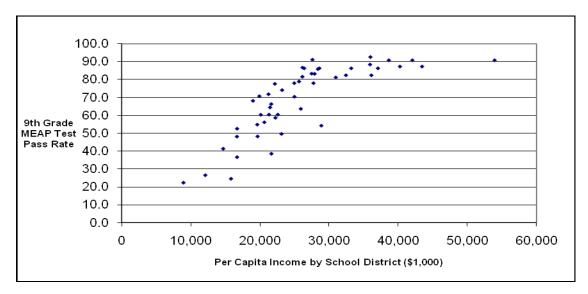
Figure 1: MEAP Pass Rate versus US Census Bureau Per Capita Income for Individual Metropolitan Detroit School Districts

Before development of the model could begin, three issues needed to be addressed regarding use of the data. Educational data is reported at a school district level, while Census Bureau demographics are reported by municipality. One school district may be made up of more than one municipality; for example, a city and township together in one school district. In these cases, consolidated census bureau demographic numbers for an entire school district are created from a weighted average (by population) of the constituent municipalities. Where a single municipality is divided into two school districts, the same census bureau demographic figures are used for both districts.

The geographic areas used by the census bureau, defined by city / township boundaries, do not always match exactly to school district boundaries, especially in rural areas. These geographic variations, however, tend to be small with the preponderance of individuals in a single school district corresponding to one or more whole municipalities. In such cases, the census bureau data assigned to a school district is that of the municipality or municipalities where the great majority of the population resides.

Population density is used in the final model. While any district will have some non-residential area, the presence of an extremely large non-residential area may dominate the land area of a district. In extreme cases, this may cause the population density reported by

the Census Bureau to be become much too low, unrepresentative of the actual situation in the district. In the present study, the city of Romulus is such a case, with 84% of its land area occupied by Detroit Metropolitan Airport. Unadjusted use of census bureau data gives a population density of 640 persons per square mile. After removal of the area for the airport, this becomes a more representative 4,014 persons per square mile. In this study, only Romulus has received such a correction.

Description of the Statistical Model

Some description of the mathematical model employed in this analysis is in order. Initially, several distinct demographic factors related to poverty were considered. Ideally, the final model would utilize the smallest number of independent factors making a statistically significant contribution to educational outcomes. Per capita income and population density were found to be independent factors contributing to the variation in MEAP scores between different school districts.

Regression is commonly used in statistics to develop predictive models. In the present application, per capita income and population density for public school districts in the metropolitan Detroit area are used to create a linear regression model predicting the % Pass/Fail rate on the MEAP test administered to 9th grade students. The values for the Detroit Public School District are not included in the development of the model. As a result, this analysis provides an unbiased comparison between the actual performance of the Detroit Public Schools to the Pass/Fail rate to be expected given Detroit's socioeconomic context, based on the performance of other public school districts in the same area. The advantage of such a model is that is allows for a relative measure, evaluating the performance of all school districts – affluent or poor, urban or rural - within the context of the socioeconomic challenges faced by each. Such a relative measure is to be preferred to absolute metrics such as national, state or local averages that are unrepresentative of school districts except for those few near the average in terms of socioeconomic factors.

The statistical model performs well, using Census Bureau data to predict the Pass / Fail rate on the 9th Grade MEAP test with a standard deviation of 3.6 percentage points. While

the model was developed using data only from the Detroit metropolitan area, MEAP scores are available for all public school districts in Michigan. In studying poverty factors and educational outcomes, the lower end of the model with the poorest school districts are particularly of interest. Therefore, the model was further verified by testing it against the actual performance of an economically disadvantaged school district outside of the Detroit metropolitan area and independent of the development of the model. Benton Harbor, Michigan is one of the poorest areas of the state, with a per capita income of $8,965. This is less than the value for the poorest district in the model (Highland Park at $12,121), making Benton Harbor a good test case for the lower end of the model. The model predicts a Pass rate for Benton Harbor of 21.6%, while the actual rate is 22.2%. This result provides a sound verification of the model down to the lowest socioeconomic level in the State.

General Results

In Figures 2 and 3, the relationship between the Pass / Fail rate on the 9th Grade MEAP test is plotted separately for Per Capita Income and Population Density.
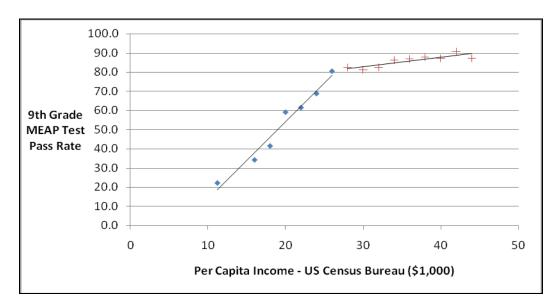

Figure 2: MEAP Pass Rate versus US Census Bureau Per Capita Income. As expected, test score performance correlates strongly with per capita income strongly at low incomes but levels off at higher amounts.
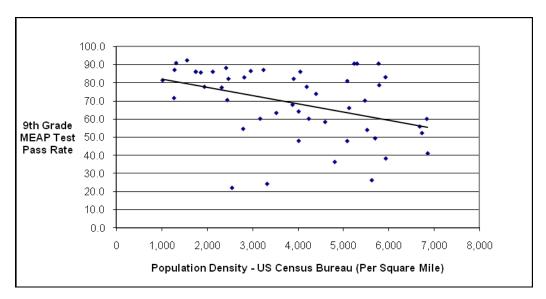
Figure 3: MEAP Pass Rate versus US Census Bureau Per Capita Income. While there is considerable variation, test performance is seen to generally trend downward with increasing population density.

