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Joint provision of public goods: the consolidation of school districts

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Abstract

A new methodological approach investigates the factors that cause and inhibit political jurisdictions from jointly providing public services. Previous statistical approaches study whether consolidation occurs but are incapable of exploring with whom it occurs. The Poirier bivariate probit analysis suggests population and property value factors matter more than socio-demographic factors in determining whether two neighboring entities will form a consolidated school district. Small and large districts merge with each other, while medium-sized communities tend not to merge. Contrary to prior studies, neither racial composition, income levels, nor hypothetical school quality has a statistically significant effect on the probability of merging.

Keywords: Consolidation; School district; Poirier bivariate probit; Public schooling quality

JEL classification: H4; H73; I21; R50

Sometimes one municipality will cooperate with another to form a joint school district, also called a consolidated school district, while maintaining independent control over other local public services like police protection. School district consolidation has been a frequent occurrence: the number of school districts in the United States has fallen from 125 000 in 1900 to 84 000 in 1950 to 15 500 in 1990 (Wiles, 1994). Each community must decide not only whether to form a joint school district, but with whom. Because the quality of public schooling affects

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house prices (Jud, 1985; Haurin and Brasington, 1996), if a community chooses a partner that depresses school quality, its houses are likely to suffer a loss in value. This study will examine the factors that influence the decision to cooperate in the provision of public services, using the example of schooling.

The issue is not only would two particular communities be better off together than separated, but does this particular combination dominate others that could be formed instead to achieve the desired economies of scale? This is the first statistical study to address joint public service provision by directly comparing neighboring political entities and examining the specific set of consolidation opportunities they face. This new methodological approach appears to make a dramatic difference. Factors related to population and property valuation matter; however, contrary to prior studies, no socio-demographic factor is a significant influence in a political entity's decision to jointly provide public schooling.

Throughout this study the terms 'community,' 'political jurisdiction,' 'municipality' and 'entity' are used interchangeably. A school district is 'independent' if it contains only one community, but it is a 'joint' or 'consolidated' or 'merged' school district if more than one community sends its children to it. Ohio metropolitan communities consist of cities, villages, and townships.

1. Previous studies

The Tiebout model of local public good provision describes consumers sorting into jurisdictions that differ in tax and spending decisions on a single public service level (Tiebout, 1956; Hamilton, 1975). However, in reality, communities provide several services, each of which has its own economies of scale. In addition, consumers may have different tastes for different public goods. In response, communities may cooperate in the provision of certain services like education while retaining local control over other goods like police protection. Miceli (1993) establishes a theoretical model of the formation of joint school districts based on the above discussion. Miceli models the decision of providing schooling jointly as a tradeoff between scale economies and differences in tastes for education. He provides a case study of a vote between three towns on whether to jointly provide public schooling to support his model. However, he leaves a statistical test of the model involving a large number of observations for future research.

Ferris and Graddy (1988) assess the determinants of intergovernmental cooperation in service provision by modeling a tradeoff between cost savings and loss of local control. They find that jurisdictions with very large and very small populations are most likely to provide services jointly, with medium-sized communities being most likely to retain local control. However, public schooling is not one of the services Ferris and Graddy examine, and they do not control for

differences in contracting laws across states in their national survey; therefore, it is not clear if their results are applicable to public schooling.

Nelson (1990) finds metropolitan areas with more homogeneous populations have fewer political jurisdictions. This implies that similar people have similar tax and service preferences and thus need fewer governmental units. Nelson's study also suggests that two communities that differ greatly in socio-demographic composition are less likely to cooperate in public service provision. However, while Nelson studies the factors correlated with the number of jurisdictions in a metro area, the current approach takes a more focused look at the characteristics that inhibit and promote joint service provision between specific neighboring governmental units within the same MSA.

Finney (1997) studies joint provision of police service in the Los Angeles area. He tests for scale economies and rejects increasing returns to policing. Finney therefore concludes that there is no evidence for an efficiency explanation of the large degree of intergovernmental cooperation in police service provision. It remains to be seen whether schooling is analogous to police protection and is produced under decreasing returns to scale.

Finally, Martinez–Vazquez et al. (1997) incorporate tastes for association into a club goods model in order to investigate their influence on a system of local governments. Their empirical test finds evidence that racial heterogeneity promotes fractionalization in the number of school districts, so that differences in racial composition seem to impede district consolidation. They also find that income heterogeneity has no effect on the number of school districts in a metropolitan area, but it raises the number of school districts in a state. Although their study is suggestive of factors that influence a community's decision to provide schooling independently or jointly with a neighbor, their data is at the state level and the metropolitan-area level; thus their data is too aggregated to extrapolate to the decisions facing neighboring political jurisdictions with much confidence. In addition, the multi-state nature of their study makes it difficult to control for inter-state differences in consolidation law and possible differences in financial incentives to merging due to state funding formula inconsistencies.

Overall, economic theory and previous study would suggest that scale economies play an important role in a political entity's decision to form a consolidated school district. Theory also suggests that communities with high amenity levels in general are unlikely to want to form a joint school district with a community that has lower amenity levels. This study is the first statistical study that directly examines neighboring political entities to discover the factors that inhibit and encourage cooperation in the provision of local public schooling. It provides a more comprehensive overview of the decision to consolidate, including the relationship between consolidation and cost savings, consolidation and school quality, and the consequences of consolidation on housing prices and the local property tax base. First, the decision to cooperate in the provision of schooling is

modeled. Second, the data are discussed and the hypotheses that come from the model are tested. The final section offers concluding remarks.

