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Financing elementary and secondary education in Iowa: an economic analysis and empirical results

Robert Frederick Fix
Iowa State University

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Financing elementary and secondary education in Iowa: An economic analysis and empirical results

by

Robert Frederick Fix

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CHAPTER I. INTRODUCTION

Since World War II, expenditures on education have risen dramatically. Perhaps no other area of the economy, with the possible exception of the health care industry, has experienced such a marked increase in demand with its concomitant price increase. Both education and health care are economic services to which most economists and laymen alike attribute the involvement of a strong element of publicness in their consumption. Hence, both are much discussed and argued about in the public domain.

With regard to education, we have moved far, perhaps too far from a purely economic view, toward treating it as a pure public good. Nevertheless, it undisputedly possesses the characteristic of publicness at the elementary and secondary levels. Recently, there have been law suits brought in several states charging that the current systems of financing education violate the Fourteenth Amendment. Put in economic terms, the plaintiffs have argued that elementary and secondary education is, in substantial part, a public good. Consequently, students should have the opportunity to consume education equally or at least more equally than at present. Also, the burden of the cost of education at this level, say the plaintiffs, should be distributed more equitably, according to some acceptable criteria of ability to pay.

In addition to this legal challenge to the present system of educational finance, it is a fact that many of the local school districts in the United States are today confronted with a taxpayer revolt. People all over the country are turning out at the polls to defeat proposals to increase the millage rate for education.

The economic reasons for this are both simple and complex. Because of increasing personal income, the demand for education is increasing, i.e., in economic terms, it is a normal good. Many goods and services, however, have income elasticities greater than 1. And yet we do not find rapid price increases concomitant with the increased demand for them. Why? It is here that the problem becomes more complex:

A. Being a service industry, education is a labor intensive process. To date, at least, the ability to substitute capital for labor in education has been almost nonexistent.

B. The increase in demand for education in most instances is not for an increase in quantity (i.e., not for longer days, more days, or more years), but rather for an increase in quality. So far, the only way the education industry has been able to supply this increase in quality is through more intensive use of labor, i.e., a higher and higher teacher-to-pupil ratio.

Given these somewhat peculiar supply and demand characteristics, the cost of education has shot up dramatically.

But why are the taxpayers revolting, given that the major reason for the increased demand for education is increased incomes? The answer to this probably lies in the antiquated way in which elementary and secondary education is, for the most part, financed in the United States.

There is a strong positive correlation between income and wealth. In the early days of this country, the major form of wealth was real property. Given this fact, plus the constitutional restriction against an income tax, the logical tax to finance education was a tax on property. Hence, a property tax would in a sense be a proportional income tax. The America of the Twentieth Century is much different. Wealth now takes many diverse forms ranging from real property through a myriad of paper assets to human wealth or human capital. No longer is there a strong positive correlation between income and property.[1] Evidence indicates in fact that for some areas there is a negative correlation between these two variables (4). The present study suggests that there is little positive correlation in Iowa between per capita income and per capita property on a county by county basis.

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[1]For purposes of this study, "property" will be defined as both real and personal property.

Given these facts, it is little wonder that in many areas of the United States millage proposals for school finance are being turned down. The people demanding better quality education are typically the people with higher incomes, while the people being asked to pay are the owners of property. Today there is little if any positive correlation between the income demanding and the "wealth" being asked to supply this service.

This study attempts to discern the important variables which determine the amount of spending on education. It is primarily concerned with the equitable treatment of taxpayers and only incidentally with the equitable treatment of students. For example, it will assume that the consumption of education is a pure public good and, therefore, all students should receive the same educational opportunities. This assumption is made in order to show what type of tax structure is needed to equitably distribute the resulting tax burden. It may or may not be a good assumption, depending upon the outcome of future court decisions.

The Problem in Iowa

The problem in Iowa concerning the financing of elementary and secondary education is generally perceived to be the wide variation in per capita and/or per student property values among local districts. This is a one dimensional perception of the problem which, as mentioned previously, is most likely a carryover from the early days of the country when real estate and wealth were highly correlated. There is indeed a wide variation in per capita property values among Iowa counties, but there is also a wide variation in per capita income across Iowa. The problem, however, is not one dimensional because variations in property are not a good indicator or proxy of the variation in wealth or income among localities.

Investment in education is a vehicle whereby society and individuals, by creating human capital, attempt to increase their total wealth and income streams. The findings of many research studies have indicated that this has been a very lucrative form of investment. It does not follow, however, that property or the owners of property (especially real estate) have captured a major or even a significant portion of this increased wealth and income. If we are concerned with horizontal and vertical equity in the taxing schemes devised to finance education, then, presumably, those who benefit more should pay more and those who benefit equally should pay equally. Heavy reliance on a property tax to finance public education does not appear to satisfy this criterion. It appears to fail even in Iowa where one would expect some correlation between income and property, given the state's heavy concentration in farming.

In this study the ninety-nine counties in Iowa are the experimental units. For each county the market value of all real and personal property was estimated on a per capita basis.

In addition, county per capita income estimates were obtained from the 1970 U.S. Census (7). The correlation coefficient between these two variables was .0188, indicating virtually no linear association between them.

The problem to be addressed in this study, then, is threefold:

1. A method must be devised to accurately measure the variation in school tax burden among Iowa localities. Because of data limitations, counties will be used here. (Observations on school districts would be more satisfactory.)
2. A model will be constructed which attempts to explain the variation in demand for education which exists among Iowa counties.
3. The model will be solved and the resulting implications will be analyzed to ascertain if the model contains a realistic solution to the problem of public school finance. The criteria used to judge the results will be consistency and horizontal and vertical equity.

Consistency is here defined as a tax scheme which will raise the same dollar total presently raised by the school millage, with reasonable tax rates and economically sound tax bases.

Horizontal equity refers to the equal treatment of equals. In this context we will be concerned with the equal treatment of equals who are situated in different counties. Given the present system of school finance, equals (using property as the unit of measure) may be treated (taxed) quite differently depending upon their county of residence. We are interested in gaining or at least moving toward a tax system which is horizontally equitable.

Vertical equity refers to the unequal treatment of unequals. It is an almost universally accepted taxation criterion in America that the rich should pay more than the poor. This does not and need not imply progressive taxation. A consistently defined and fairly enforced proportional tax will provide vertical equity in an absolute sense. Those who own or control more of the tax base will pay more, dollar-wise, than those who are less fortunate or industrious. The problem of vertical equity is complex. Both wealth (property) and income are reasonable tax bases. The problem is how to determine who is better off--the taxpayer with little property but high income or vice versa. As stated above, this would not be such a pervasive problem if there was a good correlation between income and property.

To the layman, the most obvious injustices of the present school tax system are problems of horizontal equity. Serious problems of vertical equity exist, however, and hopefully the analysis contained here will shed light on this.

CHAPTER II. MEASURING THE INEQUITY AND THE PROBLEM OF TAX BASE

The primary purpose of this chapter is to quantify the variation in school millage rates across Iowa in a fashion which will permit statistical analysis. In addition, a simple solution will be tried and analyzed.

Given the existing variation in the assessment/sales ratio among counties, simple comparison of millage rates between two or more localities is misleading. One way to correct this bias is to convert assessed values to market values. Each year the State of Iowa publishes a summary of its real estate assessment/sales ratio study. The report used for this study was the 1971 edition (6). With the use of this report and the additional assumption that personal property is assessed at the same rate as real property, an estimate of the market value of taxable property in each county can be made. After performing this transformation, one can make legitimate comparisons concerning taxable property and school millage rates across counties.

The procedure used below to calculate market values is the same as that used by Meyer in 1962 (2).

Let:

AV_i = assessed value of taxable property in county i.

SR_i = ratio of assessed value to market value in county i.

MV_i = market value of taxable property in county i.

Then:

$$MV_i = \frac{AV_i}{SR_i}$$

Since the ratio of assessed value to market value varies significantly between urban and rural property in many counties, the formula was applied separately to urban and rural property for each county. The market values used to calculate per capita property in Table 1, Column 1, were obtained by summing the calculated market values for urban and rural property in each county. The data on assessed value were obtained from the State of Iowa (5), while the population estimates came from the 1970 Census (7).

With these estimates of the market value of taxable property in each county, it is now a simple matter to convert school millage rates so that they too are comparable.

Let:

$\$_i$ = total dollars raised by the property tax for education in county i.

MV_i = the market value of all taxable property in county i.

r_i = the market value millage rate for education in county i.

Then:

$$r_i = \frac{\$_i}{MV_i}$$

Table 1. Variation in the existing local school tax base, rate, and yield

County	$\frac{MV_i}{n_i}$	r_i	$\frac{\$_i}{n_i}$	$\frac{\$_i}{s_i}$	$\frac{r_i - R}{R}$	$\frac{\frac{\$_i}{n_i} - \frac{\Sigma\$_i}{\Sigma n_i}}{\frac{\Sigma\$_i}{\Sigma n_i}}$	$\frac{\frac{\$_i}{s_i} - \frac{\Sigma\$_i}{\Sigma s_i}}{\frac{\Sigma\$_i}{\Sigma s_i}}$
Adair	17,650	.0116	205	792	-.1145	.2732	.1250
Adams	17,070	.0121	205	803	-.0763	.2732	.1406
Allamakee	12,602	.0114	144	570	-.1297	-.1055	-.1903
Appanoose	9,029	.0135	122	599	.0305	-.2422	-.1491
Audubon	18,782	.0109	206	767	-.1679	.2795	.0894
Benton	17,154	.0112	193	739	-.1450	.1987	.0497
Black Hawk	7,762	.0174	135	592	.3282	-.1614	-.1590
Boone	14,305	.0117	167	800	-.1068	.0372	.1363
Bremer	11,508	.0126	146	625	-.0381	-.0931	-.1122
Buchanan	11,856	.0136	161	655	.0381	0	-.0696
Buena Vista	15,934	.0097	154	674	-.2595	-.0434	-.0426
Butler	15,876	.0111	177	674	-.1526	.0993	-.0426
Calhoun	20,951	.0099	204	857	-.2442	.2670	.2173
Carroll	14,066	.0081	115	722	-.3816	-.2857	.0255
Cass	14,651	.0096	141	581	-.2671	-.1242	-.1747
Cedar	16,026	.0125	201	776	-.0458	.2484	.1022
Cerro Gordo	12,182	.0137	168	721	.0458	.0434	.0241
Cherokee	16,860	.0103	163	631	-.2137	.0124	-.1036
Chickasaw	13,210	.0117	155	564	-.1068	-.0372	-.1988
Clarke	14,483	.0105	153	744	-.1984	-.0496	.0568
Clay	16,829	.0106	178	702	-.1908	.1055	-.0028
Clayton	11,253	.0146	165	653	.1145	.0248	-.0724
Clinton	13,203	.0124	165	699	-.0534	.0248	-.0071
Crawford	15,351	.0116	179	745	-.1145	.1118	.0582
Dallas	14,887	.0114	170	676	-.1297	.0559	.0397