The model performs well, with predictions close to the actual values for many different school districts - rich and poor, rural and urban. This analysis therefore provides a measure for the performance of the Detroit Public School District relative to its socioeconomic context and the challenges it faces. This metric may be used in comparison to poor urban districts in the same area and metropolitan Detroit districts in general.

This analysis identifies four general results, tending to hold true for all or most school districts:

(1) While there is considerable variation, MEAP test performance trends slightly lower with increasing population density. This indicates that, for the same income level, rural affluent schools districts tend to perform slightly better than urban affluent districts, while poor urban schools tend to have a slightly lower test scores than poor rural school districts.

(2) As expected, basic educational outcomes at lower socioeconomic levels are a direct function of affluence as indicated by per capita income and, to a lesser extent, population density.

(3) At high socioeconomic levels, greater affluence does not substantially improve scores on a test designed to measure basic educational outcomes. Since the model predicts the Pass / Fail on the 9th Grade MEAP test, there is a natural upper limit to the result fixed at 100%. Further, since some few will always fail under any conditions, the effective upper limit is a little lower than 100%. Thus, this result is also to be expected: the model shows a straight linear progression up to a certain point and then levels off.

(4) The point at which the model levels off may be lower than anticipated. As expected, the strongest single factor in the predictive model was per capita income. However, the "Tipping Point", beyond which increasing affluence does not markedly improve basic educational outcomes, is found at a per capita income level of only about $27,600. We must anticipate in existence of a tipping point: at some point, more money allows for more educational enrichment but doesn't provide more basic education - which is what the MEAP test measures. However, the income level at which nature of the model changes is smaller than might be anticipated - only about the level of the Livonia Public School District. Livonia certainly isn't poor but neither would be generally classified among the most affluent districts. Yet, there it stands at the tipping point: having more resources per student than Livonia provides further enrichment but does not support markedly better basic educational outcomes.

Results for the Detroit Public School District

According to the US Census Bureau at the last census, the City of Detroit has an annual per capita income of $14,717. Based on the model fit for per capita income alone, the Detroit may be expected to have a Pass / Fail rate on the 9th grade MEAP test of only 32.3%. Correcting for its high population density (6,855 persons per square mile) lowers this prediction still further to 30.1%. However, the actual Pass / Fail rate for Detroit, reported by the state of Michigan in 2007, is 41.2%. This higher performance in comparison to what would be expected based on other public school districts in the area

is statistically significant at a 95% confidence level and is higher the model prediction by 2.44 standard deviations.

By employing demographic factors to accurately model basic educational outcomes, a means is provided for analyzing the performance of school districts - rich or poor, rural or urban - within context of the socio-economic challenges they face. In identifying a district with an actual score higher than the model by statistically significant amount, whether that district performs poorly or is among those doing very well in an absolute sense, it is shown to be an over-performing school district with the socioeconomic context in which it exists.

It is important to place these results within the broader context: 41.2% passing and 58.8% of students failing to meet educational benchmarks is alarming by any standard. The performance of the Detroit Public School District is not to be considered satisfactory – rather, it is to be understood as over-performing given the severe challenges it faces.

Conclusions

A linear regression model is used to identify a relationship between demographic factors – Per Capita Income and Population Density – and the Pass rate on the Michigan Educational Assessment Program (MEAP) test administered to 9th-grade students for public school districts in the Detroit metropolitan area. This model was built without the use of data for the Detroit Public School District, allowing for evaluation of the performance of Detroit against its peer districts within the context of the socioeconomic challenges faced by each. The statistical model performs well, with the predicted Pass rate matching actual scores with an error of plus or minus 3.6 percentage points.

At lower socioeconomic levels, test scores improve in direct relation to increasing affluence indicators; beyond a certain point, test scores do not improve markedly with increasing affluence. This "Tipping Point" is found to occur at a moderate annual income level of $27,600 per capita, lower than might be expected.

For the Detroit Public School District, the model predicts a Pass rate of only 30.1%. However, the actual performance of the Detroit Schools on the 9th grade MEAP test is 41.2%. This result is 11.1 percentage points and 2.44 standard deviations higher than would be expected based Detroit's socioeconomic context and the performance of other schools in the Detroit metropolitan area. This increase over the value predicted by the model is statistically significant at a 95% confidence level, strongly indicating Detroit as an over-performing school district given its socioeconomic context.

In seeking remedies for sub-standard performance of a school district in absolute terms, identification that it is over-performing in a *relative* sense may be significant. In Detroit, the Pass/Fail rate on the 9th grade MEAP that is both very low - 41.2% - and yet 37% above a level consistent with its income and population density within the entire body of school districts in the same metropolitan area. This indicates considerable success in addressing the severe socioeconomic challenges this District faces. With above average achievement in factors restricted to the classroom, further improvement may only be possible through addressing the underlying the socioeconomic challenges that create an upper limit of what is possible and practicable in terms of school performance. The city of Detroit faces many such disadvantages, including high unemployment, percentage of households below the poverty line, percentage of single-parent households and widespread illiteracy of student's *parents*. Unless and until it is possible to make progress in environmental factors beyond the classroom such as these, further improvement in the test scores of this highly-challenged school district may not be possible.

References

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