2. Theoretical model

Now presented is a version of Miceli's (1993) model of joint provision of public goods that is slightly modified to emphasize the consequences of school district partner choice on house prices. Consumers in each community are identical, but they differ from members of other communities. Each person in community i has the following budget constraint:

$$y_i = x_i + p_i(1 + t_i)h_i \tag{1}$$

where y is income, x is the numeraire good, p is the price of a unit of housing, t is the property tax rate, and h is the quantity of housing consumed. Furthermore,

$$p_i = f(g_i, t_i) \tag{2}$$

where g is the quantity–quality of public schooling in community i. Education is assumed to be the only public service locally produced and financed. Housing is produced competitively by constant returns to scale technology.

Due to Eq. (2), the joint provision of public schooling affects house prices through the resultant quality of public schooling. The quantity–quality of schooling could change due to consolidation in three ways. First, after consolidation, the electorate changes, and the new electorate may express a different demand for local public schooling, thus changing schooling outcomes and levy passage probability (Brasington, 1997b; Rubinfeld, 1977). Second, consolidation causes a new mix of students with a new set of parent characteristics, which also could lead to a shift in the supply curve of education (Brasington, 1997b). Third, consolidation itself may have an impact on the quality of schooling. Evidence to date primarily points to a negative relationship between school enrollment and student performance (Brasington, 1997c; Stern, 1989; Fowler and Walberg, 1991).

Consumers choose x and h to maximize utility, taking the available combinations of g_i and t_i as given. The solution to the demand for these commodities can be substituted back into the utility function to achieve the following indirect utility function:

$$V = V(y_i, p_i(1 + t_i), g_i) \tag{3}$$

The community's tax base is given by

$$B_i = p_i H_i + S_i \tag{4}$$

where B is the tax base, H is total housing consumption, and S is the value of non-residential taxable property in the community.

Let $c(n_i)$ be the cost of providing a unit of public education to the n_i students in the community. The total derivative of c with respect to n signifies whether returns to scale are constant, increasing, or decreasing. If schooling is a pure public good, $(\mathrm{d}c/\mathrm{d}n_i)=0$; that is, adding a student does not raise the cost of providing g. If schooling has some degree of rivalrousness in consumption, $(\mathrm{d}c/\mathrm{d}n_i)>0$. Finally, if there are unclaimed scale economies, $(\mathrm{d}c/\mathrm{d}n_i)$ is less than average cost. Total education costs are $c(n_i)g_i$, so that average cost is $c(n_i)g_i/n_i$. A balanced budget for schooling can be written

$$t_i B_i = c(n_i)g_i \tag{5}$$

so that total revenues equal total costs. Transforming to a per-pupil basis and rearranging,

$$t_i = \frac{c(n_i)g_i/n_i}{B_i/n_i} \tag{6}$$

Economies of scale play an important role in the theoretical model. When a school district's size changes, it moves closer to or farther from the minimum point on its average total cost curve. In Eqs. (5) and (6), holding quality and the tax base constant, such a movement will necessitate a change in the tax rate to keep the budget balanced. According to Eq. (2), this subsequent change in the tax rate may in turn influence house prices. Some studies find great potential cost savings due to cooperation in the provision of public schooling (Duncombe et al., 1995; Ratcliffe et al., 1990). If average costs fall, there is potential for a lower tax rate, which may be capitalized into house value (Oates, 1969). However, Young (1994) and Deller and Rudnicki (1992) find little evidence of cost savings. The current study's purpose is not to investigate whether there truly are cost savings due to school district consolidation; however, it will show that voters appear to approve mergers on those grounds.

Given the existence of unexploited scale economies, two communities may consolidate schools to lower their average operating costs. However, the level of $g_{i=1}$ may differ from $g_{i=2}$. If so, at least one community must move away from its independently most-preferred level of education provision to reap additional scale economies. Therefore, a community deciding whether to cooperate in the provision of public schooling must balance possible cost savings with a potential loss in control over the educational agenda.

The model also suggests that the tax base B_i will be influenced by the choice of partner for a joint school district in two ways. First, a potential merger partner may have a lucrative non-residential tax base which may enable a community to lower its tax rates due to both economies of scale gains and an enhanced property tax base. If taxes are capitalized into house price p_i, according to Eqs. (2) and (4), B_i will change. Second, the choice of joint school district partner will affect the quality of education through the type of students and parents that live in the other

community. Because school quality is capitalized into house value in (2), B_i will change as p_i responds to the new level of school quality in a joint school district.

Under which set of conditions will two or more communities form a joint school district? The benefits of consolidation must outweigh the costs. The change in p_i, $c(n_i)g_i/n_i$, and g_i must result in a net utility gain by all partners before they will form a joint school district. Prior to consolidation, each community had decided upon a level of g_i to provide. If the difference between desired levels of g_i are small between communities, a joint school district is more likely. The level of g_i (and therefore p_i) depends in part on socio-demographic influences. The model therefore predicts that income and race play a role in the consolidation decision.

In addition, the model indicates that size and property values matter. Communities small in population are more likely to want to form a joint school district because they have the most scale economies to gain (Duncombe et al., 1995), even if they must adopt the desired school quality of their larger merger partner. Along these lines, a populous district is likely to retain its desired level of school quality and therefore may not be averse to joining with a small jurisdiction, unless the large community is already at the minimum of its average cost curve. Furthermore, because $[dt_i/d(B_i/n_i)]<0$, communities rich in property value will not be inclined to merge with property-poor communities unless they are sufficiently compensated by cost savings.

