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Leveling the Internet Playing Field
Connecting Kansas Schools and Libraries in Small, Poor,
Rural, and Widespread Areas

Prepared for the
Kansas Task Force on Internet Access

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EXECUTIVE SUMMARY

This report deals with inequality in Internet access in Kansas public libraries and schools. It provides empirical findings and discusses possible policy actions.

Many public libraries and school districts are slow to adopt Internet connections, while some are more rapid. This difference is leading to an inequity between students and library patrons in different districts, leading to a competitive disadvantage for those students, at least in the short run and possibly in the long run. This inequity could be overcome by means of state government action in the form of cost-sharing. This report estimates the costs that would be involved.

This report relies on several important assumptions and findings from other reports in this series. In particular:

- Dial-in Internet access by modem is widely available in Kansas. However, modem access provides an inferior level of service. In particular, its high cost leads to very limited hours of access per client. It also restricts the types of use that can be made of the Internet. Direct connections to the Internet provide much better service than modem connections, but only a few districts have provided them as yet.
- Inequality could be analyzed from the taxpayer's point of view, as differences in the cost per client of providing access. Instead, this report takes the client's point of view, and analyzes inequality as differences in the level of access actually provided. This report defines "equal access to the Internet" as the existence in each Kansas district of direct connections to the Internet with at least one connected computer per 30 students plus one per teacher in each school building, and one computer per librarian plus one per 2000 citizens served in each library. Because Internet access in a time of rapidly changing technology is a moving target, the report assumes that all equipment is replaced after five years, so that equipment is 2.5 years behind the cutting edge, on average.

The findings of this report include these:

- Only 21 Kansas school districts with direct connections to the Internet were identified as of February 1996. These districts were disproportionately large and metropolitan, but the number of these districts is so small that a detailed statistical analysis would not be meaningful.
- At the same time, a meaningful statistical analysis can be performed on "advanced" school districts. We define "advanced" school districts as those with high speed area networks, and/or with direct connections to the Internet, either in existence or planned for 1996. Providing an area network is an important precursor to providing direct connections to the Internet. Many schools districts adopt area networks first for reasons independent of Internet access.
- "Advanced" school districts are disproportionately large, metropolitan, densely populated, and wealthy, both in terms of assessed value per pupil and budget per pupil. However, a detailed,

statistical analysis shows that the most important influences on network adoption are population density and assessed value per pupil.

- Behavioral models of local school board budget decisions were developed using “median voter” assumptions and Kansas data. Models were developed both for being “advanced” and for providing a given total school budget per pupil.
- The models show that a 10% increase in tax costs leads to a 5% reduction in school expenditures per pupil, while a 10% increase in assessed value per pupil leads to a 3% increase in school expenditures per pupil.
- Differences across locations in access costs per client are important *causes* of differences in the level of access actually provided. However, local wealth and local attitudes are also important.
- These models show that achieving near-universal access to the Internet will depend on taking steps toward:
 1. Equalizing costs per pupil of Internet access.
 2. Helping districts with low wealth and income.
 3. Helping laggard districts to get started.
- *Exactly* equalizing per pupil costs and per patron costs across regions would require around \$22 million annually. However, it may be neither necessary nor even desirable to equalize per-client costs exactly. A practical degree of cost-equalization can probably be achieved for \$4 million per year.
- Some \$10-15 million per year, at most, would be required to overcome differences in wealth and overcome attitudes of resistance to providing Internet access. (That is in addition to an assumed \$4 million in cost-equalization.) In order to keep abreast with rapidly changing Internet technology, these expenditures would need to continue over time.

CHAPTER 1. INTRODUCTION

This paper discusses equality in access to the Internet across regions in Kansas. Some people express a concern that small, poor, and rural districts may be left behind in the effort to connect schools and libraries to the Internet. Ironically, these are the districts that stand to gain the most from the Internet. This paper looks at which factors theoretically cause unequal access and which factors do in fact cause unequal access at this moment in Kansas. It also addresses what can be done to change the situation.

In a sense, practically all factors that cause unequal access boil down to money. In particular, no matter what may be the source of inequality, there is usually some amount of money which, if spent wisely, could overcome that unequal access. (Even if local community leaders simply didn't want to be connected to the Internet, there would usually be some amount of money, e.g. in the form of state revenue sharing, that could persuade them to change their minds). This paper suggests which financial policies would be required, and also provides rough estimates of the amount of money required to provide equal access to the Internet in Kansas (using certain benchmark assumptions). In other words, this paper estimates the cost of "leveling the playing field."

The Concept of "Level Playing Field."

Unfortunately, the idea of a "level playing field" is conceptually unclear. We need to consider at least four different concepts:

- 1. Equal Regional Cost.* One may think about equalizing the cost per student or cost per library patron of providing access. That would put all regions on an equal footing in terms of the taxpayer's cost per individual client being served.
- 2. Equal Regional Ability to Pay.* Even with equal costs per client, regions would remain unequal because they differ in their ability to pay that cost. If the cost is sufficiently high, then only the richest districts will be able to afford the Internet. Therefore leveling the playing field may entail equalizing the effects of tax base across regions.
- 3. Equal Desire, or "Gumption."* Even if costs and resources were equal across regions, some forward-looking regions may decide to install the Internet, while more cautious regions may decide against it or may decide to wait. In that case, even if regions as a whole faced an equal playing field, individual students and individual library patrons would not. That is, some *individuals* would have access to the Internet and others would not. Differences in the desire of public officials to fund Internet access in public schools and libraries might be overcome through special grants and incentives. This approach, however, would upset the principle of equal regional cost.

4. *Equal Outcomes.* In practice, we need to recognize that various types of costs of education and library services are always going to be unequal across regions, so that equalizing one cost (the Internet) without equalizing other costs (e.g., buildings, transportation) merely creates *illusory* equality. Moreover, ability to pay as well as desire for a given service is always going to be unequal across regions. Achieving perfect equality of costs and resources is inconsistent with a market economy and inconsistent with local school board autonomy. Conversely, if all regions have equal access to the Internet, then we would say that a practical equality of access has been achieved, *even if* some regions make bigger sacrifices than others in order to achieve that outcome. The concept of a level playing field as equality in outcomes provides only an approximate fairness criterion to the taxpayers of different regions, but it provides a more practical standard than the alternatives.