Table 1 (Continued)

County	$\frac{MV_i}{n_i}$	r_i	$\frac{\$_i}{n_i}$	$\frac{\$_i}{s_i}$	$\frac{r_i - R}{R}$	$\frac{\frac{\$_i}{n_i} - \frac{\Sigma\$_i}{\Sigma n_i}}{\frac{\Sigma\$_i}{\Sigma n_i}}$	$\frac{\frac{\$_i}{s_i} - \frac{\Sigma\$_i}{\Sigma s_i}}{\frac{\Sigma\$_i}{\Sigma s_i}}$
Davis	13,926	.0124	173	700	-.0534	.0745	-.0056
Decatur	11,550	.0102	118	589	-.2213	-.2670	-.1633
Delaware	13,010	.0132	172	683	.0076	.0683	-.0298
Des Moines	9,577	.0159	153	682	.2137	-.0496	-.0312
Dickinson	19,419	.0084	166	675	-.3587	.0310	-.0411
Dubuque	8,559	.0144	124	845	.0992	-.2298	.2002
Emmet	13,803	.0116	160	652	-.1145	-.0062	-.0738
Fayette	12,251	.0137	168	676	.0458	.0434	-.0397
Floyd	13,403	.0127	171	717	-.0305	.0621	.0184
Franklin	24,904	.008	201	794	-.3893	.2484	.1278
Fremont	19,937	.0109	219	924	-.1697	.3602	.3125
Greene	21,194	.0102	217	904	-.2213	.3478	.2840
Grundy	22,048	.0095	211	854	-.2748	.3105	.2130
Guthrie	15,471	.0103	160	728	-.2137	-.0062	.0340
Hamilton	19,451	.0111	216	856	-.1526	.3416	.2159
Hancock	22,474	.0091	206	793	-.3053	.2795	.1264
Hardin	16,466	.0094	155	665	-.2824	-.0372	-.0553
Harrison	14,807	.0018	175	716	-.0992	.0869	.0170
Henry	11,345	.0121	138	602	-.0763	-.1428	-.1448
Howard	13,233	.0126	168	708	-.0381	.0434	.0056
Humboldt	21,143	.0103	219	841	-.2137	.3602	.1946
Ida	19,687	.0111	220	857	-.1526	.3664	.2173
Iowa	16,081	.0114	185	769	-.1297	.1490	.0923
Jackson	11,146	.0132	148	635	.0076	-.0807	-.0980
Jasper	12,940	.013	169	690	-.0076	.0496	-.0198

Table 1 (Continued)

County	$\frac{MV_i}{n_i}$	r_i	$\frac{\$_i}{n_i}$	$\frac{\$_i}{s_i}$	$\frac{r_i - R}{R}$	$\frac{\frac{\$_i}{n_i} - \frac{\Sigma\$_i}{\Sigma n_i}}{\frac{\Sigma\$_i}{\Sigma n_i}}$	$\frac{\frac{\$_i}{s_i} - \frac{\Sigma\$_i}{\Sigma s_i}}{\frac{\Sigma\$_i}{\Sigma s_i}}$
Jefferson	11,372	.0131	149	673	0	-.0745	-.0440
Johnson	9,317	.0177	165	909	.3511	.0248	.2911
Jones	13,642	.0126	173	755	-.0381	.0745	.0724
Keokuk	14,799	.0122	166	720	-.1450	.0310	.0227
Kossuth	19,293	.0104	202	939	-.2061	.2546	.3338
Lee	10,600	.0132	140	620	.0076	-.1304	-.1193
Linn	9,534	.0182	174	755	.3893	.0807	.0724
Louisa	15,524	.012	187	735	-0.839	.1614	.0440
Lucas	11,630	.0128	150	626	-.0229	-.0683	-.1107
Lyon	18,028	.0093	168	637	-.2900	.0434	-.0951
Madison	17,553	.0107	189	785	-.1832	.2298	.1150
Mahaska	11,328	.0144	164	796	.0992	.0186	.1306
Marion	10,704	.0114	123	607	-.1297	-.2360	-.1377
Marshall	12,013	.015	181	811	.1450	.1242	.1519
Mills	22,947	.0084	193	846	-.3587	.1987	.2017
Mitchell	13,690	.0114	157	636	-.1297	-.0248	-.0965
Monona	17,375	.0106	185	771	-.1908	.1490	.0951
Monroe	11,579	.0138	160	737	.0534	-.0062	.0468
Montgomery	14,851	.0109	162	722	-.1679	.0062	.0258
Muscatine	11,372	.0128	146	596	-.0229	-.0931	-.1534
O'Brien	16,604	.0092	154	658	-.2977	-.0434	-.0653
Osceola	20,049	.0106	214	847	-.1908	.3291	.2031
Page	12,280	.0122	150	709	-.0687	-.0683	.0071
Palo Alto	16,351	.0117	192	753	-.1068	.1925	.0696
Plymouth	15,875	.0101	161	736	-.2290	0	.0454

Table 1 (Continued)

County	$\frac{MV_i}{n_i}$	r_i	$\frac{\$_i}{s_i}$	$\frac{\$_i}{s_i}$	$\frac{r_i - R}{R}$	$\frac{\frac{\$_i}{n_i} - \frac{\Sigma\$_i}{\Sigma n_i}}{\frac{\Sigma\$_i}{\Sigma n_i}}$	$\frac{\frac{\$_i}{s_i} - \frac{\Sigma\$_i}{\Sigma s_i}}{\frac{\Sigma\$_i}{\Sigma s_i}}$
Pocahontas	21,942	.0091	202	852	-.3053	.2546	.2102
Polk	9,524	.0167	159	702	.2748	-.0124	-.0028
Pottawattamie	8,696	.0164	143	566	.2519	-.1118	-.1960
Poweshiek	14,436	.0117	170	720	-.1068	.0559	.0227
Ringgold	16,162	.0124	201	856	-.0534	.2484	.2459
Sac	18,908	.0097	184	720	-.2595	.1428	.0227
Scott	10,014	.0179	179	735	.3664	.1118	.0440
Shelby	16,647	.0108	181	750	-.1755	.1242	.0653
Sioux	15,263	.0097	149	792	-.2595	-.0745	.1250
Story	9,166	.0149	137	723	.1374	-.1490	.0269
Tama	14,891	.0123	184	731	-.0610	.1428	.0383
Taylor	13,569	.011	152	682	-.1603	-.0559	-.0312
Union	11,714	.012	140	607	-.0839	-.1304	-.1377
Van Buren	11,867	.0119	138	614	-.0916	-.1428	-.1278
Wapello	6,722	.0188	127	547	.4351	-.2111	-.2230
Warren	10,461	.0153	160	586	.1679	-.0062	-.1676
Washington	15,487	.0119	185	734	-.0916	.1490	.0426
Wayne	14,163	.0104	147	680	-.2061	-.0869	-.0340
Webster	12,461	.0112	141	626	-.1450	-.1242	-.1107
Winnebago	15,352	.0095	146	644	-.2748	-.0931	-.0852
Winneshiek	10,320	.0132	136	668	.0076	-.1552	-.0511
Woodbury	9,297	.0142	132	599	.0839	-.1801	-.1491
Worth	19,473	.01	197	847	-.2366	.2236	.2031
Wright	19,954	.0105	211	874	-.1984	.3105	.2414
State-wide average	12,276	.0131	161	704			

The school millage levied in Iowa ($\Sigma\$_i$) in 1970 and collected in 1971 amounted to \$455,321,653.83. The total market value of taxable property in Iowa (ΣMV_i), as estimated above, comes to \$34,672,571,709.00. Letting R equal the state-wide average we get:

$$R = \frac{\Sigma\$_i}{\Sigma MV_i} = \frac{455,321,653.83}{34,672,571,709.00} = .0131$$

Thus, the average rate of property taxation in Iowa for public schools is 1.31 percent of market value. Or alternately stated, the school levy on average is 13.1 mills per market value dollar. As can be seen in Column 2 of Table 1, there is considerable variation above and below this state-wide average.

The remaining columns of Table 1 were calculated as follows:

Column 3: $\frac{\$_i}{n_i}$ = the total dollar levy in county i ($\$_i$) divided by the total population in county i (n_i).

Column 4: $\frac{\$_i}{s_i}$; this is calculated in the same manner as Column 3 except that the number of public school students in grades K through 12 is used instead of the total county population. The data on students were obtained from the 1970 Census (7).

Column 5: $\frac{r_i - R}{R}$; this column is a measure of the percentage variation in school tax rates. From the calculated millage rate in each county (r_i), the state-wide average (R = .0131) is subtracted and the difference is divided by the state-wide average.

Column 6: $$\frac{\frac{\$_i}{n_i} - \frac{\Sigma\$_i}{\Sigma n_i}}{\frac{\Sigma\$_i}{\Sigma n_i}}$$; Column 6 measures the percentage deviation in dollars per capita raised by the local school tax. The state-wide average was calculated as follows:

$$\frac{\Sigma\$_i}{\Sigma n_i} = \frac{455,321,653.83}{2,834,376} = \$161.00$$

Column 7: $$\frac{\frac{\$_i}{s_i} - \frac{\Sigma\$_i}{\Sigma s_i}}{\frac{\Sigma\$_i}{\Sigma s_i}}$$; Column 7 is calculated in the same fashion as Column 6 except that the appropriate student population is used in place of the total population of the state or counties. In this case the state-wide average equals $704.00.

From Table 1 it is plain that there is a great deal of variation in per capita property values. Likewise, there is considerable variation in school millage rates, dollars raised per capita, and dollars raised per student. The important question to be asked is, "Is the variation in per capita property values the sole or at least the primary cause of the variation in the latter variables?" In many cases, although this question is not directly posited, an affirmative answer is assumed. Therefore, assume for now that the answer is yes.