Given the above discussion, the following variables are hypothesized to affect the probability of joint school district formation between neighboring political jurisdictions. Very small entities are hypothesized to be relatively eager to gain scale economies, whereas more populous jurisdictions are expected to desire to maintain control over the education process by remaining independent. Thus, the number of pupils in a jurisdiction is expected to depress the probability of cooperation in public schooling. However, Ferris and Graddy's (1988) study of public services other than schooling reveals that small and large jurisdictions tend to contract for services, while medium-sized jurisdictions tend to remain independent. The number of pupils squared is therefore hypothesized to be positively related to school district consolidation. As political entities become sufficiently large, they are likely to maintain control over the educational process and be willing to consolidate to reap additional scale economies.[1] The difference in

[1]There are circumstances in which a small community will hold a substantial influence in the quantity–quality of schooling that stems from the merger between a large and a small political jurisdiction. Consider an existing joint school district composed of two communities that is deciding whether to allow a third, small community join its consolidated district. Suppose that if they merge, the population breakdown will be 49%, 47%, and 4%. Previously, the larger member of the joint school district determined the demand for school quality. If, however, the small community tips the balance of power against the largest community, the most populous member of the school district will no longer control the educational agenda. In this situation, the larger member of a joint school district may be unwilling to merge with a small political entity. Another situation in which a small community may have a substantial influence on school quality is the case when the small community has a particularly violent or disruptive student contribution to the student body.

the number of pupils between two neighboring political entities is hypothesized to be positively related to joint school district formation for the same reason. Finally, the number of pupils that a school district would have if it merged with a neighboring municipality's school district is related to the probability of consolidation because it signals how close the combined unit would be to achieving optimal scale economies.[2]

Property valuation per pupil is expected to be negatively related to consolidation: holding the number of pupils constant, a political entity endowed with high per-pupil property valuation requires a relatively small tax rate to support a given level of funding compared to a property-poor jurisdiction. For this entity, consolidation would only serve to mandate a tax increase or a decline in school expenditures per pupil, and these actions may in turn be linked to a decline in constant-quality house price. The difference in per-pupil property valuation is expected to be negatively related to school district consolidation as well.

Due to their effect on g_i, the following variables related to socio-demographic factors are also hypothesized to affect the probability of school district consolidation: income levels, the percentage of the community that is white, and hypothetical proficiency test scores. Holding the differences in levels constant, a community with a high income level, percentage of white residents, and hypothetical school quality is more likely to find a willing merger partner than one with low levels of these attributes. The levels of the factors are thus positively related to the likelihood of joint school provision. On the other hand, large differences in income, percent white, and potential school quality between potential merger partners are expected to lower the probability of school district consolidation.

3. Empirical test

The factors that encourage and inhibit school district consolidation between neighboring political entities are now tested. Each community must agree to form a joint school district in order for a joint school district to emerge. However, what is observed is only whether a joint school district exists, not the specific votes by each neighboring community in a consolidation vote. Specifically, the following equation will be estimated:

$$J = J(\Phi_i, \Omega_i, \psi_i) \tag{7}$$

where J is a dummy variable which takes the value 1 if two adjacent entities

[2]Thanks to the referee for recommending testing whether consolidation is more likely in cases where it brings two districts closer to the optimal size. To this end, the optimal size was estimated following Ratcliffe et al. (1990) and Callan and Santerre (1990). As the estimated optimal size exceeded the maximum in the sample, any merger would function to gain economies of scale. Therefore, POTENTIAL PUPILS is included and is expected to be positively related to the probability of cooperation in the provision of public schooling.

decide to form a joint school district and takes the value 0 if at least one of the political jurisdictions chooses not to consolidate with its neighbor. Φ_i represents levels and differences in levels of population and property value of potential merger partners. Ω_i symbolizes levels and differences in levels of socio-demographic indicators. ψ_i is the hypothetical difference in school quality between two potential merger partners. It measures the difference between the quality of public schooling jurisdiction 1 could achieve on its own and the quality of public schooling jurisdiction 2 could achieve if it had its own school system.

Estimation of (7) requires a statistical technique that allows for partial observability: the observation set includes only the product of each neighboring community's consolidation vote, not the actual votes. The final outcome of the decision process of each neighbor leads to a single conclusion: a merger or no merger. Only when both communities vote in favor of consolidation is a merger observed. Any other combination of votes results in no merger. The statistical technique that fits the current situation is a Poirier bivariate probit (Greene, 1995; Poirier, 1980). The Poirier bivariate probit allows for each entity to veto a decision on a joint action. Each community's merger decision is simultaneously determined, and the errors are correlated. The log-likelihood for Poirier's partial observability model is

$$\ln L = \sum_{y=1} \ln \Phi_2[\beta_1' x_{i1}, \beta_2' x_{i2}, \rho] + \sum_{y=0} \ln(1 - \Phi_2[\beta_1' x_{i1}, \beta_2' x_{i2}, \rho]) \tag{8}$$

where y is each neighboring community's final decision on whether to consolidate, Φ_2 is the bivariate standard normal cumulative distribution function, the x's are the vectors of factors underlying the decision, and ρ is the correlation between the two entities' decisions.

Because information about school quality for each member of a joint school district does not exist, it is necessary to calculate a predicted value of ψ_i, a hypothetical school quality for each political jurisdiction. To this end an education production function[3] is estimated using actual school districts, not jurisdictional components of school districts. The reason is that performance data exists only for actual school districts. The education production function takes the following form:

$$\Lambda_i = \Lambda_i(e_i, r_i, \Sigma_i, y_i, \delta_i) \tag{9}$$

In (9), Λ_i represents school quality, measured by the percentage of students in metro-area school districts in Ohio who pass all four sections of the 1990 Ohio 9th-grade proficiency test. This school quality measure Λ_i is regressed as a function of enrollment (e_i), racial composition (r_i), property valuation per pupil

[3]See Brasington (1997a) for a detailed literature review on education production functions.