This paper focuses on equal outcomes as the appropriate definition of a level playing field. In other words, the focus is on equality between students and library patrons in different regions, not on equality between taxpayers in different regions.

However, all the other considerations will come back into play when we think about how to *achieve* equal access. In Kansas, simply mandating a level of service is probably not practical, because local governmental units traditionally have a great deal of autonomy. Therefore, the state may need to encourage them with financial assistance. That assistance should be structured to provide the most effective encouragement. We may need to make costs per student or library patron more equal; we may need to make the effects of tax base per student or patron more equal; we may need to provide incentives to overcome a lack of desire, or “gumption.” Other factors might need to be considered as well, depending upon the cause of the unequal access.

The Concept of “Access to the Internet.”

A very minimal level of access to the Internet is already being achieved throughout Kansas. A majority of students are now attending schools with at least one modem connection to the Internet. A majority of library patrons visit libraries with at least one modem connection to the Internet.¹ However, the *quality* of access is not equal, partly because many districts are using dial-in modem connections, a method that provides an inferior class of service. Higher capacity (56 kbps, and up), dedicated direct connections, which are available in few places in Kansas, provide much better service [Burrell, Livingston, and Oslund, 1996].

In particular, modems have a low data capacity which prevents some types of Internet activity. Use of modems is sometimes awkward and connections can be hard to make, which discourages many users. An even more important dimension of access quality is the number of hours per week the Internet is available to a particular student or patron. A student with access for one hour per week is in a very different position from a student with limitless access. Modems are not cost-effective when users or intensity of use increases beyond a certain point. Clients being served by modems typically receive a very restricted number of hours of use per week. Commonly, modem access is limited to teachers and library staff.

¹ [Clifford, Hoyle, and Oslund, 1996].

In other words, there are great disparities across Kansas in the amount of hands-on access allowed to individual students and library patrons. A majority receive none at all. There are disparities in hours per week and other qualitative aspects of access, even when some level of access is achieved.

This paper makes specific assumptions about what level of access should be provided. Achieving this level of access everywhere across the state will be defined as "equal access," and serves as a practical minimum of access. Additional assumptions are necessary in order to provide definite cost estimates. In particular, "equal access to the Internet" in a district, will be defined as a system providing the following:

- Dedicated lines with at least 56 kbps service from buildings to the district office and at least 384 kbps from the district office to the Internet;
- Direct hands-on access available to every teacher, student, library staff, and library patron;
- An email address for each teacher and librarian;
- A dedicated personal computer attached to the Internet for each teacher and library staff member;
- At least one hour per week on a personal computer for each student and for each library patron who requests it; and
- Hardware and software technology that averages no more than 2.5 years behind the cutting edge (leading to a 5-year replacement period).

These assumptions are justified in other reports: Kansas Internet Task Force [1996]; Burress, Livingston, and Oslund [1996]; and Carlin, Glass, and Krider [1996]. A system that provides this level of access will usually require the following:

- A wide-area network in each school district, with 56 kbps, or higher, link to the Internet;
- Email servers on each wide-area network;
- A local-area network in each school and library, attached to the wide-area network;
- One computer for each teacher and each library staff person;
- One additional computer in a school for every 30 students;
- One additional computer in a library for each 2000 population served;
- One half-time technical support person in each school district;
- One additional quarter-time technical support person in each building; and
- Training for each teacher and staff member.

These requirements are explained in Burress and Hoyle [1996]. That report also contains data sources and calculations for a general cost model for statewide Internet access in Kansas. A subsequent section of the present report examines the equalization costs that are implied by that cost model.

This report does not assume that access and technical standards represent a ceiling, but rather a baseline level of service. Several districts have already installed higher numbers of connected computers -- approaching one computer per student -- as well as connections with higher transmission rates (1.5 Mbps in particular). It is anticipated that additional districts will adopt higher

levels of service in the future. This report assumes that the state will make no efforts either to restrict or to match those higher levels of service in the near future.

At the same time, one should anticipate that Internet technology will continue to change rapidly, while the cost of achieving a given level of service will continue to fall. What constitutes an acceptable minimum level of service will continue to be a moving target. This report is concerned only with costs and policies in the immediate future. It does not take a long range view.

CHAPTER 2. EMPIRICAL ANALYSIS OF EQUAL ACCESS IN KANSAS

Descriptive Survey Results.

Surveys of Kansas public libraries, school teachers, principals, and school superintendents were conducted in February 1996 [Clifford, Hoyle, and Oslund, 1996]. These surveys showed very limited direct access to the Internet in Kansas. In particular, only 21 Kansas school districts were identified as having direct dedicated connections to the Internet.

Therefore, most students and library patrons did not have equal access to the Internet, in the sense used here of having direct connections. Access to direct connections is statistically related to the type of district. Districts with direct connections were disproportionately very large and densely populated. There were direct connections in 30 percent of districts with more than 5000 pupils per square mile and 33 percent of districts with more than 100 pupils per square mile, as compared with 10 percent overall. On the other hand, there was no discernable relationship to wealth, as measured either by school expenditures per pupil or taxable assets per pupil, nor were there noticeably more or fewer direct connections in metropolitan areas. However, the number of districts with direct connections was so small, that these comparisons are not statistically meaningful. In other words, we cannot reject the possibility that this pattern of correlations happened by sheer chance, in which case it would have no predictive value for the future.

A meaningful statistical analysis can be performed using a different variable. This variable measured whether school districts are technologically "advanced." "Advanced" school districts were defined as those with high speed area networks and/or with direct connections to the Internet (either in existence, or planned for 1996). Providing an area network is an important precursor to providing direct connections to the Internet. Area networks are not only needed for direct Internet connections, but also most organizations adopt area networks first for independent reasons. Once use of an area network is adopted, adding direct Internet connections is a less daunting task.

"Advanced" school districts are disproportionately large, metropolitan, densely populated, and have lower expenditures per pupil. Taken individually, each of these correlations is highly statistically significant. However, there is no significant relationship between assessed values per pupil and being "advanced." The simple correlation coefficients are shown in Table 2.1.²

² The variables were put into logarithmic terms to reduce the influence of outliers.