An additional assumption will be made that education is a pure public good and, therefore, each student should share equally in the total school levy. This assumption, like all assumptions in economics, is a simplification of reality. It is made here because it appears to represent, to a significant extent, current popular opinion. Also, court decisions have moved, and it appears will continue to move, in this direction. This is not to say, however, that future court decisions will require absolute equality in expenditures per student. Such a decision is extremely unlikely. The usefulness of this assumption is that it will allow us to formulate here, and in a later chapter, "equitable" solutions to the problem of public school finance by providing an objective or goal to be attained.

Given these two assumptions, the problem of equalizing tax burdens and per pupil expenditures has an obvious two-part solution. First, the state must impose the state-wide average millage rate of .0131 on all taxable property within its boundaries. Second, it must redistribute money from those counties where a millage rate of .0131 yields more than $704 per student to those counties where the .0131 rate yields less than $704 per student. The uniform rate of .0131 yields the same total revenue, solving the problem of horizontal inequity between taxpayers in different counties, and the state redistribution of the funds will provide for equal expenditures per child among the counties. This is a simple solution to the school finance problem which to many would seem both reasonable and equitable.

Table 2 shows the results of this solution along with two new variables of interest. The columns of Table 2 are as follows:

Column 1: Existing $\frac{\$_i}{n_i}$; this is simply a repeat of Column 3, Table 1.

Column 2: New $\frac{\$_i}{n_i}$ = the new per capita tax burden for each county calculated on the basis of a millage rate of .0131 per market value dollar.

Column 3: $\Delta \frac{\$_i}{n_i}$ = (Column 1 - Column 2) = the per capita change in the tax burden resulting from the application of the uniform millage rate.

Column 4: $\frac{Y_i}{n_i}$ = the per capita income of each county obtained from the 1970 Census (7).

Column 5: $\frac{s_i}{n_i}$ = the ratio of public school students in grades K through 12 to total population for each county.

As mentioned above, the solution obtained is horizontally equitable. It is also consistent to the extent that it will raise the same total revenue as the existing tax scheme with reasonable (i.e., .0131) tax rates. Whether or not the base

Table 2. The resulting change in the impact of the school levy with a uniform millage rate, and the variation in per capita income and per capita students

County	Existing $\frac{\$_i}{n_i}$	Calculated $\frac{\$_i}{n_i}$	$\Delta \frac{\$_i}{n_i}$	$\frac{Y_i}{n_i}$	$\frac{s_i}{n_i}$
Adair	205	231	26	2,914	.2587
Adams	205	223	18	2,409	.2578
Allamakee	144	165	21	2,315	.2530
Appanoose	122	118	- 4	2,414	.2045
Audubon	206	246	40	2,377	.2690
Benton	193	225	32	2,869	.2609
Black Hawk	135	102	-33	3,013	.2284
Boone	167	187	20	2,814	.2092
Bremer	146	151	5	2,926	.2329
Buchanan	161	155	- 6	2,488	.2464
Buena Vista	154	209	55	3,009	.2292
Butler	177	208	31	2,561	.2627
Calhoun	204	274	70	2,710	.2383
Carroll	115	184	69	2,406	.1590
Cass	141	192	51	2,728	.2420
Cedar	201	210	9	2,936	.2587
Cerro Gordo	168	160	- 8	2,973	.2329
Cherokee	163	221	58	2,768	.2588
Chickasaw	155	173	18	2,276	.2751
Clarke	153	190	37	2,703	.2059
Clay	178	220	42	3,070	.2542
Clayton	165	147	-18	2,272	.2534
Clinton	165	173	8	2,965	.2358
Crawford	179	201	22	2,465	.2400
Dallas	170	195	25	2,943	.2517

Table 2 (Continued)

County	Existing $\frac{\$_i}{n_i}$	Calculated $\frac{\$_i}{n_i}$	$\Delta \frac{\$_i}{n_i}$	$\frac{Y_i}{n_i}$	$\frac{s_i}{n_i}$
Davis	173	182	9	2,503	.2471
Decatur	118	151	33	1,982	.2001
Delaware	172	170	- 2	2,337	.2518
Des Moines	153	125	-28	3,103	.2238
Dickinson	166	254	88	2,785	.2423
Dubuque	124	112	-12	2,696	.1462
Emmett	160	181	21	2,554	.2458
Fayette	168	160	- 8	2,444	.2481
Floyd	171	176	5	2,682	.2379
Franklin	201	326	125	2,664	.2533
Fremont	219	261	42	2,683	.2370
Greene	217	278	61	3,092	.2405
Grundy	211	289	78	2,982	.2473
Guthrie	160	203	43	2,449	.2197
Hamilton	216	255	39	2,843	.2526
Hancock	206	294	88	2,609	.2602
Hardin	155	216	61	2,950	.2335
Harrison	175	194	19	2,510	.2443
Henry	138	149	11	2,885	.2291
Howard	168	173	5	2,662	.2371
Humboldt	219	277	58	2,634	.2608
Ida	220	258	38	3,317	.2564
Iowa	185	211	26	2,482	.2402
Jackson	148	146	- 2	2,595	.2324
Jasper	169	170	1	3,024	.2449

Table 2 (Continued)

County	Existing $\frac{\$_i}{n_i}$	Calculated $\frac{\$_i}{n_i}$	$\Delta \frac{\$_i}{n_i}$	$\frac{Y_i}{n_i}$	$\frac{s_i}{n_i}$
Jefferson	149	149	0	2,803	.2216
Johnson	165	122	-43	3,007	.1814
Jones	173	178	6	2,491	.2292
Keokuk	166	194	28	2,455	.2308
Kossuth	202	253	51	2,464	.2151
Lee	140	139	- 1	2,847	.2126
Linn	174	125	-49	3,208	.2310
Louisa	187	203	16	2,666	.2551
Lucas	150	152	2	2,594	.2395
Lyon	168	236	68	2,472	.2633
Madison	189	230	41	2,651	.2413
Mahaska	164	148	-16	2,544	.2063
Marion	123	140	17	2,677	.2025
Marshall	181	157	-24	3,095	.2232
Mills	193	301	108	3,129	.2286
Mitchell	157	179	22	2,473	.2465
Monona	185	228	43	2,603	.2402
Monroe	160	152	- 8	2,341	.2173
Montgomery	162	195	33	2,982	.2247
Muscatine	146	149	3	2,998	.2455
O'Brien	154	218	64	2,451	.2337
Osceola	214	263	49	2,598	.2529
Page	150	161	11	2,712	.2118
Palo Alto	192	214	22	2,643	.2553
Plymouth	161	208	47	2,393	.2182

Table 2 (Continued)

County	Existing $\frac{\$_i}{n_i}$	Calculated $\frac{\$_i}{n_i}$	$\Delta \frac{\$_i}{n_i}$	$\frac{Y_i}{n_i}$	$\frac{s_i}{n_i}$
Pocahontas	202	287	85	2,586	.2367
Polk	159	125	-34	3,446	.2268
Pottawattamie	143	114	-29	2,836	.2524
Poweshiek	170	189	19	3,159	.2366
Ringgold	201	212	11	2,555	.2344
Sac	184	248	64	2,875	.2558
Scott	179	131	-48	3,296	.2439
Shelby	181	218	37	2,486	.2417
Sioux	149	200	51	2,226	.1878
Story	137	120	-17	3,068	.1893
Tama	184	195	11	2,592	.2515
Taylor	152	178	26	2,278	.2226
Union	140	153	13	2,429	.2314
Van Buren	138	155	17	2,150	.2241
Wapello	127	88	-39	2,756	.2323
Warren	160	137	-23	2,838	.2737
Washington	185	203	18	2,893	.2515
Wayne	147	186	39	2,360	.2168
Webster	141	163	22	2,872	.2247
Winnebago	146	201	55	2,845	.2267
Winneshiek	136	135	- 1	2,538	.2042
Woodbury	132	122	-10	2,886	.2204
Worth	197	255	58	2,923	.2320
Wright	211	261	50	3,662	.2417
State-wide average	161	161	0	2,894	.2288

(property) is economically sound is not of primary importance here. Rather, by assumption, we have postulated that it is. This leaves the problem of vertical equity.

It is intuitively obvious that with the use of property as the base, a uniform millage rate will satisfy the criterion of vertical equity. The more property an individual or business has, the more tax will be paid. However, the standard measure of ability to pay in America is income. If it can be shown that there is a reasonably good correlation between taxable property and income, then it can be assumed that our solution will pass this test of vertical equity as well. The facts do not bear this out. The correlation coefficient between per capita taxable property (Table 1, Column 1) and per capita income (Table 2, Column 4) is only .0188. The impact of this tax, from the standpoint of vertical equity with income as the base, must be investigated.

Column 3 of Table 2 is, in effect, a state imposed property tax on the residents of each county. When Column 3 assumes a positive number it is a normal or positive tax. In the case of a negative number it may be looked upon as a negative tax or a subsidy. In essence, the state would be transferring tax burden from one county to another. If each element of Column 3 is multiplied by its respective population figure, the sum must equal zero. The total yield of the property tax is not being changed, only the distribution of the burden is being altered. From whom and to whom is this burden being shifted with respect to income? Carrying out the necessary calculations indicates that, in total, a tax levy burden of approximately 43 million dollars would be redistributed in the following fashion.

	Recipients	Payers
Number	1,567,607	1,256,769
Per capita income	$3,028	$2,725
Per capita subsidy-tax	$27.43	$34.22
Subsidy-tax as a percent of per capita income	.009	.0125

(Based on 1970 data)

It is evident, using income as the yardstick, that this solution to the school finance problem violates the principle of vertical equity. It is plainly regressive in that, in effect, it amounts to a 43 million dollar income transfer by the state from the "poor" to the "rich".[1]

This poses somewhat of a dilemma. With property as the base the condition of vertical equity is satisfied; with income as the base it is violated. Both, it can be argued, are reasonable bases upon which to tax. What is particularly sobering, however, is that unless income and property are highly correlated (and they are not), no unidimensional tax scheme will satisfy the equity criteria with respect to both

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[1]Assuming that all property is owned by the residents of that county.

bases. Which one then is the proper or more economically sound base? Instead of assuming that property is the correct base, as was done above, we will substitute a different normative assumption. In answering this question, the following value judgment will be made: "Leaving welfare considerations aside, it seems a reasonable assumption, even in the domain of public or quasi-public goods, that the individuals who demand a good should in the main pay for it." Theoretically, the answer to the dilemma hinges on the ability to distinguish between income, property, and other variables as the ultimate factors leading to differences in the demand for education. If this distinction can be made empirically as well, then, hopefully, a satisfactory solution can be obtained. The "modus operendi" will be to allocate to each independent variable its "fair share" of the total burden. To accomplish this an economic model must be developed and tested.