Table 1
Education production function[a]

Variable	Coefficient	T-ratio	Mean	Source
PUPILS	-0.13×10^{-7}	0.0040	5752	1
% WHITE	0.35	7.00	0.83	1
VALUATION PER PUPIL	0.56×10^{-6}	2.85	101 400	1,2
INCOME	0.19×10^{-5}	1.67	38 230	1
HIGH EDUCATION LEVEL	1.05	4.75	0.52	1
CONSTANT	−0.11	2.16	–	–

[a] Adjusted $R^2=0.75$. Number of observations = 72 actual school districts. Dependent variable is percentage of students passing all four sections of the 1990 Ohio 9th-grade proficiency test. Mean of dependent variable is 0.41. Sources: 1 = U.S. Bureau of the Census, 1990; 2 = Ohio Municipal Advisory Council, 1993. Variable definitions are as given in Table 2 with the following modifications: In Table 1, unlike in the rest of the paper, PUPILS is not in 10 000s of pupils, VALUATION PER PUPIL is in dollars per pupil, INCOME is in dollars, and HIGH EDUCATION LEVEL is the percentage of residents in each school district that have at least attended college.

(Σ_i), median income (y_i), and the percentage of school district residents who have at least attended college (δ_i). Definitions and sources for variables used can be found in Table 2, and exact results of the education production function are found in Table 1. Because the sample differs in Tables 1 and 2, Table 1 includes means by actual school districts.

If there is a dichotomous outcome at the individual level (pass all four sections of the proficiency test or not) but the result is aggregated to the district level, and each district has a different number of students, then using OLS will result in heteroskedasticity (Kennedy, 1992). To correct for heteroskedasticity, the OLS regression results in Table 1 are weighted by the minimum chi-square method (Maddala, 1983), where the weight is $[\text{PUPILS}/\{\Lambda_i^*(1-\Lambda_i)\}]^{1/2}$.

Limited information about the individual political entities that comprise joint school districts is available from which to construct the hypothetical school quality variable. Thus, there are relatively few independent variables that can be used in the education production function. Furthermore, it would be inappropriate to include actual school-specific factors like average teacher experience because it is not known how a jurisdiction would make its school input choices if it provided schooling independently. Even with the limited number of explanatory variables, the regression explains 75% of the variance in the school quality measure. Each variable has the expected sign, and racial composition, property valuation per pupil, income, and community education level are significant. Although the number of pupils has a negative sign, it is an insignificant determinant of school quality holding the other factors constant. The coefficients of each of these factors are then multiplied by each political entity's levels of the corresponding variables, and these mathematical products are summed to arrive at a hypothetical value of educational quality, Λ_i'. Then, $\psi_1=\Lambda_1'-\Lambda_2'$ and $\psi_2=\Lambda_2'-\Lambda_1'$.

Table 2
Means, definitions, and sources[a]

Variable Name	Definition	Mean	Std Dev.	Source
MERGED	Dummy variable that takes the value 1 if the neighboring political entities share a school district.	0.28	0.45	3
PUPILS	Number of school-aged children in the jurisdiction, in 10 000s.	0.30	0.30	1
DIFFERENCE IN PUPILS	PUPILS in community in question minus PUPILS in potential merger partner.	−0.013	0.42	1
POTENTIAL PUPILS	PUPILS in community in question plus PUPILS in potential merger partner.	0.69	0.47	1
PROPERTY VALUATION	Assessed valuation of real estate and public utility values from 1989 abstracts and 1990 collections, plus personal tangible value from 1990 collection, in $100 000 000s.	3.14	2.54	2
VALUATION PER PUPIL	PROPERTY VALUATION divided by PUPILS, in $100 000s.	1.45	1.41	1,2
DIFFERENCE IN PER-PUPIL PROPERTY VALUATION	VALUATION PER PUPIL for the community in question minus VALUATION PER PUPIL for potential merger partner.	−0.19	2.08	1,2
INCOME	Median household income, in $1000s.	43.60	21.34	1
DIFFERENCE IN INCOME	INCOME of community in question minus INCOME of potential merger partner.	0.66	21.59	1
% WHITE	Percentage of the community that is white, non-Hispanic.	0.88	0.19	1
DIFFERENCE IN % WHITE	% WHITE of community in question minus % WHITE of potential merger partner.	0.020	0.21	1
TEST SCORES	Hypothetical measure of school quality in a community derived from education production function.	1.02	0.26	1,2
DIFFERENCE IN TEST SCORES	Hypothetical 9th-grade proficiency test score of community in question minus potential merger partner's.	−0.0051	0.28	1,2

[a] Sources: 1 = U.S. Bureau of the Census, 1990; 2 = Ohio Municipal Advisory Council, 1993; 3 = Ohio Department of Education, 1985 maps.

4. Data and institutional background

The sample of potential merger partners comes from the major metropolitan areas in Ohio. Restricting the analysis to one state avoids problems due to differences in laws across states such as home rule laws and the degree of difficulty in allowing joint school districts to form and disband.

Central cities are excluded from the analysis primarily because their boundaries

are more often historical accidents rather than conscious choice based upon Tiebout sorting. In addition, many researchers argue that inflexibilities prevent the redrawing of these jurisdictional boundaries (Epple and Zelenitz, 1981; Garasky and Haurin, 1997). It is desirable to examine the consolidation decision between political entities that are relatively internally homogeneous. The theoretical model assumes that communities' residents are identical. Central cities have considerably more demographically diverse populations than the suburban municipalities that surround them. Central cities are therefore omitted from the sample. The analysis also excludes school districts that contain political jurisdictions whose geographical school assignments are significantly split among more than one school district.[4] Finally, the sample excludes any metropolitan community that forms a school district which also includes a significant portion of land from nonmetropolitan communities. Thus, by examining maps, it is possible to find 298 potential pairings of metropolitan communities that either clearly belong to a joint school district or clearly provide schooling independently. Of these, 83 form joint school districts. Potential merger partners are coupled in random order; that is, entity 1 in a pair is not consistently the more populous community and entity 2 in a pair is not consistently the less populous political jurisdiction. For a detailed example of how the data were arranged, please see the appendix.