Table 2.1
Simple Correlates of “Advanced”§ School Districts

	Correlation coefficient	Significance level
log expenditures per pupil	-.141	.038
log-pupils/mile ²	.274	.000
log number of pupils	.197	.004
log-assessed value/pupil	-.031	.652
Metropolitan area (N=216)	.181	.008

§: direct Internet connection 2/96; or a high speed area network planned for 1996
 All correlated variables are for FY 94-95.
 [IPPBR]

Table 2.2
Descriptive Models of “Advanced”§ School Districts

Model	LOGIT	OLS
constant	-9.56 (14.12)	-1.21 (2.92)
log- expenditures per pupil	116.000 (356.000)	15.000 (75.200)
log-pupils/mile ²	181.000**** (53.700)	40.400**** (11.300)
log- number of pupils	-74.500 (88.200)	-18.800 (18.500)
log-assessed value/pupil	134.900** (69.600)	31.000** (15.600)
Metropolitan area	-0.116 (0.508)	-0.022 (0.115)
N	216	216
R ²	-	0.105
Fraction correct	0.657	-

Numbers in parentheses are standard errors.
 §: direct Internet connection 2/96; or a high speed area network planned for 1996
 Significance levels: * < .2; ** < .1; *** < .01; **** < .001
 All independent variables are for FY94-95.
 [IPPBR]

Detailed descriptive multi-variate models suggest that the most important causal influences are population density and assessed value per pupil, and that other variables are unimportant once these are controlled for. Both an OLS Regression and a LOGIT Model were estimated. Results are shown in Table 2.2. Of the two models, the LOGIT model is generally viewed as giving a more accurate picture of causality for a dichotomous, “on-off,” variable such as “advanced”. In the present case, however, all relationships were essentially the same in the two models. (Differences between the two models in the general magnitude of a particular coefficient has no significance; what is important are the signs, the relative sizes of coefficient within a model, and the significance levels of the coefficients). Many of these observed correlations are predicted by a rather standard behavioral model for school districts and libraries; that model is described in the following sections.

One exception to the expected pattern is the negative simple correlation of “advanced” with expenditures per pupil. That correlation, however, is reversed in the multi-variate descriptive analysis, which is more meaningful.³ (It is even more decisively reversed in the behavioral model which follows). Since all of these correlations are statistically significant and are confirmed by a theoretic model, it seems likely that these correlations are systematic rather than random, and that they can be expected to continue in the future. That is, there will probably continue to be better access to the Internet in districts that are large, rich, dense, and/or metropolitan.

An argument might be made to the contrary, if it could be shown that the existing inequality was caused purely by differences in rate of adaptation across districts and if “Internet access” were a stationary target. In other words, while only the more adventurous districts have adopted cutting-edge technology at this time, perhaps the other districts will catch up to that level of technology in the future. On the other hand, if Internet technology is a moving target, then the slow-moving districts may never catch up. Burrell, Livingston, and Oslund [1996] give arguments that Internet technology will continue to be a moving target in the foreseeable future. In particular, many new techniques (e.g., sounds and animation) are still being developed. New techniques will require new equipment and training, and the new techniques appear likely to provide a valuable competitive edge to the districts that keep up with them.

But whatever the long-run outcome may be, unequal access to the Internet does exist and will continue to exist in the short run. The remainder of this report assesses the costs of equalizing access in the short run.

³ Based on the behavioral model and other data, the explanation for the unexpected inverse relationship between “advanced” and school expenditures per pupil is as follows: the most important single factor that encourages advanced networking is the size and density of the school district. The main reason is that the cost *per pupil* of Internet access and advanced networking is much lower in large, compact districts than in small, rural districts (as explained below and in Burrell and Hoyle [1996]). At the same time, because of the extra advantage they receive in the state school revenue sharing formula, small districts have much larger expenditures per pupil than large districts. Therefore, expenditures are positively correlated with smallness, which is inversely correlated with networking.

Internet Adoption and the Theory of Public Choice.

In this report, the “cost of leveling the playing field” refers to the dollars the state government would have to pay in order to persuade local governments to adopt policies that would achieve equal access. It follows that the cost depends not only on the *structure* of the grants, but also on how local governments *respond* to the grants. To assess that, we need a model or theory.

Public Goods and Public Choice.

Access to the Internet in public schools and libraries in Kansas is a “local public good,”⁴ provided as a public service by local governments that are ruled through representative democracy. Public finance economists and public choice theorists have a well-developed set of theories for describing decisions about public services made under these conditions.⁵ While the theories differ in some details, they agree in certain general predictions. These general predictions have been verified empirically.

These general theories agree with common sense. Much of what follows will seem fairly obvious, once it is clearly understood. (Readers who want to skip the technical and quantitative details may prefer to jump ahead to the next section). The most important reason to dwell on the theory is to be quite clear about the least expensive way to design a state program that encourages local regions to provide equal access to a service. Most state revenue-sharing programs are *not* designed to be least expensive ways for achieving equal access to a given service. They may be designed to achieve some other concept of fairness, such as equalizing the tax burden, or they may represent a political compromise between fairness and various other objectives.

Other reasons to apply the theory in detail are to show that the correlations described previously are causal rather than accidental, and to estimate specific parameters that will be used in some of the cost estimates.

⁴ This is a technical term which means that Internet access benefits nearly everyone in the community. Even people who do not directly use the Internet, may benefit to the extent that Internet access encourages economic development, or increases their property values.

⁵ In particular, median voter models. The seminal papers are Borcharding and Deacon [1972] and Bergstrom and Goodman [1973].

Table 2.3
Behavioral Models of Kansas School Expenditures

Model	log-excess expend./pupil†	“advanced”§	“advanced”
	OLS	OLS	LOGIT
constant	0.484** (0.252)	0.155 (0.478)	-1.868 (3.936)
log-tax price	-0.540**** (0.089)	-0.220* (0.168)	-0.867 (0.899)
log-assess. value/pupil	0.309*** (0.100)	0.103 (0.190)	0.601 (0.912)
log-enrollment	-0.089 (0.103)	-0.245* (0.195)	-1.131* (0.899)
log-pupils/mile ²	0.211*** (0.077)	0.390*** (0.145)	1.756*** (0.692)
N	109	109	109
R ²	0.490	0.118	-
Fraction correct	-	-	.689

Numbers in parentheses are standard errors.

†: expenditures per pupil in excess of the guaranteed minimum, FY94-95

§: direct Internet connection 2/96; or a high speed area network planned for 1996

Significance levels: * < .2; ** < .1; *** < .01; **** < .001

All independent variables are for FY94-95.