The task of Chapters III and IV will be to develop and test such a model. If the results indicate that property is the sole, significant source of variation in the demand for education, then we will conclude that property is the relevant base for school taxation. Furthermore, the solution described above will be accepted as the "correct" one. If, on the other hand, income accounts for a statistically significant amount of the variation, it must share the burden. Indeed, this applies to other causal variables as well.

CHAPTER III. THE MODEL

Before building a model it is first necessary to clearly define the problem. Then, with the aid of economic theory, certain a priori restrictions or conditions can be established. Chapters I and II defined the problem, namely the inequities involved in financing public schools. It is the latter necessity to which we will now turn.

The problem to which this study is addressed is the variation in inter-county millage rates for education. The purposes of the paper are to explain this variation and to find an equitable solution. Intimately associated with this problem, indeed it is the same problem differently stated, is the variation in per capita tax burdens to finance public education. The task at hand is to construct a theoretical model that will consistently explain both phenomena.

Let us begin by making the assumption that the dollar cost (price) of a given quality of education does not vary significantly among Iowa counties. This assumption implies that any variation in expenditure per pupil among counties results in actual differences in the quality of education being consumed by the pupils in these counties. At first, such a supposition may seem exceedingly restrictive and unrealistic. In many states, especially those with large metropolitan areas, this would undoubtedly be true. It does not appear, however, that the cost of living, except for housing, varies significantly across Iowa. With respect to the cost of housing, it must be remembered that, in fact, a large part of the variation in its cost is due to variations in expenditures for education as expressed through millage rates. Even in Iowa the dollar cost of a given quality of teacher probably does vary to some extent due to collective bargaining pressure. However, this pressure is most common in urban areas where one would expect some economies of scale to exist. In addition, these urban areas also have lower transportation costs. Considering all factors, making this assumption for Iowa may not be as restrictive as it first seems. The purpose of this assumption, while not obvious at this time, is that it will allow us to put certain a priori homogeneity restrictions on the model to be formulated.

Variation in Per Capita Expenditure

Given the above assumption, variations in per capita dollar expenditures for elementary and secondary education can loosely be construed as the variation in the demand for education. Treating it in this way helps to delineate the variables which an economist would expect to exert a causal effect on these expenditures. In general we would expect:

$$W = f(X_1, X_2, \ldots X_k)$$

where:

W = the dollars raised per capita by the local school millage.

X's = the various factors influencing or determining how much is raised per capita by the school millage.

It is impossible to include every factor (X) which influences expenditures per capita (W). There are undoubtedly an unwieldly number of them. In limiting the number of X's, we must theoretically posit which are the important ones. For this study the general hypothesis will be that:

$$W = f(X_1, X_2, X_3, X_4) \qquad (A)$$ [1]

where:

X_1 = per capita income (see Column 4, Table 2);

X_2 = per capita taxable property (see Column 1, Table 1);

X_3 = the ratio of public school students in grades K through 12 to population (see Column 5, Table 2);

X_4 = the ratio of nonpublic school students in grades K through 12 to population.

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[1] The following system will be used in designating equations: Capital letters will denote general functional forms; numbers will denote specific functional forms. The following format will be used for numbered equations: The first number will indicate chapter number; the number following the decimal point will indicate position within the chapter; e.g., Equation 3.1 is the first specific functional form equation listed in Chapter 3.

The income variable (X_1) certainly belongs in any demand equation. In the specific case of interest here, we can make use of previous information gathered from numerous other studies and postulate that income will exert a positive influence on W. This is testable hypothesis one:

$$\frac{\partial W}{\partial X_1} > 0 \qquad \text{(A-H-1)}$$ [1]

The per capita taxable property variable (X_2) belongs in the equation for two distinct reasons. First, and most obvious, property is the base upon which the school tax is levied; therefore, it must influence expenditures per capita. Second, property is a form of wealth. Theoretically, wealth influences an economic unit's demand for goods and services. The higher the wealth the greater the demand and vice versa. The second testable hypothesis will be:

$$\frac{\partial W}{\partial X_2} > 0 \qquad \text{(A-H-2)}$$

The third variable (X_3) would appear to be an important determinant of expenditures per capita. Ceteris paribus, the higher the student per capita ratio in a county, the higher will be its per capita expenditure on education. Therefore we have:

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[1] This notation is to be read, "Equation A, hypothesis one."

$$\frac{\partial W}{\partial X_3} > 0 \qquad \text{(A-H-3)}$$

The last variable (X_4) would appear to be highly significant if it varies to any extent from county to county. On purely theoretical grounds it should be included as a possible source of variation in expenditures per capita.

$$\frac{\partial W}{\partial X_4} < 0 \qquad \text{(A-H-4)}$$

Now that the relevant variables have been specified, the problem of functional form arises. It will be possible in this case to theoretically determine a specific functional form. Before this is attempted, however, it is necessary to discuss the second source of variation of interest in this study.

Variation in School Millage Rates

Since the variation in school millage rates is an integral part of this investigation, a functional explanation must be developed. This is an easy task now that Equation A has been formulated. All that is involved is elementary mathematical manipulation.

By definition, the school millage rate (r) is simply equal to expenditures per capita on elementary and secondary education (W) divided by per capita taxable property (X_2). Dividing both sides of Equation A by per capita taxable property yields a functional representation of the millage rate in terms of the same independent or explanatory variables contained in Equation A.

$$r = f(X_1, X_2, X_3, X_4) \qquad \text{(B)}$$

where:

$$\frac{\partial r}{\partial X_1} > 0 \qquad \text{(B-H-1)}$$

$$\frac{\partial r}{\partial X_2} < 0 \qquad \text{(B-H-2)}$$

$$\frac{\partial r}{\partial X_3} > 0 \qquad \text{(B-H-3)}$$

$$\frac{\partial r}{\partial X_4} < 0 \qquad \text{(B-H-4)}$$

Notice that three of the four predicted signs are the same as in Equation A. The one sign reversal involves the taxable property variable (X_2). In Equation A we hypothesized that property, because it is a form of wealth, will exert a positive influence on expenditures per capita for education. Now we predict that as taxable property per capita goes up, holding other variables constant, the school millage rate will fall. Taken separately, there is nothing unusual or suspect about either prediction. They are both plausible hypotheses consistent with economic theory. For both to hold simultaneously, however, requires a specific relationship which provides the basis for an additional empirical test.

The elasticity of the school millage rate (r) with respect to changes in per capita taxable property (X_2) must lie somewhere in the range between 0 and -1.

$$-1 < \frac{\%\Delta r}{\%\Delta X_2} < 0 \qquad \text{(C-H-1)}$$

In nontechnical terms the condition is fairly straightforward. As property increases (decreases), the millage rate will fall (increase). The change in the millage rate, however, measured in percentage terms must be less than the percentage change in per capita taxable property. This condition must hold in order for the hypothesized wealth effect to exist.

Of course, this new hypothesis could have been formulated in terms of Equation A. In this event, the restriction would have been on the elasticity of W with respect to X_2. Specifically, it would be:

$$0 < \frac{\%\Delta W}{\%\Delta X_2} < 1 \qquad \text{(C-H-1')}$$

Choosing a Functional Form

We have now identified the problem and specified the relevant variables along with their theoretically correct signs. One degree of indeterminancy remains. Up to this point nothing has been said about how the variables combine or interact in determining school millage rates and expenditures per capita. Theoretically, this is the problem of selecting a specific functional form. In general, this is a very difficult problem and many times the choice is made simply on the grounds of empirical convenience. Fortunately, given the problem and the assumption made in this instance, it is possible to do better.

Following our assumption, the dollar cost of a given quality of education does not vary significantly across Iowa. One can logically proceed to the conclusion that the function explaining the variation in per capita school expenditures must be homogeneous of degree one. Verbally, this implies that if all the independent variables in Equation A increase (decrease) K-fold, per capita expenditures on education will increase (decrease) K-fold. The logic of this conclusion can be seen by expressing the relationship in per student terms where it is obvious that such a change leaves the dollar amount of income and property per student and the ratio of private to public school pupils unchanged. It seems reasonable in such a case that the existing expenditures per pupil would be maintained. Expressing this algebraically we have:

Starting with Equation A:

$$W = f(X_1, X_2, X_3, X_4) \qquad \text{(A)}$$

Dividing through by $X_3 = \frac{S_i}{n_i}$

$$\frac{\$_i}{S_i} = f\left(\frac{X_1}{X_4}, \frac{X_2}{X_3}, 1, \frac{X_4}{X_3}\right) \qquad \text{(A1)}$$

Here it is obvious that if all variables, including X_3, double (for example) there will be no change in the dependent variable. The reason is, of course, that in this formulation the dependent variable is a function of relative magnitudes, which are unaffected by the hypothesized change. The main point is, however, that if $X_1, \ldots, X_4$ increase K-fold, and there is no reason to expect any change in per student expenditures (i.e., Equation A1 is homogeneous of degree zero), the dependent variable in Equation A must change by K-fold (i.e., Equation A is homogeneous of degree one).

Continuing with this same reasoning process, it becomes obvious that Equation B, which expresses the school millage rate in terms of variables X_1 through X_4, must be homogeneous of degree zero. This must hold because in deriving Equation B we simply divide all the terms of Equation A by X_2. This manipulation is completely analogous to the one performed in arriving at Equation A1 which we have seen is homogeneous of degree zero.

If the reader accepts this analysis, the theoretical basis for selecting a specific functional form for Equations A and B has been supplied. Starting with Equation A, which must be homogeneous of degree one, the functional form must be such that dividing through by the taxable property variable (X_2) yields an equation for the school millage rate which is homogeneous of degree zero. It can be shown that a simple linear formulation will not satisfy this condition. Fortunately, a multiplicative model, linear in the logs, satisfies this and all other conditions set down.

