PATTERNS OF COST ALLOCATION STRATEGIES: A LOOK AT COOPERATIVE FIRE DEPARTMENTS IN THE STATE OF MICHIGAN

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ABSTRACT

COST ALLOCATION STRATEGIES AND THEIR PRINCIPLE DETERMINANTS: A LOOK AT COOPERATIVE FIRE DEPARTMENTS IN THE STATE OF MICHIGAN

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Intergovernmental cooperation is an important topic in Michigan's current economic climate and has received a lot of treatment by researchers. However, very few studies have been conducted regarding cost sharing agreements made by cooperating groups, especially in the realm of fire service. This study identifies common cost allocation mechanisms and develops a conceptual framework that predicts prevalent patterns between low transaction cost sharing arrangements and similarities among involved communities. Other theories are presented regarding patterns with expenditures and other budgetary data. Patterns were identified using two-step cluster analysis in SPSS. Three tests were done uncovering several variables significant in determining clusters. Among these variables were cost allocation choice, total expenditures, number participating municipalities per fire district, median home value, and percent white population. There were several limitations to this study, including a small number of observations and limited variables.

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1. Introduction

Intergovernmental cooperation is an increasingly important issue in Michigan due to the state's struggling economic climate. Municipalities are faced with shrinking budgets and growing expenses. It is common for cities, townships, and villages to spend up to or more than fifty percent of their annual budgets on emergency services such as fire, police, ambulance and support services such as dispatch centers. Michigan's municipalities are faced with the choice of cutting public services, impending bankruptcy, or finding mutually beneficial cooperative service contracts with neighbors. The third option has been shown to decrease the financial burdens of public services on municipal budgets while sometimes increasing service quality.

Intergovernmental cooperation is generally seen by most groups and individuals involved in policy making as a beneficial endeavor however, as Gerber and Gibson (2005) point out, the policies imposed in the Great Lake states, including Michigan, create "a challenging environment for voluntary regional cooperation, since state governments have, to date, taken a very limited role in mandating or encouraging regional governance; regional entities therefore have few means for offsetting local government disincentives and encouraging regional cooperation" (Gerber and Gibson 2005, 14). While this may be true, Michigan policies over the last half-century have begun to break down many of the legal impediments to ease collaboration among government services in which economies of scale may be the greatest. The Police and Fire Protection Act of 1951 focusing on municipalities with populations of less than 15,000 and the Emergency Services Act of 1988 are great examples of the legislature taking an active role in easing the ability of municipalities to work together. As a result,

Michigan boasts up to 65 taxing fire districts that have filed independent audits with the state treasurer, though the US Census of Governments only recognizes four districts by their definition. Over 120 cooperative groups have been identified in Michigan, and all but a handful have shown activity within the last two years indicating over 100 active interlocal fire agreements today[1].

Fire service is particularly expensive because it is capital intensive. Fires are infrequent, unpredictable, and their incidence in the United States has been declining over the last few decades, yet fire departments are typically fully staffed at a level capable of combating serious structural fires. Additionally, fire service faces a peak load problem that translates into excess capacity during downtimes (Scorsone 2006). These issues translate into higher costs for cities and tax payers. One strategy, which has been used in recent years to alleviate these problems, is to cross train firefighters as emergency medical personnel and paramedics. Despite these improvements in capabilities, cities are not receiving the cost reductions that they had hoped. Thus, fire service consolidation is an attractive option that offers potentially vast savings.

Cooperation can range in degree from basic equipment sharing, informal or formal mutual aid agreements, to a functional consolidation of shared central dispatch services, equipment, training resources, and joint purchasing efforts. The most extreme option, which also has the largest potential economies, is the full consolidation of departments into a single entity, which in Michigan is called an authority under PA 57 of 1988. As the extremity of departmental integration increases, the more difficult

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[1] The number of active interlocal agreements comes from the independent annual audits submitted to the Department of Treasury in 2005 or 2006. The audits list any fire departments with which they are collaborating but the degree of cooperation for all cases is either unknown, vague, or has been formally filed with the Office of the Great Seal under PA 57 or PA 7.

contractual negotiations become, yet the potential for savings is typically greatest with full consolidation.

The phenomenon of why governmental entities come together, who is most likely to cooperate, and where they can find the most savings has been thoroughly explored to date. Researchers generally find that a desire to cooperate is derived from financial necessity or the inability to meet service demand and those communities which have the most in common are more likely to participate with one another. However, the specifics of the agreements made by those cooperating organizations have received little treatment, especially in fire service. The issues regarding cost allocation decisions are incredibly important since they may directly lead to the economies or diseconomies achieved by the participants. Thus many issues need to be explored. For example, when cooperating fire departments realize economies of scale are the reduced costs allocated among all the parties? Does each party receive an equal share of the cost savings? If one department brings more to the agreement in terms of apparatus or other equipment, thus lowering the total future expenditures required from the group, are they then rewarded by paying a smaller share of the costs?