[IPPBR]

According to public choice theory, the level of public service is predicted to:

- Increase with per capita wealth or income in the region; and
- Decline with the *tax price*, i.e., the taxes a typical taxpayer in a local region must pay in order to obtain a unit level of service.

The “level of public service” refers to the services received by a typical user, e.g., the number of hours of Internet access available to a client per week.

Application to Kansas.

A rough test of this theory, using 1994 Kansas school expenditure data, found general agreement with the theory.⁶ In particular, we found that:

- A 10 percent increase in assessed valuation per pupil leads to a 3 percent increase in expenditures per pupil; and
- A 10 percent increase in the tax price leads to a 5 percent drop in expenditures per pupil.

⁶ Data were by school district. We took data from the 1994-95 *Kansas Statistical Abstract* [IPPBR, 1996], from the surveys, and from a report by the Kansas State Board of Education [1995].

The tax price variable was defined as: (school mill rate, less 35 mills)/(per pupil expenditure, less the per-pupil expenditure guaranteed by the state revenue sharing formula). Note that the 1994-95 revenue sharing formula guaranteed each district a minimum of \$3600 per *weighted* pupil, but the ratio of “weighted pupils” to actual pupils in a district ranged from around 1 to around 2. The tax price is defined in terms of expenditures per *actual* pupils. This tax price variable accurately reflects the marginal tax cost to taxpayers per assessed value of property they own, but could be somewhat off from reflecting the theoretical tax price concept in two respects. First, it may not account for the effects on taxpayer perceptions from non-linearities in Kansas school equalization formulas; that is, taxpayer might look at some kind of average price instead of marginal price. However, in practice, experiments with average tax prices led to much worse statistical results than with marginal tax price. Second, median amounts of household assessed value differ across school districts, and the tax price was not adjusted for median assessed value. Since assessed value of the house increases with income on average, the true tax price experienced by the median voter increases with income. It can be shown that omitting this effect probably induces a downward bias on the income elasticity, but leads to no predicted direction for bias on the price elasticity.

The wealth variable (assessed value per pupil) is different from the theoretically correct median income per household. The two variables are correlated, but not perfectly. This could lead to bias in an unknown direction on the wealth elasticity (if it is interpreted as an income elasticity).

The dependent variable was: (total operating expenditures per pupil, less the guaranteed minimum expenditure per pupil). Note that total operating expenditures per pupil (without the subtraction) would be theoretically correct under a simple model. As it turned out, however, regressions of that simple model showed strong evidence of a “flypaper effect” [e.g. see Fisher, 1982]; i.e. voters or district decision makers tend to ignore dollars already provided by the state when they make decisions. In particular, the ratio of weighted students to actual pupils was the most important factor by far in all tested versions to the simple model, while in theory the tax price variable should have controlled for all effects due to the revenue sharing formula. Based on the assumption of a 100% flypaper effect, subtracting off the dollars guaranteed by the state should exactly correct for the flypaper effect. In practice, doing so reduced the importance of the weighted students ratio to being economically negligible and statistically insignificant. (Moreover, its coefficient did not change sign, which firmly supports the hypothesis of a 100% flypaper effect).

The sample was truncated to omit districts with the minimum expenditure of \$3600 per weighted pupil. The reason for the truncation is that districts at the minimum expenditure level do not have an observable tax price. This truncation may lead to sample censorship bias; in particular, the constant representing the general level of willingness to pay for school expenditures will probably be overstated, because only those districts that chose to pay more than the minimum were selected. Directions of truncation biases on the elasticities are unclear, but is possible that the tax price elasticity is biased towards zero and the income elasticity is biased away from zero.

The sample also omitted districts that failed to respond to the survey. Since the response rate was a respectable 72%, this is not expected to seriously bias the results.

The detailed model and its regression statistics are shown in the first column of Table 2.3. These results are in the predicted directions, and the tax price elasticity is similar to other studies, but the wealth elasticity is smaller than found in most other studies.⁷

A similar model is applied to the “advanced” variable. The detailed model and regression statistics are shown in the last two columns of Table 2.3. The statistical fit is much worse than in the model for expenditures. Most of the coefficients are not very significant, which is to be expected because “advanced” is a dichotomous, or “on-off,” discontinuous variable. Another limitation is that the model did not control for differences in the per pupil cost of Internet access. However, the signs of all elasticities are the same as signs of the corresponding elasticities for the budget model, and the magnitudes of the elasticities are reasonably similar. These behavioral models of “advanced” performed better than the descriptive models described in the previous section. In the absence of any better information, it seems reasonable to assume that the demand for making particular school expenditures on Internet access is similar to the general demand for making general school expenditures, as described by the first column.

Comparable data were not easily obtained for public libraries, so no model was run for libraries. Empirical work in other states suggests that the library results should be roughly similar to the school district results.

Applying the Theory to State Grants.

The theory of public choice refers to the behavior of *average* governmental units. It does not make a hard and fast rule for predicting outcomes in particular units, because there are variations between regions in desire for the service and speed of adaptation. According to this theory, all regions respond in the same general way to changes in tax price and changes in regional wealth, but regions have different starting points. Even in a district with very low desire for a given service, there is generally some conceivable tax price so low that the district would voluntarily provide the service if it faced that tax price.⁸

⁷ Those studies calculated income elasticities, rather than wealth elasticities. See previous footnote for possible effects leading to the low observed wealth elasticity.

⁸ Conversely, it is conceivable that policy makers in a district might be actively averse to all Internet access. For example, in some traditional religious communities, the Internet might be viewed as a source of undesirable outside information. As a state policy matter, active aversion can be addressed by means of grants which exceed the cost of access, which amounts to providing a “negative tax price”. It is, however, by no means assured that any sum of money is large enough to overcome all cases of active aversion. In other words, “some people just can’t be bought.” In those cases, the only available state policy tool to achieve universal access would be a universal mandate. In practice, surveys of school superintendents did turn up a few cases of opposition to Internet access on the part of superintendents who thought it a waste of time, especially in primary grades [Clifford, Hoyle, and Oslund, 1996]. However, for simplicity this report assumes that regional policy making bodies are at least mildly in favor of having Internet access.

It follows that state government can persuade almost any local government to adopt a service, if it provides enough dollars. In general the state will not need to pay *all* the costs of providing the service, but only part. Moreover, careful design can reduce the number of state dollars that are required.