In Ohio, school district consolidation must be at all levels of schooling, K–12. After consolidation, voters elect a new unified school board, and the old separate school boards cease to exist. While joint school districts typically maintain buildings in each of the member jurisdictions, there are cases in which very small communities have no school buildings and therefore can be said to contract out for educational services. These cases are omitted from the analysis if the communities are encompassed by a larger political entity; however, if the small community has a choice of contracting partners, it is included in the analysis.

Ohio law allows for relatively easy formation and disbanding of joint school districts. Such actions depend primarily upon a majority vote of the relevant school districts' boards of education (Baldwin's Ohio Revised Code, 1995). After consolidation, voters elect a new unified school board, and the old separate school boards cease to exist. Consolidation has gained and lost favor in cycles. The number of school districts in Ohio fell from 1936 to 611 between the 1930s and the 1996–1997 school year. Most of these mergers occurred in the 1930s and the 1960s. In the 1930s wave, county offices encouraged consolidation, while the State

[4]In Ohio, not every political jurisdiction sends its students to the same public school district. Due to a law change in 1955, annexation for political purposes was no longer automatically annexation for school district purposes. There are some municipalities served by multiple school districts, then. These communities are typically townships rather than villages or cities. Data for property valuation is available at the school district level and at the municipal level, but it is not available for school district *x*'s portion of a municipality and school district *y*'s portion of the same municipality. The analysis is therefore restricted to examining only political jurisdictions that send their children to a single public school district.

Board of Education encouraged consolidation in the latter wave. However, in neither episode were legal threats or financial incentives used to promote consolidation. Since 1985, three communities have formed joint school districts with neighboring jurisdictions, one school district disbanded completely for lack of students, and one split into its pre-merger component parts (Ohio Department of Education, 1996).

Once a new local political entity forms, it is charged by the state constitution to have some arrangement for providing public education. It may form its own school district immediately, continue to use the school district it previously used, or it may contract for public education with a different but contiguous school district. Underlying jurisdictional boundaries may change, but this is common only on the edge of a metropolitan area. The most typical case of political boundary change is when a city annexes part of a neighboring township. The township losing property is typically rural and therefore is not part of the urban area sample analyzed in this study.

Local property taxes provide slightly over half of Ohio school districts' revenues. Approximately one-third of revenues comes from the state, and the remainder comes from miscellaneous sources and the national government. Because property taxes figure prominently in school district finance in Ohio, the property tax base and differences in property tax base between communities are expected to be important factors in the consolidation decision. In addition, approximately 92 of Ohio's 611 school districts have instituted school district income taxes. These communities tend to be rural; in fact, only one school district in the sample has a school district income tax.

The variables used in the Poirier bivariate probit, along with means, definitions, and sources, are shown in Table 2.

5. Empirical results

The results of the Poirier bivariate probit are shown in Table 3. A bivariate probit typically has two sets of coefficients for each variable; however, the coefficients of each variable are constrained to be the same across potential merger partners. Therefore, only one set of coefficient estimates is reported in Table 3. Due to randomly assigned pairings, there is no reason to believe that the decision-making model is different between entity 1 and entity 2 of each pair. Constraining the coefficients is therefore a legitimate procedure which simplifies the analysis and the interpretation of results.

The covariance matrix is reported in Table 4, and a table of actual and predicted frequencies is shown in Table 5. According to Table 5, the Poirier bivariate probit is able to successfully predict 95% of the cases in which mergers did not occur, although it predicts more consolidation that actually exists.

The most striking aspect about Table 3 is that the population and property

Table 3
Poirier bivariate probit results[a]

Variable	Baseline
PUPILS	−16.9**
	(4.04)
PUPILS SQUARED	3.48**
	(1.47)
DIFFERENCE IN PUPILS	6.47**
	(2.25)
POTENTIAL PUPILS	0.57**
	(0.19)
VALUATION PER PUPIL	−0.13*
	(0.072)
DIFFERENCE IN PER−PUPIL PROPERTY VALUATION	0.11
	(0.30)
INCOME	−0.011
	(0.009)
DIFFERENCE IN INCOME	−0.0091
	(0.036)
% WHITE	−0.42
	(0.49)
DIFFERENCE IN % WHITE	−0.75
	(1.72)
TEST SCORES	1.00
	(0.91)
DIFFERENCE IN TEST SCORES	−1.44
	(3.46)
CONSTANT	1.00
	(0.63)

[a] Coefficients shown with standard errors below. Number of observations = 298. Dependent variable is MERGED dummy variable, 1 if merged. Coefficients are constrained to be equal across both potential merger partners. * = significant at .10, ** = significant at .05.

valuation variables are significant but the demographic variables are not. For instance, PUPILS is negative and significant, while PUPILS SQUARED is positive and significant. Together, this implies that very small communities tend to join consolidated districts, but as population rises, a political jurisdiction is more likely to maintain its own independent school district. After the critical mass of 8544 students is reached, the community is once again willing to cooperate in the provision of public schooling. This makes sense: a small community apparently has great scale economies to gain and is willing to relinquish a great deal of control over its educational system to reap them. A large community is not in great danger of losing its ability to set educational policy and will consolidate to reap additional scale economies. Medium-sized communities are large enough that the additional scale economies gains are not worth the loss of control. Including a cubic term proved insignificant; however, if the sample contained sufficiently