This thesis examines the second stage of the collaborative process by looking only at those groups that have already agreed to work together, and then have formed an agreement about how costs will be shared. It intends to find patterns among social, political, geographical and economic variables likely to be related to a certain type of cost allocation agreement. Based on past work, it is expected that communities that share a greater number of similar characteristics are more likely to reach cost allocation agreements that are less costly to negotiate and implement by each participating

municipality.   In other words, communities that share a greater number of similar characteristics will more often be associated with cost allocation agreements that have lower transactions costs than those who are more dissimilar.

2. Literature Review

There are two main financial issues associated with fire department consolidation: economies of scale and transaction costs. Economies of scale occur when the cost of servicing the next unit declines. In fire service, economies of scale can be realized by spreading out the costs of apparatus and personnel over a larger service area. Consequently, by sharing assets and resources and expanding the service area, departments can see cost savings without sacrificing service quality.

Depending on the degree of integration, cooperation can lead to greater efficiency and quality of service. Fixed costs are a major factor in department budgets because of excessive equipment and personnel requirements. Fire stations need to be manned twenty-four hours a day, 365 days per year, resulting in higher personnel costs than most businesses. Additionally, each station needs to be equipped with fire equipment, such as hoses and trucks. Economies of scale can be realized by sharing equipment among a larger service area, reducing the total number of firehouses, or by placing them in more efficient locations, providing joint training, creating a central call station, and utilizing excess labor during downtimes.

While economies of scale are usually viewed positively, institutional economists recognize that there are consequences of these budgetary benefits. While the service may be more efficient with shorter response times, consumers of the fire service have only one

type of service from which to choose. The lack of variety is the result of lower prices (Schmid 2004). This uniform service is most obvious in the form of fire fighter training. Instead of having a variety of resources to draw from, the fire district area has homogenous protection ability. Institutionalists also acknowledge the difficulty in determining cost allocation strategies. Economies of scale results in constant or falling marginal costs and the allocation of the fixed costs is particularly difficult (Schmid 2004). The demise of many cooperative efforts has come from the inability to correctly allocate fixed costs tending to place more financial strain on one party.

Institutional economists also offer two types of transaction costs relevant to cost allocation negotiations. The first is fundamental uncertainty, which is the uncertainty in predicting the future (Schmid 2004). Risk is an issue in cost negotiations especially in fiscally volatile times. Decisions may be harder to reach if each party is trying to ensure they are protected from any current or future risks. The second relevant transaction costs are contractual, which are critical to this particular study. These include decision-making costs such as the opportunity cost of time and expenses incurred in meetings to negotiate contracts (Harvey 2003). As both the number of parties and complexity of the agreement increase so do the costs of transaction (Schmid 2004).

Another issue with fire service is the difficulty in identifying the user of the good. Because of this, fire protection is a high exclusion cost good; free riders, or nonpaying users, are difficult to exclude from the service. The mere existence of a fire department and joint emergency services benefit the entire community, yet under certain cost allocation methodologies it is not possible to charge service fees to everyone[2] (Schmid

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[2] An example of this is when costs are apportioned by usage. While one city or township may require more runs than another, all the other municipalities benefit. However, they are not charged for the benefits

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2004). Consequently, when localities come together to form an interlocal agreement, exact costs and users of service are not easily identified. Fixed costs are particularly hard to allocate and fire departments are faced with high fixed equipment expenditures. Thus, it is important in negotiations to ensure that the buyer of the service is not subsidizing the seller, or vice versa, in order for economies of scale to be realized.

2.1 *Determinants of Cooperation and Empirical Work*

The topic of intergovernmental cooperation determinants has been thoroughly researched to date. Most studies agree to the same factors but often have different names for the same terms. General determinants of a positive agreement are a smaller number of participants, higher number of previously shared activities, rurality, low ratio of elected to appointed officials, excess demand due to deficient service provision, rapid expansion and creation of needed services from growth, and homogeneity in demand factors as well as economic, political and social factors among participating localities (Olson 1966; Gerber and Gibson 2005; Feiock 2007; Krueger and McGuire 2005). Other research on determinants of intergovernmental cooperation finds that those jurisdictions with less restrictive laws regarding cooperation are most likely to come to formal agreements (Feiock, 2007; Gerber and Gibson 2005).

Political determinants of intergovernmental cooperation include factors such as the level of member support required to approve plans, rules regarding ease of vetoes or decision challenges, and other governance and legal issues (Gerber and Gibson 2005). Local actors often put more weight on political costs than potential economic savings.

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they receive as potential users. This concept may be more obvious in police protection. The existence of a police department protects the whole community through preventative measures and their presence in high crime neighborhoods.

The current political climate, both local and federal, as well as the type of cooperative activity proposed and regional demand and supply for those services heavily influence perceived political costs (Gerber and Gibson 2005; Feiock 2007). Political transaction costs from structure, power distribution, and security during negotiations between public officials and other agents involved have also been proposed to have an inverse relationship with cooperation.