Let:

$$W = A\, X_1^{\beta_1}\, X_2^{\beta_2}\, X_3^{\beta_3}\, X_4^{\beta_4} \tag{3.1}$$

where:

$$\beta_1 + \beta_2 + \beta_3 + \beta_4 = 1 \tag{3.1-H-1}$$

$$\frac{\partial W}{\partial X_1} = \beta_1\, A\, X_1^{\beta_1 - 1}\, X_2^{\beta_2}\, X_3^{\beta_3}\, X_4^{\beta_4} > 0 \tag{3.1-H-2}$$

$$\frac{\partial W}{\partial X_2} = \beta_2\, A\, X_1^{\beta_1}\, X_2^{\beta_2 - 1}\, X_3^{\beta_3}\, X_4^{\beta_4} > 0 \tag{3.1-H-3}$$

$$\frac{\partial W}{\partial X_3} = \beta_3\, A\, X_1^{\beta_1}\, X_2^{\beta_2}\, X_3^{\beta_3 - 1}\, X_4^{\beta_4} > 0 \tag{3.1-H-4}$$

$$\frac{\partial W}{\partial X_4} = \beta_4\, A\, X_1^{\beta_1}\, X_2^{\beta_2}\, X_3^{\beta_3}\, X_4^{\beta_4 - 1} < 0 \tag{3.1-H-5}$$

Since all the X's are positive, these hypotheses simply imply that A and β_1, β_2, and β_3 must be positive, while β_4 must be negative.

Dividing both sides of Equation 3.1 by X_2 we get:

$$r = A\, X_1^{Z_1}\, X_2^{Z_2}\, X_3^{Z_3}\, X_4^{Z_4} \qquad (3.2)$$

where:

$$Z_1 + Z_2 + Z_3 + Z_4 = 0 \qquad (3.2\text{-H-1})$$

$$Z_1 = \beta_1 \qquad Z_2 = \beta_2 - 1$$

$$Z_3 = \beta_3 \qquad Z_4 = \beta_4 \qquad (3.2\text{-H-2})$$

$$\frac{\partial r}{\partial X_1} = Z_1\, A\, X_1^{Z_1-1}\, X_2^{Z_2}\, X_3^{Z_3}\, X_4^{Z_4} > 0 \qquad (3.2\text{-H-3})$$

$$\frac{\partial r}{\partial X_2} = Z_2\, A\, X_1^{Z_1}\, X_2^{Z_2-1}\, X_3^{Z_3}\, X_4^{Z_4} < 0 \qquad (3.2\text{-H-4})$$

$$\frac{\partial r}{\partial X_3} = Z_3\, A\, X_1^{Z_1}\, X_2^{Z_2}\, X_3^{Z_3-1}\, X_4^{Z_4} > 0 \qquad (3.2\text{-H-5})$$

$$\frac{\partial r}{\partial X_4} = Z_4\, A\, X_1^{Z_1}\, X_2^{Z_2}\, X_3^{Z_3}\, X_4^{Z_4-1} < 0 \qquad (3.2\text{-H-6})$$

Again, since all the X's are positive, the hypotheses imply that A, Z_1, and Z_3 are positive, while Z_4 is negative. Notice that here Z_2 (β_2-1) must be negative as well.

Next, consider the a priori elasticity restriction. For a continuous function such as $r = f(X_1, X_2, X_3, X_4)$, we can write the formula for the point elasticity of r with respect to X as:

$$E_{rX} = \frac{\frac{\partial r}{\partial X}}{\frac{r}{X}} = \frac{\text{marginal function}}{\text{average function}}$$

Specifically, the elasticity of r with respect to X_2 will be:

$$\frac{\frac{\partial r}{\partial X_2}}{\frac{r}{X_2}} = \frac{Z_2\ A\ X_1^{Z_1}\ X_2^{Z_2-1}\ X_3^{Z_3}\ X_4^{Z_4}}{A\ X_1^{Z_1}\ X_2^{Z_2-1}\ X_3^{Z_3}\ X_4^{Z_4}} = Z_2 \qquad (3.3)$$

Thus, the testable hypothesis is:

$$-1 < Z_2 < 0 \qquad (3.3\text{-H-1})$$

It should be noted that, although hypothesis 3.3-H-1 appears to be intuitively obvious, given the previous analysis, such is not in general the case. The fact that the elasticity hypothesis simplifies to an obvious restriction on the exponent for per capita taxable property is a curiousity peculiar to the specific functional form adopted here.

The Tax Implications of the Model

Now that equations have been developed and specified to explain the variation in the expenditure for public schools, the problem becomes one of determining how much of the burden should be applied to each causal variable. First, some mathematical manipulation is required. Starting with Equation 3.1, factor X_3 out of the righthand side:

$$W = X_3^1 \; A \; X_1^{\beta_1} \; X_2^{\beta_2} \; X_3^{\beta_3 - 1} \; X_4^{\beta_4} \tag{3.4}$$

Equation 3.4 can be rewritten as:

$$W = X_3 \; A \; X_1^{\beta_1} \; X_2^{\beta_2} \; \frac{1}{X_3^{1-\beta_3}} \; X_4^{\beta_4} \tag{3.5}$$

Since $\beta_1 + \beta_2 + \beta_4 = 1 - \beta_3$, Equation 3.5 can be transformed to:

$$W = X_3 \; A \left(\frac{X_1}{X_3}\right)^{\beta_1} \left(\frac{X_2}{X_3}\right)^{\beta_2} \left(\frac{X_4}{X_3}\right)^{\beta_4} \tag{3.6}$$

By assumption, the education of public school students is to be treated as a pure public good. This is mathematically equivalent to treating X_3 not as a variable, but rather as a parameter set equal to the state-wide average student per capita ratio .2288. This gives rise to:

$$\frac{W}{.2288} = A \left(\frac{X_1}{.2288}\right)^{\beta_1} \left(\frac{X_2}{.2288}\right)^{\beta_2} \left(\frac{X_4}{.2288}\right)^{\beta_4} \tag{3.7}$$

One rather straightforward approach to distributing the burden would be to allocate it in proportion to the percent of the total demand accounted for by each variable. These percentages are represented by the β's in our model. If the function is linearly homogeneous, the percentages will add up to one and the burden will be allocated. A proof of this would involve Euler's Theorem which states that for a linearly homogeneous function:

$$\sum_{i=1}^{n} X_i \frac{\partial W}{\partial X_i} = W \qquad (3.8)$$

For the problem at hand this would mean that, if the W-function were evaluated at a specific point, the partial derivatives could be interpreted as the "fair share" tax rates on each base (i.e., each factor would be taxed the value of its marginal demand). There may be disagreement as to whether this method is an equitable way to divide the burden among the factors; however, from an economic and mathematical standpoint, it is both objective and consistent. Furthermore, the constant or proportional tax rates on each base obtained in this fashion will, if applied consistently, distribute the burden on each base in accordance with the horizontal and vertical equity criteria of Chapter I. That is, a proportional tax applied uniformly throughout the counties will ensure equal treatment of equals, satisfying the horizontal equity criterion. In addition, the uniform application of proportional rates will distribute the burden on each base in accordance with the vertical equity criterion since those who own or control more (less) of a base will be taxed more (less) in absolute terms.

After arriving at Equation 3.7, we are left with only 3 variables (X_1, X_2, and X_4) upon which to distribute the burden of education. In addition, the revised W-function is no longer homogeneous of degree one. This means that the sum of the first partial derivatives multiplied by their corresponding independent variables will not equal W. This is not surprising. We first hypothesized that variable X_3 is a significant factor in explaining variations in expenditures for education. In deriving Equation 3.7, we assumed (made the value judgment) that the education of public school students is a pure public good and that, therefore, variations in X_3 should not influence per student expenditures or interpersonal tax rates. Implicitly, then, we are assuming that the other variables (X_1, X_2, and X_4) must bear the full burden.

After deriving Equation 3.7 we have:

$$(\beta_1+\beta_2+\beta_4)\frac{W}{.2288} = \frac{\partial\left(\frac{W}{.2288}\right)}{\partial\left(\frac{X_1}{.2288}\right)}\left(\frac{X_1}{.2288}\right) + \frac{\partial\left(\frac{W}{.2288}\right)}{\partial\left(\frac{X_2}{.2288}\right)}\left(\frac{X_2}{.2288}\right) + \frac{\partial\left(\frac{W}{.2288}\right)}{\partial\left(\frac{X_4}{.2288}\right)}\left(\frac{X_4}{.2288}\right) \quad (3.9)$$

Consequently, the first order partials cannot be interpreted as tax rates because they will not be consistent (i.e., they will not yield the proper number of dollars per student). The partial derivatives must be "scaled up" by dividing through by $(\beta_1 + \beta_2 + \beta_4)$.

$$\frac{W}{.2288} = \frac{\dfrac{\partial\left(\frac{W}{.2288}\right)}{\partial\left(\frac{X_1}{.2288}\right)}}{(\beta_1+\beta_2+\beta_4)}\left(\frac{X_1}{.2288}\right) + \frac{\dfrac{\partial\left(\frac{W}{.2288}\right)}{\partial\left(\frac{X_2}{.2288}\right)}}{(\beta_1+\beta_2+\beta_4)}\left(\frac{X_2}{.2288}\right) + \frac{\dfrac{\partial\left(\frac{W}{.2288}\right)}{\partial\left(\frac{X_4}{.2288}\right)}}{(\beta_1+\beta_2+\beta_4)}\left(\frac{X_4}{.2288}\right) \qquad (3.10)$$

These revised partials can then be interpreted as tax rates. Each will in fact be equal to what we have previously called the "fair share" tax rate plus that variable's "fair share" of the burden belonging to X_3.

If the reader has accepted the analysis up to now, we are left with only one additional problem; namely, at what point is Equation 3.10 to be evaluated? Actually we have no choice in this matter. If we assume that each student should receive an equal dollar expenditure for education, we are implying that each student should have an equal amount of X_1, X_2 and X_4

at his disposal. Thus, Equation 3.10 must be evaluated with the variables set equal to their respective state-wide averages. All that remains then is to estimate the β's so that the partial derivatives can be calculated.

Before concluding this chapter, it should be emphasized that the solution discussed in this last section is contingent upon the "goodness" of the model we have specified. In fact, one can never be sure he has the right model. In practice, we must use economic theory as much as possible in establishing testable a priori hypotheses, and then, by the use of statistics, determine how well the model actually fits the data. If the signs and coefficients statistically bear out the a priori hypotheses, we can, with varying degrees of confidence, accept our model as a "good" one. This is the topic of Chapter IV.