Dollars coming from state government act almost entirely through the “tax price effect.” In other words, by lowering the tax price, you can raise the quantity of service demanded in a region. In particular, regions that lack a given level of Internet access can be induced to purchase it, if their cost for achieving that level of service is lowered sufficiently. In principle, a school district can also be induced to increase their Internet expenditures because of an “income” or “wealth effect,” i.e., the region is induced to purchase a service because the state grant dollars have the same effect as a new contribution to income or wealth. However, state grants are such small shares of existing total income in the district that the income effects are negligible.

There is an existing school district equalization formula for Kansas which seeks to equalize total school expenditures per pupil by equalizing the tax base, i.e., the taxable wealth that is effectively available per weighted pupil. This formula does not affect *personal* wealth as it is perceived by taxpayers. Instead, what it does is to adjust the tax price for achieving a given per-weighted-pupil expenditure so that the tax price is equal across most school districts.⁹

As a result, the present Kansas equalization formula does not go far enough to achieve equal expenditures between rich and poor districts. Even if the tax price is the same in most districts, the tax price remains a smaller share of personal income in high income districts than in poor districts. High income districts tend to provide a higher level of expenditures than poor districts, even after the tax base has been equalized.¹⁰ Both the descriptive models and the behavioral models for Kansas, as

⁹ The true tax price is equalized only among taxpayers with equal amounts of taxable property. Also, the present formula equalizes the tax price only in the bottom 75 percent of school districts.

¹⁰ This statement is true both in theory and in actual Kansas practice. Theoretically, this statement depends on an additional assumption. For a majority of voters, the main asset subject to property tax is an owner-occupied dwelling. The average value of the dwelling increases with income. Therefore, after the tax base is equalized, the tax price of school expenditures increases with income. An increase in tax price with income could conceivably prevent rich districts from having higher school expenditures than poor districts. Therefore it must also be assumed that, as district income increase, the tax price effect increases more slowly than the income effect.

In practice, a positive wealth effect was measured in the descriptive model of Kansas. There are probably two reasons why the increase in tax price with income did not prevent this from occurring. First, when income rises, average house values increase less than proportionately. Therefore with a fixed mill rate, the tax price is a declining share of income as income rises. Second, according to most studies, the income elasticity of demand for school expenditures is around 1.0, while the absolute value of the price elasticity of school expenditure demand is less than 1.0. Consequently, if tax price and household income were increased in the same proportion, the demand for school expenditures would rise. (An income elasticity of 1.0 may seem inconsistent with the relatively small wealth elasticity of .3 measured above. However, the two elasticities are different; for example, due to an unequal distribution of industries, some districts have higher taxable wealth without having higher income).

described above, show that expenditures on pupils increase with school district wealth per pupil, *even though* equalization formulas are in place (and even though the density of students in the district is controlled for in the model).

Moreover, equalizing the tax price of a per-pupil *expenditure* does not equalize the tax price of a given *service level*. For example, many services are more expensive per pupil in small, rural areas than in large, urban areas. This is especially true of Internet access, i.e., there are strong “economies of scale.” If state Internet grants were structured to equalize the per-pupil cost of access, then the tax price of Internet service level would be equalized at the same time. (Or equalized at least across households with equal taxable assets, and to the extent that Kansas school aid formulas already equalize the tax price of per-pupil expenditures).

Summary.

In summary, public choice theory implies that state grants can achieve equal access to the Internet in public schools if they include three features:

- Equalization of the per pupil cost of access, except as needed to overcome differences in wealth and income or in preferences;
- Reduction of per pupil cost of access in regions that have low wealth and income or a high tax-price of expenditures;
- Reduction of per pupil cost of access in regions that have a low desire to adopt the Internet, or are slow to adopt new technology.

One important difference between regions that affects desire and rate of adaptation, as well as the cost structure, has to do with technical knowledge and experience. Districts that are already competent in using computers and networking, and are used to integrating them into the curriculum, will not find the Internet connection to be a severe challenge. Districts with less experience will find it much more challenging. Therefore some state grants will be needed to assist and motivate districts with less experience to overcome the initial hurdles of computing and networking.

The situation for libraries is similar to that for school districts (but we would replace “per-pupil cost” with “per-patron cost”). In the case of libraries, one additional feature needs to be noted: there is no tax base equalization formula in place. Therefore larger shares of state grants may need to be targeted on low wealth areas in the case of libraries, than in the case of schools.¹¹

¹¹ In some cases the existing school revenue formula may have overreaching, or even perverse, effects on Internet access, due to the weighting scheme. In particular, expenditures per pupil are now twice as high in some small rural areas as in most urban areas. This feature would certainly affect the optimal Internet grant structure, and may increase the number of dollars needed for equalizing educational access.

CHAPTER 3. COST EQUALIZATION MODELS

This chapter presents estimates of the state's projected expenditure to equalize per-pupil Internet costs across districts. These estimates are "static," meaning they do not depend on the above behavioral model. Therefore some additional "dynamic" cost estimates will be needed to include the cost of surmounting differences in wealth, desire, and motivation. This depends upon the behavior of school districts. These dynamic costs are treated in the next chapter.

The Structure of Costs.

Details on Internet access and its costs are described generally in Burress, Livingston, and Oslund [1996, Chapter 5]. A more specific cost model for Kansas is developed in Burress and Hoyle [1996]. This chapter draws upon the latter model.

Cost items can be characterized by their response to different district features. We distinguish between four important types of costs:¹²

Costs Fixed at the District Level. Every district needs certain items to support its wide-area network and its access to the Internet. These items may include the basic access fee and line charges; the hardware that connects to the Internet line; the hardware, software, and personnel that manage the wide-area network; and servers that provide email addresses and web sites.

Costs Fixed at the Building Level. Every building needs certain items to support its local-area network and its access to the wide-area network. These items may include the hardware that connects to the line to the wide-area network and the hardware, software, and personnel that manage the local-area network.

Costs Dependent upon Proximity or Location. The lines that connect buildings to the wide-area network generate costs that can vary significantly across regions. In the least expensive case, buildings that are within a block or two of the district headquarters can be connected by wires laid inexpensively by the district itself. Other buildings will be connected by wireless, or by lines leased from the phone company. In the worse case, some buildings may be in different towns and extra long-distance charges may be incurred. Also, some small, rural areas face higher long-distance charges for the initial connection into the district.