Many researchers agree that service measurability, ability to measure the quality and output of the service, is important in determining the likelihood of an interlocal agreement (Brown and Potoski, 2003; Feiock, 2007). Based on a survey of randomly selected mayors and city managers from around the country, Brown and Potoski created a scale of measurability ranging from 1 to 5 (2003). Of sixty four services, on average rating 2.69, fire prevention/suppression was rated 3.24, where a score of 1 represented an easily measured service, 3 moderately difficult, and 5, highly difficult. Thus, fire service is perceived as being more difficult to measure than the average public service.

There is another branch of literature that correlates service cooperation to transaction costs. A paper by Brown and Potoski (2003) found that transaction cost risks are key to a government's decision to collaborate in public service offerings. Intergovernmental cooperation or joint contracting, where full information exists, is a way to alleviate contact risks and high transaction costs in fire service provision. Congruent with their theory, the institution of city managers and single-member districts reduce transaction costs in cooperative agreements. Institutional variables such as the existence of a city manager over a mayor and a higher proportion of single member districts versus at-large districts are positively correlated with the decision to engage in a

collaborative venture. Municipalities with a city manager are 5.3 percent more likely to engage in interlocal cooperation. The authors of this study speculate that city managers "are more likely to limit the impact of rent seekers and find common ground among competitors in interlocal cooperation" (Krueger and McGuire 2005, 27).

Other empirical studies that seek to discover benefits of fire protection cooperation have found little evidence of economies of scale. Three different studies have found that economies exist in cities with populations under 10,000, 100,000, or 300,000 with larger cities showing proof of diseconomies (Doeksen and Peterson 1987). Other studies of larger U.S. cities (greater than 25,000 populations) found that fiscal pressure is not a statistically significant variable in contracting considerations whereas cost factors and political influences are significant (Morgan and Hirlinger 1991). It has also been demonstrated that private firms may provide fire service at a lower cost than public fire protection (Doeksen and Peterson 1987).

2.2 *Cost Allocation Agreements (i.e. cost sharing mechanisms)*

To date, fire service consolidation studies have looked mostly at the determinants of intergovernmental cooperation decisions, existence of economies of scale or changes in the quality of services provided. Scorsone and Martin (2006) researched the impact of cost allocation formulas among 24 cooperative fire departments in Michigan. Using data from political, financial, and organizational characteristics of the entities involved in the study, the authors sought to determine patterns of choice among cost allocation mechanisms. Focusing on community characteristics, specifically population and SEV, they tested correlation with cost sharing allocation choice, either equal or usage based.

Through various testing, they found evidence of a correlation between these variables. However, due to limited data and a constrained model, their analysis deserves further study to determine conclusive results.

Cost allocation studies have been conducted in other industries that share common features with fire protection. The electric industry suffers from the task of allocating cost via electric rates but faces similar problems as fire departments in doing so because it is largely capital intensive and has peak load problems. Additionally, some types of electric services, like fire services, can be traced in a direct way to a consumer and the loss or gain of a consumer does not correspond with a proportional decrease or increase in cost. Because of these issues, there are some researchers who believe that cost allocation, whether fixed or proportional to usage, does not effectively distribute costs (Kelly 2004; Sunder 1983). One argument against the reliability of cost sharing strategies is that, "fully allocated cost methodologies do not yield reliable information about whether it is worthwhile for a business and for society to produce another unit of output given the prevailing price for that output. They provide cost estimates that reflect opportunity cost…to produce more or less of a particular good" (Kelly 2004, 22)[3].

There have been other studies regarding cooperation among electric utility companies where cooperative groups are referred to as power pools. These power pools typically share in the activities of electricity generation and transmission and cost studies mainly focus on allocating fixed costs. These studies have revealed that across different cost sharing options, total electricity prices and customer payments vary widely suggesting that no method accurately distributes cost shares. In 1996, one researcher

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[3] In his article, Kelly focuses on the futility of cost allocation strategies in the electric industries. However, he does point out that his theory applies to all industries, "regardless of whether the common cost is a sheep or a 500-MW power plant" (22).

wrote, "Designing a cost allocation rule which encompasses both the complexities of power transmission business and the economic and regulation requirements is a topic still open to much discussion" (Marangon Lima, 1413). The problem of designing a cost allocation mechanism among governmental units is also undecided. While the topic of fixed cost distribution among power pools is widely discussed in the literature, there has been little consideration of this same issue across fixed cost intensive governmental service units.

3. Michigan's Rules

There are many laws in Michigan that facilitate and may even encourage intergovernmental cooperation. Public Act (PA) 57 of 1988, the Emergency Services to Municipalities Act, allows two or more municipalities to incorporate for the purpose of providing emergency services and to levy property taxes to fund the authority. Authorities must include the entire area of the municipality incorporated under this act. The Office of the Great Seal shows that twenty-five fire authorities have been incorporated under this act since 1988. The records, however, do not show whether these groups are still currently active.