Table 4
Covariance matrix[a]

	1	2	3	4	5	6	
1	.401						
2	-0.559×10^{-3}	0.036					
3	−0.229	−0.722	16.31				
4	0.213	0.001	−1.955	2.15			
5	0.008	−0.001	0.062	−0.027	0.005		
6	0.008	-0.912×10^{-3}	0.034	−0.023	0.003	0.091	
	1	2	3	4	5	6	
7	0.047	0.392	−8.054	0.321	−0.010	0.072	
8	0.002	-0.69×10^{-4}	0.002	-0.536×10^{-4}	0.338×10^{-3}	-0.436×10^{-3}	
9	0.002	-0.705×10^{-3}	0.017	−0.004	-0.597×10^{-3}	0.300×10^{-3}	
10	−0.078	−0.006	0.050	0.061	-0.213×10^{-3}	−0.006	
11	−0.189	−0.056	1.371	−0.257	−0.010	0.145	
12	−0.130	0.037	−0.859	0.303	0.039	−0.480	
13	−0.386	0.006	−0.150	0.004	−0.035	0.018	
	7	8	9	10	11	12	13
7	5.04						
8	-0.61×10^{-3}	0.89×10^{-4}					
9	−0.012	-0.13×10^{-3}	0.0013				
10	−0.139	0.21×10^{-3}	0.0044	0.236			
11	−0.478	−0.0046	0.0294	0.115	2.95		
12	0.196	0.0116	−0.0972	−0.313	−3.65	11.94	
13	0.089	−0.0068	0.25×10^{-4}	−0.126	0.256	−0.204	0.826

[a] Key: 1=CONSTANT; 2=POTENTIAL PUPILS; 3=PUPILS; 4=PUPILS SQUARED; 5=VALUATION PER PUPIL; 6=DIFFERENCE IN PER-PUPIL PROPERTY VALUATION; 7=DIFFERENCE IN PUPILS; 8=INCOME; 9=DIFFERENCE IN INCOME; 10=% WHITE; 11=DIFFERENCE IN % WHITE; 12=DIFFERENCE IN TEST SCORES; 13=TEST SCORES.

Table 5
Frequencies of actual and predicted results

	Full Poirier		
	Predicted 0	Predicted 1	Total
Actual 0	139	76	215
Actual 1	7	76	83
Total	146	152	298

populous jurisdictions, one would expect to find diminishing returns to scale and thus an aversion to further consolidation.

DIFFERENCE IN PUPILS is strongly positive and significant. This implies that the larger the difference in population between two neighboring communities, the more likely it is that they will consolidate schooling. This provides further evidence that large and small communities tend to form joint school districts with each other, but that medium-sized communities tend to stay independent. The marginal effect indicates that, at the mean, as the difference in the number of school-aged children between two communities rises by 1000, the communities are 3.8 percentage points more likely to form a consolidated school district. Interestingly, the issue of control manifests itself once again. DIFFERENCE IN PUPILS is not an absolute value, and the regression results indicate a positive coefficient. The interpretation is that, as expected, large communities are encouraged to merge by a larger difference in the number of pupils. That is, they will gain scale economies and they will be less likely to move away from their most-desired level of educational outcome. On the other hand, for small communities a larger difference in the number of pupils discourages merging. Although these districts are in favor of merging to gain scale economies, the loss of control grows as the potential merger partner becomes increasingly larger than they are, and therefore these small entities are less likely to want to merge. POTENTIAL PUPILS is also positively related to the probability of a merger, so that the more scale economies there are to be gained, the larger is the likelihood that a consolidation will occur.

VALUATION PER PUPIL is negative and significant. Some academicians have commented that high-income people are likely to have large houses, so that VALUATION PER PUPIL will capture some of the effect of INCOME. However, by holding INCOME (and, by extension, residential property value per pupil) constant, VALUATION PER PUPIL should reflect the influence of commercial and industrial property endowment on the likelihood of a merger. Therefore, the results suggest that the more per-pupil property valuation a community has, the more likely it is to maintain its own independent school system. This makes sense. For a community laden with property value, consolidation would serve to dilute the property base, forcing some combination of higher taxes or lower expenditures on schooling. The marginal effect is 0.44. The interpretation is that, at the mean of $154 000, an increase in assessed property valuation per pupil of $10 000 will

decrease the probability of a merger by 4.4 percentage points. Thus the economic effect of property valuation on the likelihood of school district consolidation is considerable. DIFFERENCE IN PER-PUPIL PROPERTY VALUATION, on the other hand, is not statistically significant.

No socio-demographic factor is significantly related to cooperation in the provision of public education between neighboring political entities. Income, racial composition, and hypothetical school quality levels are all statistically insignificant, as are the differences in income, racial composition, and hypothetical school quality between potential consolidation partners. The DIFFERENCE variables are not calculated in absolute values. Therefore, the differences in income and race variables tested the impact on the likelihood of consolidation assuming that high income and high percentage of white community residents are valued by both parties: the entity in the potential matching pair that is richer and the one that is poorer, for example. This hypothesis was rejected for differences in income levels and racial composition.