Costs Proportional to Numbers of Clients. The quantity of computers and network connectors wires and software used by students, teachers, patrons, and library staff, as well as training for teachers and staff, depends upon the level of availability that is provided. For a fixed level of availability (and for a fixed student-teacher ratio or patron-staff ratio), costs for these items increase in direct proportion to the number of students or patrons.

¹² A fifth type of costs is costs fixed at the state level. These costs do not affect the equality of access at the local level.

The latter type of cost does not appreciably disturb the equality of per client costs across districts. That is, costs of computers and personnel¹³ are roughly the same everywhere in Kansas. Hence, this type of cost is not relevant to cost-equalization. (Of course, this type of cost can still create a barrier for districts with low desire for Internet access, which is addressed in the next chapter).

The other three kinds of costs do cause problems in equalizing per client costs. District level costs are a significant part of per client cost in small districts, yet they are almost entirely negligible in large districts, where they are shared across a large number of students or patrons. For example, the smallest school districts in Kansas have some 250 students and the largest has more than 40,000. A district-level cost of \$40,000 per year would be \$200 per pupil-year in the smallest districts, but less than a dollar per pupil-year in the largest district.

Building level costs can contribute a relatively large per-client cost in buildings that have very small numbers of students or patrons. For example, in Kansas the majority of primary schools have at least 200 students. A few primary schools however have less than 50 students. In these buildings, building level costs per pupil is at least four times as high as in most other schools. Building level costs create an even more significant barrier for small libraries.

Long-distance charges for dedicated lines can contribute a relatively large per client cost in widely dispersed districts or remote, rural districts. This factor depends on cost structures that varies with the local telephone company.

The State's Cost to Support Perfectly Equal per Client Costs.

Suppose the state sets out to exactly equalize per client costs across districts. According to this cost model, the state would need to take three steps:

- Pay all district level fixed costs;
- Pay all building level fixed costs; and
- Pay the excess of long distance charges over local leased line charges.

Estimates of statewide totals for district and building level costs are calculated in Burress and Hoyle [1996]. These are reprinted in Table 3.1:

¹³ In the short run, it may cost more to attract technical support personnel to rural areas than to urban areas. However, data presented in Burress, Clifford, Glass, and Oslund [1994] show that teaching salaries are not much different in urban and rural Kansas. Moreover, many teachers have the technical background to learn about networking technology. In the long run, it should be possible to equalize support personnel costs by retraining some teachers to handle technical support, perhaps on a half-time basis.

Table 3.1
Statewide Costs for Perfect Equalization of Internet Access Cost per Pupil

District-level Costs	\$12 million/year
Building-level Costs	\$ 9 million/year
 Total	 \$21 million/year

[Burress and Hoyle, 1996]

Long distance charges and other variations in telephone charges.

There are actually two different problems related to long-distance charges. One problem is that the basic Internet connection to the district office costs more in areas with small, private telephone companies that add on extra rents. The second problem is that the cost of connections from buildings to the district office varies with location. Buildings in a single, district-wide area network may be spread across different towns, leading to possible long-distance charges. The two problems probably would require different solutions.

The first problem can be handled simply. The statewide Internet access provider can agree to absorb and smooth all cost differences of providing an Internet access point in each district. KANREN, in particular, has proposed to put an access point into every school district and absorb the local cost difference [Burress and Hoyle, 1996, Appendix I]. The remainder of this report assumes this will occur. The implicit grants that are involved will be ignored.

The second problem requires that explicit grants be provided to level the cost of long-distance service. Unfortunately, no data has been gathered on the actual long-distance charges and related costs that are involved. (This data would require a separate survey of small rural telephone companies in Kansas, linked to a survey of small rural school districts). However, it is possible to estimate the rough order of magnitude of costs involved.

First, we need to estimate the number of buildings requiring long-distance charges in order to reach the district office. Let us assume the following:

Table 3.2
Estimated Number of Remote Buildings in Kansas

Schools	250
Libraries	50
Total	300

[Discussion with Ron Rohrer, Kansas State Board of Education]

Ron Rohrer of the Kansas State Board of Education kindly estimated the number of school buildings at remote sites by scanning the mailing addresses of Kansas school buildings. The estimated number of library buildings was based on the ratio of libraries to schools in Kansas.

Next we need some idea of the long-distance line charges, as compared to local charges. A dedicated 56 kbps line is assumed. As an order-of-magnitude estimate, we use the dedicated line rate, charged by SWB Corporation within a LATA, currently costing around \$1500 per year. This amount does not present a serious barrier to a large school building, but for a small school building with 50 pupils, it is \$30 per pupil, per year. In comparison, the cost of computers is less than \$25 per pupil, per year (assuming one computer per 30 students) for a large school building.

These numbers suggest that the total cost of equalizing buildings' line charges could be as large as half a million dollars a year (300 buildings×\$1500/building/year). We reiterate that this is an extremely rough estimate.

Some Implications.

Based on these assumptions, total costs for achieving an equalized cost-per-client in every district amount to about \$22 million annually.

In reality, exact cost equalization is not necessary to achieve equal access for students and library patrons.¹⁴ Many districts will probably adopt direct Internet links even if faced with a somewhat adverse cost structure. One could envision a much reduced grant program in which only the most severely impacted districts were assisted. For example, suppose the state adopted a program which:

- Paid only half of the district and building fixed costs in districts being assisted;
- Restricted assistance to the least well-off one-third of districts and buildings; and
- Paid only half of the excess intra-district long-distance charges.

In this scenario, the state's cost of achieving a practical level of partial equalization is reduced to less than \$4 million per year.

¹⁴ It is also true that policy makers may want to support the goal of equalizing the cost per client on the additional and independent ground of fairness between taxpayers. In that context, one should recognize that buildings and school districts that serve small populations do so simply because those local regions have chosen not to consolidate operations with other regions. In many cases, of course, consolidation would make no economic sense because of the extra transportation costs entailed for government and/or for clients. It is possible in other cases, however, that regions may have rejected consolidation purely because of the perceived community advantages of smallness and localness (other than cost). In the latter case, state grants which equalize costs are in effect state grants to support smallness and localness. Whether grants would be still be justified under this hypothetical condition is a matter for the legislature to decide. In any case, the present report is concerned with equal access for Internet users, and not with fairness between taxpayers. In the perspective of this report, the existing sizes of districts need to be accepted as facts to be dealt with, not as variables that can be influenced.