CHAPTER IV. EMPIRICAL RESULTS

Within this chapter the model developed in Chapter III is tested statistically. Since no complicated statistical problems were foreseen, a straightforward multiple regression approach was tried. Ex post analysis indicated that the estimated coefficients were relatively stable and the residuals well-behaved. Consequently, the results of this approach were eminently satisfactory from the author's viewpoint and they are the ones reported and used in this chapter. From other view-points, however, this may not be the best approach. If, for example, we are not concerned with theoretical consistency and/or the true structural relationship, but rather prediction, then the researcher may de-emphasize other criteria in searching for the model with the highest R^2. In many cases, the different criteria will lead to the selection of different models. This is, in fact, the case here. If prediction was the goal, a different model would have been selected, since a simple linear function yields a higher R^2 for Equation 3.1.[1]

Before estimating the equations, they must be transformed from exact to stochastic relationships. For the model under

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[1]A proof of this statement involves a transformation of the dependent variable, W, by dividing it by its geometric mean so as to make the residual sum of squares comparable for the two regressions. For an excellent discussion of this technique, see Rao and Miller (3), pp. 107-11.

consideration this involves adding[1] a fourth term to the right hand side of each equation:

$$W = A\, X_1^{\beta_1}\, X_2^{\beta_2}\, X_3^{\beta_3}\, X_4^{\beta_4}\, e^u \qquad (4.1)$$

$$r = A\, X_1^{Z_1}\, X_2^{Z_2}\, X_3^{Z_3}\, X_4^{Z_4}\, e^v \qquad (4.2)$$

where e^u and e^v are multiplicative error terms. We then assume that u and v are random variables with expected values of zero.

Next, the functions must be linearized in order to make them conformable to the ordinary least squares regression technique. This simply involves the taking of logarithms.

$$\ln W = \ln A + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + u \qquad (4.3)$$

$$\ln r = \ln A + Z_1 \ln X_1 + Z_2 \ln X_2 + Z_3 \ln X_3 + Z_4 \ln X_4 + v \qquad (4.4)$$

The regression results for these equations are[2]:

$$\ln W = \underset{(-.359)}{-.28440} + \underset{(3.875)}{.30268X_1} + \underset{(10.599)}{.36731X_2} + \underset{(5.149)}{.4687X_3} + \underset{(.892)}{.0053X_4}$$

$$R^2 = .7059 \qquad (4.5)$$

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[1]Adding here refers to the inclusion of another term. The reader will note that in order to estimate this model by ordinary least squares, we must assume a multiplicative error term.

[2]The figures in parentheses are the simple one-sided t-tests where $H_0 : B = 0$.

$$\ln r = -.28389 + .30264X_1 - .63269X_2 + .46850X_3 + .00532X_4$$
$$(-.358) \quad (3.970) \quad (-17.719) \quad (5.207) \quad (.893)$$

$$R^2 = .7861 \qquad (4.6)$$

In both equations the coefficients on X_1, X_2, and X_3 are correct in sign and significant at the one percent level. The intercept term and the coefficient on X_4 are insignificant in both equations. The interpretation of this insignificance for X_4 is straightforward. The percent of students attending private schools does not vary enough from county to county to be of statistical importance in Iowa. This does not mean that X_4, in general, is not an important variable theoretically or empirically. It simply means that in this specific case it is not a significant cause of the variation in either r or W. In addition, because the coefficient is insignificant and its deletion does not affect the other coefficients or decrease $\bar{R}^2$ appreciably, we can assume that the wrong sign is due to the sampling distribution of the estimates[1].

The interpretation of the intercept is a bit more subtle. Remember that the equation is in logarithmic form. The estimated value for ln A is insignificantly different from zero. Therefore, when anti-logs are taken to get back to the

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[1]In the equation for r, the deletion of X_4 lowers $\bar{R}^2$ from .7770 to .7765; however, in the equation for W, its deletion raises $\bar{R}^2$ from .6934 to .6942.

original functional form, we have for the constant term:

$$\ln A = 0$$

$$A = e^{\circ}$$

$$A = 1$$

This not only satisfies the a priori hypothesis that A be positive, but also seems to be a reasonable or logical value for A to have.

Eliminating the insignificant variable, and taking the anti-logs of Equations 4.5 and 4.6, we arrive back at our original functional forms.

$$W = X_1^{.30268} X_2^{.36731} X_3^{.46847} \tag{4.7}$$

$$r = X_1^{.30264} X_2^{-.63269} X_3^{.46850} \tag{4.8}$$

Up until now, simple observation of the B's, Z's and their respective t-values has been enough to accept Hypotheses 1-H-2 through 1-H-5 and 2-H-2 through 2-H-6. This applies as well to 3-H-1, the elasticity hypothesis. The homogeneity hypotheses, 1-H-1 and 2-H-1, however, involve a somewhat more complex test. For a discussion of this d-statistic and its concomitant t-test, see Rao and Miller (3).

For Equation 4.7 let:

$$d_1 = \beta_1 + \beta_2 + \beta_3 = 1.13846$$

$$H_n : d_1 = 1$$

$$H_a : H_n \text{ is false}$$

The estimate of the variance of d_1 is:

$$\hat{V}(d_1) = \hat{V}(\hat{\beta}_1) + \hat{V}(\hat{\beta}_2) + \hat{V}(\hat{\beta}_3) + 2\hat{Cov}(\hat{\beta}_1,\hat{\beta}_2) + 2\hat{Cov}(\hat{\beta}_1,\hat{\beta}_3) + 2\hat{Cov}(\hat{\beta}_2,\hat{\beta}_3)$$

$$\hat{V}(d_1) = .87614 + .17247 + .11885 + 2(.02417) + 2(-.10354) + 2(-.18981)$$

$$\hat{V}(d_1) = .62910$$

$$\sqrt{\hat{V}(d_1)} = .76596$$

The t-statistic computed from d is:

$$t = \frac{d_1 - 1}{\sqrt{\hat{V}(d_1)}} \qquad \text{with T-K-1 degrees of freedom}$$

$$t = \frac{.13846}{.76596} = .1807$$

This is obviously insignificant; therefore, we cannot reject the null hypothesis[1].

---

[1]For this and the following 2-sided t-test, the one percent level was used so as to conform with the level of significance obtained in the parameter estimates.

For Equation 4.8, let:

$$d_2 = Z_1 + Z_2 + Z_3 = .13845$$

$$H_n : d_2 = 0$$

$$H_a : H_n \text{ is false}$$

Here the estimate of the variance of d_2 is:

$$\hat{V}(d_2) = .00610 + .00120 + .00827 + 2(.0016) + 2(-.0072) + 2(-.00132)$$

$$\hat{V}(d_2) = .01181$$

$$\sqrt{\hat{V}(d_2)} = .06387$$

$$t = \frac{d_2 - 0}{\sqrt{\hat{V}(d_2)}} \quad \text{with T-K-1 degrees of freedom}$$

$$t = \frac{.13845}{.06387} = 2.167$$

This calculated t with 94 degrees of freedom is also insignificant at the one percent level. Here too we must accept the null hypothesis and conclude that the function for r is homogeneous of degree zero.

Empirical Solution

Now that we have an empirical estimate of the model, the next step is to solve for the equilibrium tax rates. This will be somewhat easier than the theoretical solution of

Chapter III indicated, since the X_4 variable has been statistically deleted, leaving us with a three variable model. Now when X_3 is made a parameter set equal to the state-wide average, the model is reduced to two independent variables--property and income. Thus, the empirical version of Equation 3.7 is:

$$\frac{W}{.2288} = \left(\frac{X_1}{.2288}\right)^{.30268} \left(\frac{X_2}{.2288}\right)^{.36731} \tag{4.9}$$

and, consequently, the empirical version of Equation 3.9 is:

$$(.30268 + .36731)\ \frac{W}{.2288} = \left[.30268\left(\frac{X_1}{.2288}\right)^{-.69732}\left(\frac{X_2}{.2288}\right)^{.36731}\right]\frac{X_1}{.2288} + \left[.36731\left(\frac{X_1}{.2288}\right)^{.30268}\left(\frac{X_2}{.2288}\right)^{-.63269}\right]\frac{X_2}{.2288} \tag{4.10}$$

The terms in brackets are the first order partials of $\frac{W}{.2288}$ with respect to $\frac{X_1}{.2288}$ and $\frac{X_2}{.2288}$ respectively. These terms can be rewritten in the following fashion:

$$.30268\left(\frac{X_1}{.2288}\right)^{-.69732}\left(\frac{X_2}{.2288}\right)^{.36731} = .30268\left(\frac{\frac{W}{.2288}}{\frac{X_1}{.2288}}\right) \tag{4.11}$$

$$.36731\left(\frac{X_1}{.2288}\right)^{.30268}\left(\frac{X_2}{.2288}\right)^{-.63269} = .36731\left(\frac{\frac{W}{.2288}}{\frac{X_2}{.2288}}\right) \quad (4.12)$$

Setting all variables equal to their respective statewide averages $\left(\frac{W}{.2288} = \$704;\ \frac{X_1}{.2288} = \$12,648;\text{ and } \frac{X_2}{.2288} = \$53,653\right)$, we can evaluate Equations 4.11 and 4.12 to obtain the "fair share" (value of the marginal demand) tax rates. These are:

P_y^* = value of the marginal demand tax rate on income = .01685 (4.13)

r^* = value of the marginal demand tax rate on property = .00482 (4.14)

Now, if our technique is reasonable, dividing P_y^* and r^* by $B_1 + B_2$ (which is equal to .66999) should "scale up" the income and property tax rates so that they jointly share the burden belonging to X_3 and yield a consistent solution.

$$P_y = \frac{P_y^*}{.6699} = 0.2515 \quad (4.15)$$

$$r = \frac{r^*}{.6699} = .00719 \quad (4.16)$$

It is easily verified that these rates are indeed consistent. That is to say, if they are interpreted and applied as proportional tax rates on their respective bases, they will together yield the requisite $704 per public school student. In addition, as previously mentioned, proportional rates, if evenly applied, will distribute the burden on each base in accordance with the horizontal and vertical equity criteria of Chapter I.

Table 3 contains the inter-county impact and redistribution effects of the new tax package. The columns are as follows:

Column 1: $\frac{Y_{ti}}{n_i}$ = per capita income tax burden in county i with the calculated income tax rate of .02515.

Column 2: $\frac{Pt_i}{n_i}$ = the property tax burden in county i with the new state-wide millage rate of .00712 levied on market value.