However, it is also an acceptable hypothesis that differences in both directions are detrimental to merging. That is, a rich community does not want to have its children educated with children from a poorer community, and likewise a poor community does not want to send its children to school with children from a rich community. Similarly, it can be hypothesized that a predominantly white community does not want to send its children to school with children from a community with a high minority population, and a community with a large minority population is equally averse to educating its children with white children. Therefore, DIFFERENCE IN INCOME and DIFFERENCE IN % WHITE are recalculated as absolute values. In this way, for example, if entity 1 has INCOME of $25 000 and entity 2 has INCOME of $30 000, DIFFERENCE IN INCOME is $5000 for both entities. In the previous formulation, DIFFERENCE IN INCOME was −$5000 for entity 1 and $5000 for entity 2. With the new absolute value calculations of the differences in racial composition and income levels, Table 3 is re-estimated. The results, which are not reported, show no change in statistical significance for any variable: once again no socio-demographic variable is related to the probability of a merger.

Socio-demographic factors have been found significant determinants of contracting for public services (Ferris and Graddy, 1988), the number of jurisdictions in a metro area (Nelson, 1990) and the number of school districts in a state and in a metro area (Martinez–Vazquez et al., 1997). However, the current study has found that factors related to scale economies dominate socio-demographic determinants of the likelihood of school district consolidation. In Table 6 the model is re-estimated, including only socio-demographic variables.

A corresponding table of actual and predicted frequencies for the demographics-only regression appears in Table 7.

With property valuation and population variables excluded, DIFFERENCE IN INCOME and DIFFERENCE IN % WHITE are significant. Although it is not

Table 6
Poirier bivariate probit, demographic factors only[a]

Variable	Demographics
INCOME	0.0069
	(0.0094)
DIFFERENCE IN INCOME	−0.016**
	(0.0073)
% WHITE	−0.66
	(0.55)
DIFFERENCE IN % WHITE	−1.46**
	(0.59)
TEST SCORES	0.62
	(0.65)
DIFFERENCE IN TEST SCORES	−0.75
	(2.79)
CONSTANT	0.069
	(0.58)

[a] Coefficients shown with standard errors below. Number of observations = 298. Dependent variable is MERGED dummy variable, 1 if merged. Coefficients are constrained to be equal across both potential merger partners. * = significant at .10, ** = significant at .05.

conclusive, the regression results suggest that prior studies have found significant effects of demographic variables because they inadequately controlled for size and property value influences. An alternative explanation is that the techniques used in prior studies failed to get at the heart of the matter: what are the factors that inhibit and contribute to consolidation between actual potential merger partners? Perhaps demographic factors like racial heterogeneity indices influence the number of political jurisdictions in a metro area or a state, but previous studies' methodological approaches and techniques may be incapable of properly addressing cooperation in the provision of public services between actual neighboring entities. Finally, the studies just mentioned all involve multiple states. There are positive aspects to a multiple-state analysis, and certain studies cited try hard to account for inter-state differences in laws and state funding incentives, but an inability to properly control for such factors may have biased their findings.

Table 7
Frequencies of actual and predicted results

	Poirier, demographic factors only		
	Predicted 0	Predicted 1	Total
Actual 0	58	157	215
Actual 1	17	66	83
Total	75	223	298

6. Conclusion

Using Ohio metropolitan school districts, the factors that cause and inhibit specific political jurisdictions from jointly providing public services with their neighbors have been tested. The analysis suggests that size and property valuation factors are more important than socio-demographic factors in determining whether two neighboring entities will form a joint school district. Small political entities tend to merge with large communities, while medium-sized communities and communities laden with property value tend to remain independent.

Of particular note is that racial composition and the difference in racial composition between neighboring communities have no independent effect on joint school district formation when socio-demographic factors are pitted alongside economies of scale variables. Also, income levels and hypothetical school quality levels, as well as differences in income levels and differences in predicted school quality levels, have no statistically significant influence on the probability of school district consolidation. Previous studies that have found a role for various demographic factors may have failed to properly control for size, property values or inter-state differences, or their methodology may have been inappropriate.

With this new evidence, the following story may be proposed. First, school district consolidation appears not to enhance the quality of schooling in a district (Brasington, 1997c; Stern, 1989; Fowler and Walberg, 1991). It therefore seems that whether merging school districts cuts costs or not (Duncombe et al., 1995; Deller and Rudnicki, 1992), the fact that size and property value factors overwhelm socio-demographic factors in this study suggests that voters approve school district consolidation strictly with cost savings in mind. Communities may reject consolidation to maintain independent control over the supply curve of education quality (Brasington, 1997b) or to avoid diluting the tax base and eroding house price premia based on the capitalization of low tax rates (Oates, 1969).

Further study could use the same methodological approach to examine inter-state differences in consolidation, comparing joint school district formation in states that have different school funding mechanisms and different joint public service provision laws. The direct comparison of neighbors can also be used to examine cooperation in the provision of other public services like police protection, public libraries, waste collection, and fire protection.

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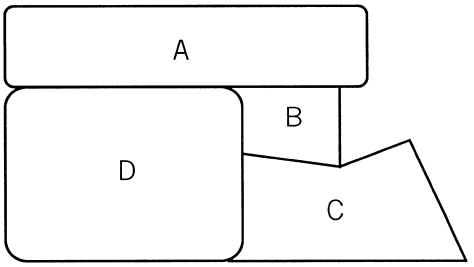
Appendix A. Data and estimation setup



The above diagram portrays four political jurisdictions in a metropolitan area. Each one can maintain its own school district, or any political jurisdiction can form a consolidated school district with a willing adjacent partner. The chart below shows how data are arranged for PUPILS and DIFFERENCE IN PUPILS for each potential matching pair.