This plan is presented only for the purpose of illustration. It is certainly not the best way to spend \$4 million. This plan would lead to a serious inequities and inefficient differences between those districts just above, and those just below, the one-third mark. Assuming that equalizing costs was the sole goal of the program, a better approach would be to exactly equalize costs among (say) the lower half of districts. This approach would result in very small grants to the near-average-cost districts and large grants to the highest-cost districts.¹⁵

This point is especially true if state Internet dollars also were being made available under other formulas related to district wealth or start-up needs. In that case, cost-equalization funds probably should be combined with funds intended for these other purposes, thus economizing on all purposes. We will return to this point in the next chapter.

¹⁵ Actually, to avoid a “notch” effect, the process of determining the grants must be reversed. First, determine a fixed pot of money that is available. Second, gather data on cost requirements for all districts. Third, calculate the number and identity of the highest-cost districts, such that exactly equalizing their costs exactly uses up all of the pot of money.

CHAPTER 4. BEHAVIORAL COST MODELS

This chapter estimates some costs of equalizing Internet access where costs depend on the dynamic behavioral responses of districts. In particular, it examines the cost of overcoming differences in income, differences in innate desire, and differences in the rate of adaptation.

State Cost in Overcoming Differences in District Income or Wealth.

As discussed in Chapter 2, districts with more income have an incentive to provide a higher level of school and library services than districts with less income. This remains true even after the tax base and per pupil costs are equalized across districts. That is, districts with higher income tend to purchase a higher level of Internet access, because the tax price is a smaller share of income. The basic reason for this is that the cost to individual taxpayers is a declining share of household income as income increases. In other words, since Internet access is a relatively insignificant cost for rich households, they are willing to purchase more of it than poor households.

This incentive difference can be compensated for by providing additional Internet dollars to regions with lower than average household income. The details are somewhat different in schools, which have tax base equalization formulas, than in libraries, which do not.

Schools.

The empirical public choice model for Kansas schools described in Chapter 2 predicts that the effect on school expenditures of a 5 percent increase in wealth would be offset by the effect of a 3 percent decline in per pupil costs. Thus, if the state paid 3 percent of school costs for a school district that had 5 percent less wealth than average, while holding other things equal, then that district would tend to adopt the same level of school expenditures as an average district. Assuming that willingness to spend on the Internet has the same demand profile as willingness to spend on general school expenditures, the same rule would work for Internet expenditures. (This rule is only approximate, because it does not account for differences between districts in the underlying level of desire for Internet access -- a problem addressed in the next section. Also, the average district may not be the appropriate threshold for a minimum standard. We will return to this question below).

Therefore Kansas can bring lagging districts up to average levels of incentive by applying this rule to all districts in Kansas that have below average assessed valuation per pupil and/or above average tax prices. Based on detailed calculations, this requires that the state pay total costs amounting to nearly 18 percent of all local costs of providing Internet access. The technical details are somewhat complicated and are explained in Appendix 1.

Our calculation assumes that nothing will be done to reduce the incentive level in districts with *above-average* wealth. This is not necessarily important, if our goal merely is to see every district at the point where it provides *at least* the average district's standard of access. Wealthier districts would continue to have incentives to provide access above the minimum standard. If any important inequalities resulted and if policy-makers regarded these inequalities as disturbing, then further steps

could be taken. The simplest additional step would be a reduction in dollars of school aid to wealthier districts, equaling 3 percent of local Internet costs per each 5 percent of above-average wealth per pupil. Implementing this step should pay for the extra costs incurred by grants to low-wealth districts. However, this additional step would be resisted by wealthier districts. Estimated costs to the state in this report are based on the assumption that poorer districts will be helped without directly hurting the wealthier districts. (Of course, they will still be hurt indirectly, because they will help pay the taxes that support the Internet grant program).

Let us suppose that a grant program based on wealth was administered simultaneously with a perfect per pupil cost equalization as described in the previous chapter. Then district level costs, building level costs, and long-distance costs can be ignored, since they would already be covered. What remains payable by the local district would be only the per client costs and local telephone tolls. An estimate of these costs is around \$60 million per year [Burruss and Hoyle, 1996]. At 18 percent, the state's share would be around \$11 million per year.

Alternatively, suppose there were no other grant programs, so that all costs were supported locally. In this case, total school district Internet costs would amount to about \$80 million per year. At 18 percent, the state's share would be around \$14 million per year.

The preceding calculation estimates what is required for all districts to reach the average level of demand for Internet access. However, the average level of demand may not be the right threshold. If school-district demand for Internet access turned out to be strong in the future, then this threshold is too high and the costs could be less. Based on data presented in Clifford, Hole, and Oslund [1966], there are several reasons to think that school district demand for Internet access will be quite strong in the future, and a majority of districts will eventually install direct links to the Internet, even if it is at their own expense. Most Kansan school superintendents have expressed strong interest in obtaining and using at least some forms of Internet access. In fact, most districts already have at least modem-based access. The majority of school districts have, or are planning to have, high speed area networks in the near future. Once these are installed, direct links to the Internet will be but a modest next step. Hence, the figures of \$11 to \$14 million should probably be taken as an upper bound on the cost of eliminating income or wealth as a factor in Internet access for schools.

Libraries.

In the case of libraries, no hard data has been developed to quantify the tradeoffs for Kansas between the effects of wealth and price effects. Based on other studies of public choice, it is reasonable to assume that these elasticities are similar to those for school districts. Also, no available data showed the wealth distribution of library districts. It is likely, however, that the distribution of wealth per capita by library district is very similar to that for school districts (since the districts are substantially overlapping). Using these assumptions, we calculate that Kansas can bring less wealthy library districts up to the average incentive level, by paying costs of roughly 20 percent of all local costs of providing Internet access. (Some details of this calculation are given in Appendix 1). Statewide aggregate costs for library access to the Internet are estimated at less than \$3 million, so the cost of grants to eliminate the influence of wealth is probably less than \$.5 million.

The State's Cost for Overcoming Differences in District's Level of Desire.

Next, we consider the costs required to compensate for underlying differences across districts in attitudes toward the Internet. In one sense, it is very difficult to estimate the costs necessary to overcome inter-district differences in basic desire for Internet access. In another sense, it is not difficult at all. It is effortless to estimate costs if the state paid *almost all* of the costs to be sure that *all* of the districts were adopting a certain standard of access.