Column 3: $\frac{T_i}{n_i}$ = the total per capita tax burden in county i under the new tax scheme. This is simply the sum of Columns 1 and 2.

Column 4: $\frac{T_i}{s_i}$ = the total dollars raised per public school student in county i under the new tax scheme.

Column 5: $\frac{\Delta T_i}{n_i}$ = the change in the per capita educational tax burden in county i resulting from the new tax

Table 3. The impact and redistribution effects of the new tax package

County	$\frac{Y_{ti}}{n_i}$	$\frac{Pt_i}{n_i}$	$\frac{T_i}{n_i}$	$\frac{T_i}{s_i}$	$\frac{\Delta T_i}{n_i}$	$\frac{R_i}{n_i}$
Adair	73	127	200	773	- 5	-18
Adams	61	123	183	710	-23	- 2
Allamakee	58	91	149	589	5	29
Appanoose	61	65	126	616	4	18
Audubon	60	135	195	725	-10	- 6
Benton	72	123	195	747	2	-11
Black Hawk	76	56	132	578	- 3	29
Boone	71	103	174	834	7	-27
Bremer	74	83	157	674	11	7
Buchanan	63	85	148	601	-13	25
Buena Vista	76	115	191	833	37	-30
Butler	64	114	178	678	1	7
Calhoun	68	151	219	919	15	-51
Carroll	60	101	161	1,013	46	-49
Cass	69	106	175	723	34	- 5
Cedar	74	115	189	731	-12	- 7
Cerro Gordo	75	88	163	700	- 5	1
Cherokee	70	121	191	750	28	-12
Chickasaw	57	95	152	553	- 3	42
Clarke	68	104	172	835	19	-27
Clay	77	121	198	779	20	-19
Clayton	57	81	138	545	-27	40
Clinton	74	95	169	717	4	- 3
Crawford	62	110	172	717	- 7	- 3
Dallas	74	107	181	719	11	- 4
Davis	63	100	163	660	0	11
Decatur	50	83	133	665	15	8
Delaware	59	94	153	608	-19	24
Des Moines	78	69	147	657	- 6	11
Dickinson	70	140	210	867	44	-40
Dubuque	68	62	130	889	6	-27
Emmett	64	99	163	663	3	10
Fayette	61	88	149	601	-19	26
Floyd	67	96	163	685	- 8	5
Franklin	67	179	246	971	45	-68
Fremont	67	143	210	886	- 9	-43
Greene	78	152	230	956	13	-61
Grundy	75	159	234	946	23	-60
Guthrie	62	111	173	787	13	-18
Hamilton	71	140	211	835	- 5	-33
Hancock	66	162	228	876	22	-45
Hardin	74	118	192	822	37	-28

Table 3 (Continued)

County	$\frac{Yt_i}{n_i}$	$\frac{Pt_i}{n_i}$	$\frac{T_i}{n_i}$	$\frac{T_i}{s_i}$	$\frac{\Delta T_i}{n_i}$	$\frac{R_i}{n_i}$
Harrison	63	106	169	692	- 6	3
Henry	72	82	154	672	16	7
Howard	67	95	162	683	- 6	5
Humboldt	66	152	218	836	- 1	-34
Ida	83	142	225	878	5	-45
Iowa	62	116	178	741	- 7	- 9
Jackson	65	80	145	624	- 3	19
Jasper	76	93	169	690	0	3
Jefferson	70	82	152	686	3	4
Johnson	76	67	143	788	-22	-15
Jones	63	98	161	702	-12	.5
Keokuk	62	106	168	728	2	- 6
Kossuth	62	139	201	936	- 1	-50
Lee	72	76	148	696	8	2
Linn	81	69	150	649	-24	13
Louisa	67	112	179	702	- 8	.5
Lucas	65	84	149	622	- 1	20
Lyon	62	130	192	729	24	- 7
Madison	67	126	193	800	4	-23
Mahaska	64	81	145	703	-19	0
Marion	67	77	144	711	21	- 1
Marshall	78	86	164	735	-17	- 7
Mills	79	165	244	1,067	51	-83
Mitchell	62	98	160	649	3	14
Monona	65	125	190	791	5	-21
Monroe	59	83	142	653	18	11
Montgomery	75	107	182	810	20	-24
Muscatine	75	82	157	640	11	16
O'Brien	62	119	181	775	27	-17
Osceola	65	144	209	826	- 5	-31
Page	68	88	156	737	6	- 7
Palo Alto	66	118	184	721	- 8	- 4
Plymouth	60	114	174	797	13	-20
Pocahontas	65	157	223	942	21	-56
Polk	87	68	155	683	- 4	5
Pottawattamie	71	63	134	531	- 9	44
Poweshiek	79	104	183	773	13	-16
Ringgold	64	116	180	768	-21	-15
Sac	72	136	208	813	24	-28
Scott	83	72	155	636	-24	17
Shelby	62	120	182	753	1	-12
Sioux	56	110	166	884	17	-34
Story	77	66	143	755	6	-10
Tama	65	107	172	684	-12	5

Table 3 (Continued)

County	$\frac{Yt_i}{n_i}$	$\frac{Pt_i}{n_i}$	$\frac{T_i}{n_i}$	$\frac{T_i}{s_i}$	$\frac{\Delta T_i}{n_i}$	$\frac{R_i}{n_i}$
Taylor	57	98	155	696	3	2
Union	61	84	145	627	5	18
Van Buren	54	85	139	620	1	19
Wapello	69	48	117	504	-10	47
Warren	71	75	146	533	-14	47
Washington	73	111	184	732	- 1	- 7
Wayne	59	102	161	743	14	- 9
Webster	72	90	162	721	21	- 4
Winnebago	71	110	181	798	35	-21
Winneshiek	64	74	138	676	2	6
Woodbury	72	67	139	631	7	16
Worth	73	140	213	918	16	-50
Wright	92	143	235	972	24	-65

system.[1] This is simply the difference between Column 1, Table 2 and Column 3, Table 3.

Column 6: $\frac{R_i}{n_i}$ = the per capita income redistribution among counties which results from the new tax package. If Column 6 is negative, this means that county i must pay X dollars to the state which will then be redistributed to the "needy" counties. If, on the other hand, Column 6 is positive, then that county is a recipient of revenue from the state.

[1] This analysis assumes, of course, that the amount of revenue presently raised by the state for education remains constant.

Obviously, the sign of Column 6 is dependent upon the dollar amount of Column 4. If the new combined income and property tax raises more than $704 per public school student, Column 6 will be negative. However, if the new combination raises less than $704 per student, Column 6 will be positive.

It may be of interest to compare and contrast the tax package developed here with two alternative proposals. These schemes are: first, an all income tax system and, second, as referred to in Chapter II, the equalized property tax method. The impact and differential effects are contained in Table 4[1].

Column 1: $\frac{(Yt)_i^*}{n_i}$; this is the per capita burden that would result if the school property tax was eliminated and the requisite dollar amount raised solely by a personal income tax (i.e., it would take a proportional income tax rate of 5.56 percent to raise $704 per student).

Column 2: $\frac{(Yt)_i^*}{n_i} - \frac{f(Py,r)}{n_i}$; this is the resulting differential between the all-income tax scheme and the proposal developed here.

Column 3: $\frac{(Pt)_i^*}{n_i}$; this is the per capita burden that would result if the school tax levy was standardized at the

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[1]Also of interest is the impact and differential effects of these tax schemes with respect to different socio-economic areas of the state. This is discussed in the Appendix.

Table 4. The impact of alternative programs

County	$\frac{(Yt)_i^*}{n_i}$	$\frac{(Yt)_i^*}{n_i} - \frac{f(Py,r)}{n_i}$	$\frac{(Pt)_i^*}{n_i}$	$\frac{(Pt)_i^*}{n_i} - \frac{f(Py,r)}{n_i}$
Adair	162	-38	231	38
Adams	134	-49	224	46
Allamakee	129	-20	165	16
Appanoose	134	69	118	- 7
Audubon	132	-63	246	51
Benton	160	-36	225	29
Black Hawk	168	36	102	-30
Boone	156	-17	187	14
Bremer	163	6	151	-56
Buchanan	138	- 9	155	75
Buena Vista	167	-23	209	18
Butler	142	-36	208	29
Calhoun	151	-68	274	56
Carroll	134	-28	184	23
Cass	152	-23	193	18
Cedar	163	-26	210	21
Cerro Gordo	165	3	160	- 3
Cherokee	154	-37	221	30
Chickasaw	127	-26	173	21
Clarke	150	-22	190	18
Clay	171	-28	220	22
Clayton	126	-12	147	9
Clinton	165	- 5	173	35
Crawford	137	-35	201	29
Dallas	164	-17	195	14
Davis	139	-24	182	19
Decatur	110	-23	151	18
Delaware	130	-22	170	18
Des Moines	173	3	126	-21
Dickinson	155	-55	254	45
Dubuque	150	21	112	-17
Emmett	142	-21	181	17
Fayette	136	-14	160	11
Floyd	149	-15	176	12
Franklin	148	-98	326	80
Fremont	149	-62	261	50
Greene	172	-58	278	47
Grundy	166	-68	289	55
Guthrie	136	-37	203	30
Hamilton	158	-53	255	43
Hancock	145	-82	294	67
Hardin	164	-29	216	23
Harrison	140	-30	194	24

Table 4 (Continued)

County	$\frac{(Yt)_i^*}{n_i}$	$\frac{(Yt)_i^*}{n_i} - \frac{f(Py,r)}{n_i}$	$\frac{(Pt)_i^*}{n_i}$	$\frac{(Pt)_i^*}{n_i} - \frac{f(Py,r)}{n_i}$
Henry	160	6	149	- 5
Howard	148	-14	173	11
Humboldt	146	-72	277	59
Ida	184	-41	258	33
Iowa	138	-40	211	33
Jackson	144	- 1	146	1
Jasper	168	-95	169	0
Jefferson	155	4	149	- 3
Johnson	167	25	122	-21
Jones	138	-22	179	18
Keokuk	137	-32	194	26
Kossuth	137	-64	253	52
Lee	158	10	139	- 9
Linn	178	29	125	-24
Louisa	148	-30	203	25
Lucas	144	- 5	152	3
Lyon	137	-54	236	44
Madison	147	-45	230	37
Mahaska	141	- 4	148	3
Marion	149	5	140	- 4
Marshall	172	8	157	- 7
Mills	174	-70	301	57
Mitchell	138	-23	179	19
Monona	145	-46	228	37
Monroe	130	-12	152	9
Montgomery	166	-16	195	13
Muscatine	167	10	149	- 8
O'Brien	136	-45	217	36
Osceola	144	-65	263	53
Page	150	- 6	161	5
Palo Alto	147	-37	214	30
Plymouth	133	-41	208	34
Pocahontas	144	-79	287	65
Polk	192	36	125	-30
Pottawattamie	158	24	114	-20
Poweshiek	176	- 8	189	6
Ringgold	142	-38	212	31
Sac	160	-48	248	39
Scott	183	28	131	-24
Shelby	138	-44	218	36
Sioux	124	-42	200	34
Story	171	28	120	-23
Tama	144	-28	195	23