There are four relevant acts regarding the issue of fire cooperation in Michigan. The Urban Cooperation Act of 1967, PA 7, allows for interlocal public agency agreements and for certain tax revenues to be received as revenues by the agreements. The act requires that these agreements be publicly filed. Similarly, PA 8 of 1967, the Intergovernmental Transfers of Functions and Responsibilities, allows two or more political entities to enter into a contract in which they are able to transfer functions or

responsibilities, with certain limitations. The act also allows for creation of a separate administration to oversee implementation of the agreement. The Office of the Great Seal as well as self-reporting data show that about twenty-eight fire groups have cooperated under the statutes provided by PA 7.

PA 33, the Police and Fire Protection Act of 1951 is a tool for fire cooperation for cities, villages, and townships with populations less than or equal to 15,000. This act allows for joint purchasing of equipment, charging and collection of fees for these purchases, and creation of special assessment districts and administrative boards. In our comprehensive database, we have five fire groups which are cooperating under PA 33. In this case, data from the Office of the Great Seal were unavailable so these figures are based on self-reporting information from annual fire audits. Since most of the agreements we found had an average population under 15,000, we can probably assume that many more than five groups are taking advantage of this statutes.

4. Common Cost Allocation Choices

In order for cooperation to occur among fire departments, costs must be allocated such that municipalities can reach an agreement while maintaining fiscal benefits in each area. Cost allocation is challenging for many reasons. First, cooperating units need to decide which factors are most important in determining an equitable cost formula. Municipalities that are similar in size, population, SEV, and number of residential dwellings are less likely to encounter problems distributing costs. However, when municipalities differ greatly in characteristics, then it is more difficult to determine a

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formula that will charge each unit according to the actual cost they elicit, making one unit is subside another.

Secondly, both fixed and variable costs must be accounted for in the cost allocation formulas to ensure savings for all units. Fixed costs are often difficult to allocate for many reasons. First, many units bring physical capital with them when they merge but the buyer of the services often only pays for incremental variable costs. While variable costs are easier to calculate and allocate, omission of fixed costs in cooperation agreements often leads to the financial demise of one or more of the cooperators. Additionally, capital purchases often have more accounting requirements, such as depreciation and loan interest, which is difficult to distribute in a cost agreement.

There are many methodologies for cost allocation in interlocal agreements. The most common methods, at least in Michigan, include annual subscription fee, run charges, percentage usage share, SEV share, and weighted formulas. Many cooperative efforts rely on a combination of the above strategies, such as an annual subscription fee plus run charges.

4.1 *Weighted Formula*

The weighted formula method allocates costs based on the share of certain factors of each locality. Common factors include population, SEV, and historical service usage. The formula can be updated annually or as often as new statistics are available. This formula is popular since many qualitative factors are implicitly included. Population may reflect the demand for fire service in each area and has a positive correlation with fire runs or historical usage. SEV takes into consideration increased demand for fire service

associated with higher valued properties. Persons with more valuable property are willing to pay more to protect it. Other advantages of the weighted formula are that it more accurately reflects benefits and costs, reduces uncertainty, is flexible and allows for changes in communities over time. Further, the process of agreeing to the weights in the formula increases the transaction costs of this strategy.

4.2 *Run Charge*

Choosing to share costs, based on run charges, requires that the group establish a cost per run rate by dividing the total costs of fire protection by the total number of runs. This is usually calculated from the previous year's data and can be updated annually as costs rise due to inflation. This method of cost allocation is simple to calculate and to implement but it treats all fire runs equally in terms of cost whether the run required above average equipment and services (such as a HAZMAT team) or was an average fire run. Additionally, if the number of runs varies from year to year the seller of the fire service may be left to cover remaining costs as well as any fixed costs that were not adequately incorporated into the budget (MSA 2005).

4.3 *Subscription Fee*

With this cost allocation method, the buyer of service pays a fixed annual sum to the seller for fire protection. No other variable costs are added based on usage later, which may be detrimental to the seller if they underestimated costs when fixing the price of the service. This method is not common because fire service may be unpredictable from one year to the next but it does provide the seller with budget certainty. Further,

since the subscription fee must be uniform, it acts as a regressive tax, leaving low income households with a much higher burden. More commonly, this method is combined with run charges to help eliminate any risk of variation from year to year.

4.4 *Percent Usage Share*

Percent usage share uses the total fire personnel hours for each city or township as a percent of the total personnel hours from the previous year. This carefully considers the difference in cost between various types of fire service. For example, it would charge more for a fire run that is in an outlying area and less for smaller, more controllable fires that use fewer resources such as garbage fires (MSA 2005). However, it is difficult to distribute fair portions of fixed costs using this strategy and it also heavily relies on dependable cost and personnel data. Surveys on service measurability have found that fire service output is generally considered difficult to measure which may lead to unreliable computations and cost distributions (Brown and Potoski, 2003).