The argument goes like this: Individual districts vary from having almost no desire for a given public good to having extremely high desire. Most districts are near the middle, but a few are at the extremes. Among extreme districts, there is probably at least one district that would not adopt the Internet unless the state paid nearly all of its cost, or perhaps *more* than the total cost. There is no way to know that such a district does not exist, without checking every district, and if a district has not already adopted Internet access, there is no reliable way to check its level of desire. In this situation its "desire" is partly a hypothetical construct, referring to discussions and votes in the local legislative bodies that have actually not yet occurred.¹⁶ Therefore, paying almost all the costs is required to be certain of motivating *all* districts.¹⁷

Motivating *all* districts, however, is not a reasonable policy goal. If it *were* a reasonable goal, the legislature would use mandates rather than incentives. Rather, a reasonable goal is to motivate *most* districts. Finding what sum of money would do this is a difficult and circular problem. The legislature would presumably want to adjust its target for the percentage of buildings attaining full access upwards or downwards, depending on the prospective costs involved. Because we have neither a definite target rate, nor any hard data on the distribution of desire, we can make only very general statements.

One piece of evidence is the survey on district barriers to adoption of the Internet [Clifford, Hoyle, and Oslund, 1996]. Most school superintendents believe that Internet access is very desirable, and that financial costs are the main barrier to adoption. Since they find it desirable, they are presumably willing to recommend substantial expenditures from district sources, (though some school boards may not agree to support the recommendation). Similarly, most librarians support Internet access and see cost as the main barrier.

¹⁶ Of course, the state could proceed as follows: it sets a certain level of state aid and waits to see what happens, then raises the level of aid, then waits again, etc., until all districts have adopted the desired level of access. Assuming that each round would take a full legislative cycle, this process would be very slow. Kansas would remain behind other states for a protracted period. It would also introduce a "game" element, in which some districts had an incentive to wait until the level of aid became higher.

¹⁷ The state can think about cutting costs by discriminating between districts with low desire and those with high desire. For example, districts that have already made progress may be given reduced amounts of aid. These approaches tend to be perceived as unfair.

The best information available is the response observed in other states that have provided state grants for technology adoption. Missouri, for example, has grants and state grants amounting to \$10-15 million per year for computers, networks, and Internet access in schools and libraries. Assuming that Missouri's costs are similar to Kansas' costs, total costs for a minimum access level in Missouri would run around \$150 million per year. Missouri seems to be on track for connecting most schools and larger public libraries within 3-4 years. Hence a 10% grant program appears to be sufficient. Similar situations exist in Iowa and Nebraska. At the same time, other states lacking statewide grant programs lag behind states that do have grant programs. Apparently, a grant of 10% of costs or less can be an effective motivator.

One reason why relatively small grants may be effective is that the grants are directed to the most visible costs -- the costs that create administrative barriers. Much of the cost of Internet access is in personnel which can be transferred relatively easily from existing uses (i.e., it is an opportunity cost but not an additional expense). For example, teachers and librarians can spend more time on Internet provision and less time on other services. In contrast, budgets for hardware and software are extremely tight in schools and libraries. Funds from the state for that purpose can make a big difference.

CHAPTER 5. CONCLUSION

Equal access to the Internet is affordable from local resources in most regions, if the desire is there. Some relatively poor districts have already provided high-quality Internet access without any state support.

For exactly that reason, cost differences in Internet access may not be a very large problem *per se*. Most districts can probably provide an adequate level of access on their own. A few, very small, rural districts, however, appear to face significant barriers and may need help from the state. In general, differences in desire and in extent of activism are much more important than differences in cost.

There is also a problem of overall speed of adaptation. Most Kansan districts and libraries are moving rather slowly. They have reached the level of modem access which provides limited availability of access time per client. Many of the states we compete with have moved beyond that level. If Kansas reaches a policy decision that its schools and libraries should stay at the competitive edge, state funds would be necessary to help many districts overcome their networking hurdles.

Thus, the main problem is motivation. It seems, both from these calculations and from experience in other states, that state expenditures on the order of \$15-20 million per year would be sufficient to motivate most regions to provide at least a minimum level of access to the Internet through direct dedicated connections. To the extent that Kansas wishes to keep abreast with Internet technology that continues to change rapidly, these expenditures would need to continue over time.

APPENDIX. THE COST OF EQUALIZING TAX-PRICE AND WEALTH EFFECTS IN SCHOOL DISTRICTS

Chapter 4 contains estimated costs of state grants to cancel out effects from below average wealth and/or above average tax prices in school districts. This appendix explains in more detail how the model was formed.

In the following, we assume that tax price is defined as in Chapter 2, namely, as the increase in mill rate on assessed property, per increase in expenditures per pupil. (It would be better to multiply this by the median household wealth, but that data was not readily available by school district). The basic demand function D_i for Internet services for a school district "i" is assumed to be:

$$(1) \quad \log D_i = +.31(\log W_i) - .54(\log T_i) + \text{irrelevant terms}$$

where W_i = assessed value per pupil, and
 T_i = tax price.

Let $\delta_i = +.31(\log W_i) - .54(\log T_i)$, and let δ^* be its median value.

The goal is to identify school districts with $\delta_i < \delta^*$, and then calculate the tax price grant needed to bring δ_i up to δ^* . Let ϵ_i be the required rate of subsidy. Then we have

$$(2) \quad [+ .31(\log W_i) - .54(\log (1-\epsilon_i)T_i)] = \delta^* \quad (\text{for } \delta_i < \delta^*)$$

Solving, we have

$$(3) \quad \epsilon_i = 1 - \exp\{[.31(\log W_i) - \delta^*]/.54 - \log T_i\} = 1 - \exp(-\delta^*/.54)W_i^{.31}/T_i \quad (\text{for } \delta_i < \delta^*)$$

$$\epsilon_i = 0 \quad (\text{for } \delta_i > \delta^*).$$

A computer program calculated the individual ϵ_i and the resulting costs to the state. It also calculated the average value of ϵ_i , both unweighted, and weighted by number of pupils. Both results were around 1/5 (.20 for the unweighted and .18 for the weighted average).

One important complication has to do with the tax price in school districts which spend only the minimum level of expenditures per pupil guaranteed by the school revenue formula. These districts do not have a well-defined tax price. (Below the minimum expenditure, the tax price is zero. Above the minimum expenditure, it is determined by the school-revenue formula. At the minimum expenditure, the tax price is undefined.) These districts were omitted from the calculation of the mean ϵ .

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