Potential Merger Pair	Entity 1	Entity 2	Merged	Pupils 1	Pupils 2	Difference Pupils 1	Difference Pupils 2
1	A	B	0	2000	3500	−1500	1500
2	A	D	1	2000	4500	−2500	2500
3	D	B	0	4500	3500	1000	−1000
4	D	C	0	4500	4750	−250	250
5	C	B	0	4750	3500	1250	−1250
6	C	A and D	0	4750	6500	−1750	1750

In the above example, only A and D merge. A and C are not adjacent. They cannot legally consolidate their school districts with each other; therefore, there is no potential merger pair observation between A and C directly. However, because A and D form a joint school district, C has the opportunity to join the existing consolidated school district AandD. In this way, C may merge with A, but only through the joint school district comprised of entities A and D. With the data arranged as shown, the Poirier bivariate probit analysis may proceed as follows:

1. Dependent variable = MERGED dummy
2. Right-hand side 1: pupils 1, difference in pupils 1, . . .
3. Right-hand side 2: pupils 2, difference in pupils 2, . . .
4. The coefficients of the independent variables are constrained to be equal. This makes the interpretation of the results easier, and it is a legitimate procedure (see text).

References

Baldwin's Ohio Revised Code, Annotated, 1995. Title 33, Chapter 3311, Sections 3311.53 on p. 493 and 3311.54 on p. 494. Banks–Baldwin Law Publishing Company, division of West Publishing Company.

Brasington, D.M., 1997a. The Relationship Between House Prices and School Quality, The Ohio State University, Doctoral Dissertation.

Brasington, D.M., 1997b. The supply and demand for public goods: introducing the supply of public school quality. Working paper, The Ohio State University.

Brasington, D.M., 1997c. School district consolidation, student performance, and cost: district-level vs. school-level analysis. Journal of Regional Analysis and Policy 27 (2), 43–54.

Callan, S.J., Santerre, R.E., 1990. The production characteristics of local public education: a multiple product and input analysis. Southern Economic Journal 57 (2), 468–480.

Deller, S.C., Rudnicki, E., 1992. Managerial efficiency in local government: implications on jurisdictional consolidation. Public Choice 74 (2), 221–231.

Duncombe, W., Miner, J., Ruggiero, J., 1995. Potential cost savings from school district consolidation: a case study of New York. Economics of Education Review 14 (3), 265–284.

Epple, D., Zelenitz, A., 1981. The implications of competition among jurisdictions: does Tiebout need politics? Journal of Political Economy 89 (6), 1197–1217.

Ferris, J., Graddy, E., 1988. Production choices for local government services. Journal of Urban Affairs 10 (3), 273–289.

Finney, M., 1997. Scale economies and police department consolidation: evidence from Los Angeles. Contemporary Economic Policy 15 (1), 121–127.

Fowler, Jr. W.J., Walberg, H.J., 1991. School size, characteristics, and outcomes. Educational Evaluation and Policy Analysis 13 (2), 189–202.

Garasky, S.J., Haurin, D.R., 1997. Tiebout revisited: redrawing jurisdictional boundaries. Journal of Urban Economics 42 (3), 366–376.

Greene, W.H. (Ed.), 1995. Limdep Version 7.0 User's Manual, Econometric Software, Inc, pp. 465–466.

Hamilton, B., 1975. Zoning and property taxation in a system of local governments. Urban Studies 12 (2), 205–211.

Haurin, D.R., Brasington, D.M., 1996. The impact of school quality on real house prices: interjurisdictional effects. Journal of Housing Economics 5 (4), 351–368.

Jud, G.D., 1985. A further note on schools and housing values. American Real Estate and Urban Economics Association Journal 13 (4), 452–461.

Kennedy, P., 1992. A Guide to Econometrics, 3rd ed., The MIT Press, Cambridge, MA, 368.

Maddala, G.S. (Ed.), 1983. Limited-Dependent and Qualitative Variables in Econometrics, Cambridge University Press, New York, NY, pp. 28–29.

Martinez–Vazquez, J., Rider, M., Walker, M.B., 1997. Race and structure of school districts in the United States. Journal of Urban Economics 41 (2), 281–300.

Miceli, T.J., 1993. The decision to regionalize in the provision of education: an application of the Tiebout model. Journal of Urban Economics 33 (3), 344–360.

Nelson, M.A., 1990. Decentralization of the subnational public sector: an empirical analysis of the determinants of local government structure in metropolitan areas in the U.S. Southern Economic Journal 57 (2), 443–457.

Oates, W.E., 1969. The effects of property taxes and local public spending on property values: an empirical study of tax capitalization and the Tiebout hypothesis. Journal of Political Economy 77 (6), 957–971.

Ohio Department of Education, 1996. Conversation with G. Saribalas. Columbus, OH.

Ohio Department of Education, 1985. Maps of Ohio School Districts: City, Exempted, Local. Columbus, OH.

Ohio Municipal Advisory Council, 1993. Compendium of Municipal Debt. Independence, OH.

Poirier, D., 1980. Partial observability in bivariate probit models. Journal of Econometrics 12 (2), 209–217.

Ratcliffe, K., Riddle, B., Yinger, J., 1990. The fiscal consolidation of school districts in New England: is small beautiful? Economics of Education Review 9 (1), 81–99.

Rubinfeld, D.L., 1977. Voting in a local school election: a micro analysis. Review of Economics and Statistics 59 (1), 30–42.

Stern, D., 1989. Educational cost factors and student achievement in grades three and six: some new evidence. Economics of Education Review 8 (2), 149–158.

Tiebout, C., 1956. A pure theory of local public expenditure. Journal of Political Economy 64 (5), 416–424.

U.S. Bureau of the Census, 1990. 1990 Census of Population, Summary Tape File 3A. U.S. G.P.O., Washington, D.C.

Wiles, D.K., 1994. What is useful policy information in school consolidation debates? Journal of Education Finance 19 (3), 292–318.

Young, E., 1994. Questioning consolidation. Tennessee School Board Association Journal 11 (2), 33–37.