4.5 *State Equalized Value Share (SEV)*

Cost sharing using SEV is based on the assumption that the demand for fire service is a function of property values. Collaborations that incorporate this sharing strategy usually levy equal millages on local SEVs, a strategy that is easily integrated into communities that have already levied special millages for fire protection previous to the cooperation agreement (MSA 2005). Since SEVs tend to vary little from year to year, this strategy reduces uncertainty in the fire provision budget.

Table 1. Summary of Cost Allocation Methods

Method	Pros	Cons
Weighted Formula	May reduce uncertainty and the probability of one group paying for another	Tends to be more complex and information may be difficult to gather
Run Charge	Simple to calculate if data are readily available	May not accurately distribute costs
Subscription Fee	Creates budget certainty	All variable costs must be estimated prior and with the chance that they may not be covered by the fee
Percent Usage	Better reflects costs of service	Difficult to incorporate fixed costs
SEV Share	Easily implemented and reduces budget uncertainty	May not accurately distribute costs by usage and need

4.6 *Examples*

In 1995, Plymouth Township and the City of Plymouth fully consolidated their fire services into one joint department. The agreement provided for the city to contract with the township, with the equity ownership being divided such that the township has 75% and the city 25%. They used a weighted formula to allocate costs with equal weight on SEV, population, and runs, with a stipulation that the city's share is never less than 25%. As a result of the merger, a projected $6 million was saved over the 10-year contract. The joint department also increased its accessibility to all areas, reduced response time in the township's western side, and found that firefighter performance and safety had improved.

In 2002, after five years of planning and negotiations, the Howell Area Fire Authority was formed under PA 57 of 1988, consisting of the City of Howell, and Townships of Genoa, Howell, Marion, Oceola, and Cochoctah. The city and townships had previously worked together under an arrangement in which the city covered 51% of the operating budget and the townships shared the remaining 49%. In 2003, the authority

passed a millage that covers all the expenses of the new fire department, eliminating the need for a cost allocation formula among the participants.

5. Conceptual Framework

The conceptual framework for this topic has not been thoroughly developed in intergovernmental research. The hypothesis regarding cost allocation strategies is that communities which share similarities in fire service demand characteristics are more likely to be involved in an equal cost sharing formula or any mechanism with an inherently low transaction cost (Scorsone and Martin 2005). The determinants of fire service demand are broad, varied and could logically include most municipal characteristics. Similar to cooperation, when municipalities share commonalities among determinants, transaction costs decline, raising the inevitability of a positive outcome. When negotiating cost allocations, similar municipalities will choose to keep transaction costs low and opt for the ease of equal cost sharing. When factors differ, municipalities may fear the possibility of paying a larger portion of the costs and subsidizing fire service. It is these fears that would lead to other usage or size based cost allocation formulas.

Theoretically, weighted formulas help distribute the burden of costs to those who incur the greatest costs. However, as discussed above, there is no optimal cost allocation formula, and there may be no methodology that accurately distributes a cost to its correct source. As a result, the main theory of cost allocation formula adoption is that weighted cost sharing formulas and other non-equal methodologies increase transaction costs. Therefore, only municipalities which have an incentive to annually reallocate costs or

determine a fair weighted formula (i.e. a department in which the benefits of negotiation outweigh the costs) will choose a cost sharing arrangement associated with higher transaction costs. Municipalities that have less in common are more likely to realize fiscal benefits as transaction costs rise. Similarities in demand determining characteristics will help ensure power and information symmetries and lessen the likelihood of a buyer or seller of public service subsidizing another user. In other words, since similar communities will not see a large difference in the amount paid to the cooperative fire department as they move from a low transaction cost agreement to a higher one, they are more likely to adopt lower transaction cost formulas; the benefits of low transaction cost agreements outweigh the cost of higher transaction cost ones.

There are two datasets that are referred to throughout this paper. The first is a comprehensive dataset that includes all of the known fire cooperatives throughout the state, totaling 126, as well as all the data available regarding their cost allocation structure and vote sharing methods. I used this database to collect the average of certain variables and used that information to fill in missing data into the other smaller dataset which was used for testing. The smaller dataset of 55 fire cooperatives includes those from the comprehensive dataset that were started after 1990, had cost allocation information, and were testable[4].

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[4] The dataset was selected to only contain fire groups that began after 1990 because of the time constraints in finding data for those beginning prior to that date. As mentioned earlier, data from the US Census prior to the year of initiation was used to gather the majority of the data with the exception of budgetary and SEV data. Finding data for the 1980 Census for each of the appropriate groups would have been beneficial if a time were not a constraint.
There were approximately five fire authorities that had to be eliminated from the dataset because they were "untestable". I used the coefficient of variation for the SEV data and the Census information in order to be able to compare the values despite the various means. Untestable groups were those that only included one non-Village participating entity, where data were not available for Villages. Thus, the coefficient of variation could not be calculated with comparative significance for these groups leading to their elimination from the dataset and their classification of untestable.