Table 4 (Continued)

County	$\frac{(Yt)_i^*}{n_i}$	$\frac{(Yt)_i^*}{n_i} - \frac{f(Py,r)}{n_i}$	$\frac{(Pt)_i^*}{n_i}$	$\frac{(Pt)_i^*}{n_i} - \frac{f(Py,r)}{n_i}$
Taylor	127	-28	178	23
Union	135	-10	153	8
Van Buren	120	-20	155	16
Wapello	153	36	88	-30
Warren	158	11	137	-10
Washington	161	-23	203	19
Wayne	131	-30	186	24
Webster	160	- 2	163	1
Winnebago	158	-24	201	19
Winneshiek	141	3	135	- 3
Woodbury	160	21	122	-18
Worth	163	-51	255	42
Wright	204	-32	261	26

.0131 state-wide average rate.

Column 4: $\frac{(Pt)_i^*}{n_i} - \frac{f(Py,r)}{n_i}$; this is the differential impact between the uniform imposition of the state-wide average millage rate and the proposal developed here.

The Equity Implications Compared and Contrasted

It was demonstrated in Chapter II that, with income as the base, the equalized property tax version results in a "perverse" redistribution of 43 million dollars in tax burden. Those results are repeated here for comparisons sake. The statistics were:

All property tax method with income as the base:

	Recipients	Payers
Number	1,567,607	1,256,769
Per capita income	$3,028	$2,725
Per capita subsidy-tax	$27.43	$34.22
Subsidy-tax as a percent of per capita income	.009	.0125

(Based on 1970 data)

The next comparison involves the all income tax method, evaluated with property as the base. In toto, this amounts to approximately 31 million dollars in tax burden being redistributed. Again, the switching of bases results in a perceived inequitable transfer.

All income tax method with property as the base:

	Recipients	Payers
Number	1,199,406	1,624,970
Per capita property	$15,974	$9,547
Per capita subsidy-tax	$25.92	$19.13
Subsidy-tax as a percent of per capita property	.0016	.002

(Based on 1970 data)

Finally, the same test can be applied to the tax package developed in this study. With this method, a total redistribution of approximately 17.3 million dollars in burden takes place. Since this is a two dimensional tax scheme, the total transfer of burden must be examined with respect to both bases.

Two-tax system with property as the base:

	Recipients	Payers
Number	1,511,192	1,313,184
Per capita property	$11,733	$14,052
Per capita subsidy-tax	$11.43	$13.16
Subsidy-tax as a percent of per capita property	.0010	.0009

(Based on 1970 data)

Here, with property as the base, it appears that the transfer of burden is in the right direction. Indeed, the 17.3 million dollars is flowing from the "wealthy" to the "poor".

Two-tax system with income as the base:

	Recipients	Payers
Number	1,511,192	1,313,184
Per capita income	$2,999	$2,772
Per capita subsidy-tax	$11.43	$13.16
Subsidy-tax as a percent of per capita income	.0038	.0047

(Based on 1970 data)

Disconcerting as it may seem, the two-tax system evaluated with income as the base results in a "wrong-way" transfer of burden. On second thought, however, this should be expected. Given that property is still taxed and still carries the lion's share (55%) of the total levy, one would expect that the two-tax system evaluated with income as the base would have the same qualitative equity consequences as the all property tax method.

In Chapter II it was asserted that no unidimensional tax evaluated with respect to several different bases will have the same perceived equity results unless the several bases are highly correlated. We can now add to this statement. No multi-tax system will have the same perceived equity consequences when the total resulting burden is evaluated with respect to each specific base, unless the bases are highly correlated.

Thus, absolute equity, that is equity invariant with respect to base, is in general not possible. But this should not be surprising. What is equitable, after all, is a value judgment. Does this imply that the analytical efforts contained here have been futile? It does not, if the fundamental assumption of Chapter II is accepted.

The purpose of this paper has been to supply an alternative method for determining what is equitable. The method developed here does not assume that this or that base is the correct one for taxation. Nor does it assume that this or that base is the correct one for measuring equity. Rather, we started with a more fundamental value judgment that escapes the base-switching equity dilemma. This premise was: "Leaving welfare considerations aside, it seems a reasonable assumption, even in the domain of public or quasi-public goods, that the individuals who demand a good should in the main pay for it." Given this statement, the problem was to isolate the variables giving rise to the demand for education. Once these variables were isolated, each could be allocated its "fair or equitable share" of the total burden. The imposition of consistently applied tax rates on each base will then equitably distribute the burden allotted to each base. With this system, base-switching, with respect to the total burden, becomes a non-sequiter.

CHAPTER V. CONCLUDING REMARKS

This study has developed a method for determining how to distribute equitably the tax burden resulting from expenditures for public elementary and secondary education. At this time one observation concerning the theoretical model comes to mind. With respect to the empirical results, however, several comments should be made.

The observation with respect to the theoretical model is one of interpretation. The β's and Z's were interpreted as elasticities throughout the paper. Strictly speaking these are not elasticities in the true sense of the term. The model was developed and tested with respect to cross-sectional data. The true concept of elasticity, however, is best tested by a time-series study on a homogeneous group of people.

The following reflections on the empirical results are in order:

First, because of data restrictions, the model was tested with county-wide data. Since the problem involved public education, data on the local school districts themselves would have been more satisfactory. If this data should become available and the model rerun, different and more precise estimates for the parameters will almost certainly be the result.

Second, the income tax rates used in the calculations contained here exclude corporate income from the tax base.

This was done because, on theoretical grounds, corporate income does not belong in the demand equation for education. Politically, however, it may be impossible to make such an exclusion. Consequently, the income tax rate of .02515 solved for in this study may be higher than actually needed if this system was to be adopted.

Third, the proportional income tax rate advanced in this study may need some defense. It may seem unfair to impose a flat rate income tax with no exemptions. However, one must keep in mind that the present alternative is the property tax. Foeller showed in 1972 (1) that the incidence of the property tax in Iowa is highly regressive. In fact, then, the substitution of a flat rate income tax would be a move away from regressivity.

Fourth, the results obtained here indicate that the number of students attending nonpublic schools was statistically insignificant. Therefore, this variable was deleted before the model was empirically solved. This is fine for abstract analysis. When it comes to real world decisions, however, it may be hard to justify the increase in levies in some counties (e.g., Carroll and Plymouth) that have a relatively high percentage of their students enrolled in private schools. In fact, it could be argued that all education at the elementary and secondary level (including students enrolled in private schools) is a public good. Such an assumption would lead to significant changes with respect to the transfer of burden among counties.

In summary, the revenue and equity problems involved in financing public education are pervasive. Furthermore, they are not going to disappear if we simply ignore them. Rather, if the demand for quality education continues to increase as it has in the last twenty years and nothing is done, these problems are likely to become more pestiferous.

This study has centered on the specific problem of taxpayer equity, given that each public school student is entitled to an equal dollar amount of education. The major result was the finding that income has such an important influence on the demand for education. This result, coupled with the almost nonexistent correlation between income and the property tax base used to finance the major share of public education in Iowa, takes us a long way toward understanding this taxpayer equity problem. If a conclusion is to be drawn, it is that a "higher correlation" between the individuals demanding and the individuals financing education is needed.

Simple solutions, such as an equalized property tax rate across the state, may appear to be equitable. But if, as this study shows, a major reason for high millage rates in some areas is high income and not just low per capita property values, this simple solution may not be as equitable as it appears. In fact, it would probably be the type of tax, if measured with income as the base, that the proponents of this system would be the first to deplore.

In conclusion, it is hoped that this paper has provided some new insights into the problems involved in financing public education. Needless to say, further research is needed. The methodology developed in this study could be a fruitful approach for this research to take.

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APPENDIX. IMPLICATIONS OF THE DIFFERENT TAX SCHEMES WITH RESPECT TO SOCIO-ECONOMIC REGIONS IN IOWA

For the purpose of this analysis, Iowa counties were divided into three regions on the basis of urbanization:

1. Metropolitan - These are the seven counties classified as Standard Metropolitan Statistical Areas in the 1970 Census (7). These seven counties are Black Hawk, Dubuque, Linn, Polk, Pottawattamie, Scott and Woodbury.

2. Urban - All counties with a city of 10,000 or more (excluding the seven Metropolitan Counties) were classified as urban. The fourteen counties falling into this classification are: Boone, Cerro Gordo, Clay, Clinton, Des Moines, Jasper, Johnson, Lee, Mahaska, Marshall, Muscatine, Story, Wapello and Webster.

3. Rural - The remaining seventy-eight counties, all containing cities with a maximum population of less than 10,000, are classified as rural.

The results are:

Metropolitan

Tax scheme	Existing	All Income Tax	All Property Tax	Two-Tax
Dollar burden per capita	$138	$158	$108	$131
% change from existing burden per capita		+13.66%	-22.3%	-5.07%

Urban

Tax scheme	Existing	All Income Tax	All Property Tax	Two-Tax
Dollar burden per capita	$156	$164	$146	$154
% change from existing burden per capita		+5.12%	-6.4%	-1.28%

Rural

Tax scheme	Existing	All Income Tax	All Property Tax	Two-Tax
Dollar burden per capita	$185	$160	$220	$193
% change from existing burden per capita		-13.51%	+18.91%	+4.32%

(Based on 1970 data)

As is easily seen, the differences are clear cut. The all income tax method with a proportional rate of .0556 shifts the burden away from the rural taxpayer onto the urban and metropolitan populace. The equalized property tax method, on the other hand, leads to a dramatic shift in the opposite direction. In the middle lies the two-tax system developed in the body of this text. This system leads to a moderate transfer of burden away from the metropolitan and urban taxpayer onto the rural counties.