5.1 *Cost Allocation*

The database consists of four types of cost allocation choices: equal, property value share, fire runs, and a weighted formula. This list is also ranked in order of contractual costs, with an equal formula implying the least costly sharing method and the weighted formula requiring the highest negotiation investment. An equal cost allocation formula implies that the group has decided that each municipality contributes the same nominal amount. For example, the Tri-City Fire Department in Oakland County, which consists of the cities of Keego Harbor, Orchard Lake Village and Sylvan Lake have stated in their cooperation contract that each city will contribute exactly one third of the fire department's annual budget.

Property value share includes any cost allocation formula which is based solely on proportion or share of SEV, Taxable Values (TV), or requires millage or assessments. Property values are easily calculated since the state assesses these figures annually and the data are made public. However, since property values for Villages are not assessed, cooperatives that incorporate Villages typically do not use SEV as a method of cost allocation, other than a few exceptions. The basis for calculation in these few exceptional circumstances is unknown to the researcher.

Fire runs, which also include usage based strategies, are considered to have a higher negotiation cost than property values since it is more difficult to collect these data and the method requires each fire department to maintain their own accurate records. As mentioned above, when using fire runs as a cost allocation mechanism each party has to agree to the cost of a fire run. They must also come to an agreement as to whether each call that requires a fire truck should be given the same weight. For example, the group

needs to decide whether a garbage fire should carry the same weight as a house fire, and if not how each should then be weighted. In general, whether the group uses fire runs or percent usage, this methodology is generally difficult to measure and implement.

Weighted formulas are the most contractually costly methods since there are more variables to decide upon. The contracting groups have to first decide which variables should be included in the formula, some of which may be more difficult to measure, such as fire runs, and secondly they need to assign weights to these variables. In the fire cooperatives contained in this database most limited the number of variables to three and often included percent of taxable values or SEV, population, and historical usage.

There were some variables that did not directly fit into these four categories. One such example is when an authority used only population to determine their cost sharing formula. Since population data are readily available from the U.S. Census Bureau, which eases the calculations, it was categorized under property values because it is most similar to that method. There were other scenarios where cooperatives assigned unequal percents to each municipality, but did not specify how these percents were calculated. Under this scenario it is possible that the percents are decided upon by SEV share or by a weighted formula. Since there was no way to determine how the shares were decided upon I took the average in difficulty between property values and weighted formula and defined it as a fire run.

A final case is when groups had hybrid cost methods. In the final database there were only 2 such cases and I sorted them into the category which translated to their highest cost variable. For both these cases that variable was fire runs and thus they were put into the appropriate category. Table 2 lays out the distribution of cost allocation

methods among the fire departments included in the analytical portion of the study (i.e. these data come from the smaller database rather than the comprehensive one).

Table 2. Distribution of Cost Allocation Method in Database

Allocation Type	# Of Groups	% of Total
Equal	2	3.6
Property Value	30	54.5
Fire Runs	9	16.4
Weighted Formula	14	25.5
Total Contracts in Database	55	100.0 %

These four cost allocation mechanisms can be further collapsed into two groups if necessary: low transaction and high transaction cost. Equal share and property value share require little effort on the part of participating groups because while the former requires no research, the latter requires very little. These two groups are then best identified as low transaction cost. Further down the spectrum, fire runs or usage based and weighted formula allocations both require much more involvement on the part of the fire department and are considered a high transaction cost group for reasons discussed above.

5.2 *State Equalized Value, Taxable Values*

In 1994, Michigan voters passed Proposal A, which drastically changed the way properties were assessed and taxed. Previous to Proposal A, property taxes were based on SEV which is calculated as half of the appraised market value. However, since 1995 the Assessor is required to record three values for each property: SEV, the capped value,

and the taxable value. The capped value is equal to the previous year's taxable value increased by the amount of the Consumer Price Index (CPI) plus any construction modifications. A major impact of Proposal A was that the taxable assessment could only be increased by the amount of the CPI at a maximum of five percent. The taxable value, the third value recorded for each property, is the lesser of the SEV and capped value; this figure is used to calculate property taxes.

Since the dataset includes interlocal agreements previous to 1994, we used only SEV data for consistency. The SEV data would tell us the value of protecting the properties and would positively correlate with unequal, formula, or usage based allocation formulas. The larger the degree of difference between SEVs among cooperating groups, the more likely a non-equal allocation strategy would be used.

5.3 *Vote Sharing*

Vote sharing information is important to include in the study because the conceptual framework suggests that voting power among the cooperating municipalities reflects the choice of cost allocation. In other words, if the costs are based on a weighted formula then the final percent contribution by each locality would be proportional to their number of board members. However, this is not the case. In many of the intergovernmental ventures voting is equally weighted among the municipalities, yet, cost sharing is variable. It seems that in most cases board membership in cooperative agreements works much like the United States' taxation and voting system- even though an individual pays less in taxes they still deserve a vote that weighs as much as the person who pays more.

Table 3 below shows the breakdown of vote sharing among the fire departments included in this study. Over seventy percent of the 55 total fire cooperatives have fireboards with a fixed number of equal representatives from each participating municipality. Thus, each fireboard consists of the same number of appointed or elected officials (according to the rule of the agreement) from each municipality regardless of the differences in population represented or any other factor. This also includes the possibility that the board elects another member at large. Other fire departments, over sixteen percent, choose to weight representation by some factor, and allow a fixed number of members from each municipality that is not equal.

Table 3. Distribution of Vote Sharing
Method in Database

Vote Sharing Method	# Of Groups	% Of Total
Fixed Equal	40	72.7
Fixed Unequal	9	16.3
Variable Unequal	1	1.8
Unknown	5	9.2
Total Contracts in Database	55	100.0 %

5.4 *Number of Cooperating Parties*

As the number of cooperating parties increases the more difficult the cost allocation decision process becomes. The comprehensive dataset, which identifies 126 cooperative fire departments, has an average group size of 3.54. More cooperating parties will increase transaction costs. Therefore, if larger groups want to avoid even higher contractual costs they will opt for a lower cost sharing agreement such as property value share. Figure 1 shows the distribution of fire district size within the smaller testing

dataset, where the average number of participating entities is 3.85, slightly higher than the larger dataset average.

Figure 1: Group Size Frequency
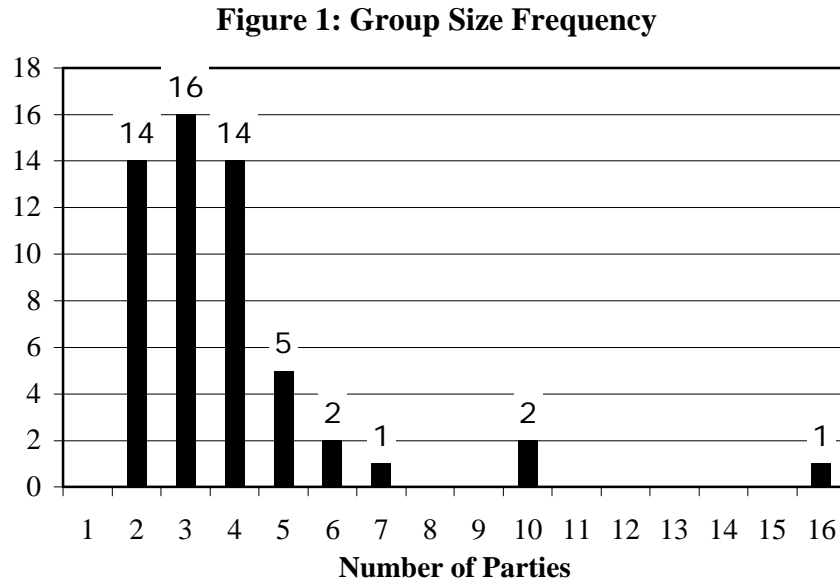
5.5 *Budget Data*

Following the theory proposed by Gerber and Gibson (2005) wealthy communities are less likely to cooperate since they do not have the pressure or incentive to do so, especially if political costs are high. In applying the hypothesis to cost allocation, departments that are not fiscally stressed would not be as concerned about accurately assigning costs, leading to a higher probability of an equal cost sharing agreement. Wealth, as it is used here, is simply defined as having both a large general fund as well as a consistently positive, non-borderline, end of year fund balance.

Within the annual audits, higher total expenditures may imply a greater degree of integration among the cooperating parties because of the higher risk involved. This is not

to be confused with the degree of integration discussed above which ranged from informal mutual aid to full consolidation. What I am referring to here is the amount of risk and interdependence carried by groups with higher yearly spending, which should correlate with the degree of urbanity or rurality. However, these groups are risking more and have more to lose should costs be inaccurately assigned.

There are two possible perspectives regarding expenditures' relationship to cost allocation mechanisms. On one hand, groups which have higher total expenditures will want to ensure that costs are more accurately distributed to the user and despite the additional contractual costs would opt for a user based or weighted formula allocation method. This is one way to reduce risk, especially if collaborating municipalities are very different. On the other hand, with costs already nominally higher, groups may want to reduce any further negotiation costs and seek a low transaction cost, particularly among similar cooperating groups. Therefore, if a group has high expenditures and the fire department is relatively dissimilar across participants, then the group is most likely to adopt a high transaction cost allocation formula. If on the other hand, the same group has a smaller expenditure level then they would theoretically be associated with a less costly allocation formula.

5.6 *Municipal Size*

The physical area of the municipalities plays a role in the efficiency and cost of service delivery. The variable chosen to measure this is the total square miles of the municipal area as defined by the U.S. Census Bureau. Theoretically, it is not the size of the municipalities which matters, but the standard deviation among them. However, it is

possible that larger areas may also face higher contractual costs when traveling to and from meetings. Additionally, larger areas are correlated with a higher population which may further raise contractual costs as more people become involved in the municipality's decision making process.

5.7 *Population, Income, and other Variables*

Population is another variable where similarity in size would imply the adoption of a less contractually costly sharing agreement. Population can often indicate the degree of rurality and rural areas are more likely to cooperate (Gerber and Gibson 2005; Feiock 2007; Krueger and McGuire 2005). Metropolitan areas experience more difficulty in creating interlocal agreements because transaction costs are higher due to higher population densities and greater political costs. This same principle should apply to cost sharing agreements.

Many more variables are included that follow the same conceptual framework as above. For these municipalities, data from U.S. Census Bureau was available for per capita income, median home value, percent of population categorized as white, percent of employed residents, percent of those below the poverty line, number of housing units, the rate of owner occupied versus renter occupied housing units, and the age breakdown of the population. Additionally, SEV data were collected from the annual assessment reports for Michigan. A pattern of similarity on each of these variables among participating municipalities, signaled by a low coefficient of variation, would indicate a low transaction cost agreement.

5.8 *Crime Rates and Other Omitted Variables*

Crime rates are relevant to the decision making process because of the correlation of arson and injury with fire and EMS runs. However, only major metropolitan areas record these data and they are only available for the year 2000. While these data would be beneficial to include in the study, lack of congruency makes this impossible.

There are many variables, both identifiable and not, which were excluded from the dataset. The type of governance used in each municipality indicates lower negotiation costs in cooperation agreements and would likely hold for cost sharing agreements. However, there is no formal record keeping of these statistics on a yearly basis and is not included in the study. Additionally, the share of industry type would have an effect on service delivery costs where commercial and industrial buildings usually correspond to higher costs. Again, these data were unavailable for the purpose of this study, though their omission may be significant.

6. Methodology and Results

The main source of data is a database of cooperative fire districts in Michigan since the 1980's. Information in the database was collected via many sources. Articles of incorporation and other documents retrieved from the Office of the Great Seal were used to compose the initial list of cooperative units. Most of the authorities identified were filed under PA 57 of 1988 or PA 7 of 1967. Information regarding cost allocation strategies and vote sharing among the fireboard was also obtained from these documents. The audits from the Treasury Department were helpful in supplementing these data while also providing the budgetary information included in the analysis.

The remaining variables for this dataset were collected from the U.S. Census Bureau. The census data, such as population and demographic characteristics correspond to the census year prior to the agreement start date. For example, if a joint service agreement was made in 2004 then the 2000 census data were used since these figures would have been used by the fire departments themselves. For data that were available on a yearly basis, such as SEV, figures from the year prior to the agreement were used. Thus, for the above example I would have looked at data from 2003. If the start date for the cooperation was not available then I assumed it was created in the average year of all the contracts in which I do have data[5]. The average starting year for cooperative agreements is 1993, so for annually available data I derived figures from 1992 documents and used 1990 census data.

6.1 *Two-Step Cluster Analysis*

The purpose of this study was to find patterns among variables and learn from similarities within groups. The determinants of the various cost allocation formulae were not the focus of this study, but rather the factors that are associated with one another according to the least number of differences or the most similarities. To best interpret any patterns of cost allocation among the 55 interlocal fire agreements I employed a two-step cluster analysis. Two-step cluster analysis is aptly named since it segregates data in two steps. Using the each fire cooperative observation as the unit of analysis, the program first segregates the data into preclusters, which are clusters of the original data grouped by distance using the log-likelihood criterion. In the second step, the program

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[5] The average year was derived from the comprehensive dataset which included all 126 fire cooperatives identified in Michigan for this study.

hierarchically groups similar preclusters into the pre-prescribed number of clusters. Two-step cluster analysis is thought to work best when each variable is independent, continuous and follows a normal distribution, however, the algorithm this works well when these conditions are not met (Norušis 2007)

This method is most appropriate because while it minimizes differences within clusters and maximizes the differences between the clusters, it is also the only type of cluster analysis that allows for the use of categorical variables as well as continuous variables. This dataset includes three categorical variables: cost allocation, vote sharing, and the number of participating entities per cooperative agreement. Additionally, two step cluster analysis does not require any distributional assumptions about the data.

The dataset used for testing included 55 observations. However, the two-step cluster analysis eliminates any observations that contain incomplete data. There are four variables in which complete data were not available: vote sharing, and annual revenues, expenditures, and end of year balances. This eliminated 13 additional interlocal agreements from the dataset leaving 42 observations for the cluster analysis.

Since this thesis focuses on comparing the degree of similarities and differences between the participants of each fire district observation, coefficients of variation were calculated for most variables. The cluster analysis calculates a mean value for each variable where a relatively lower coefficient of variation for a variable would imply that the fire districts in that cluster tend to be more similar than in the other cluster. Therefore, throughout the analysis, cluster variables for which coefficients of variation were calculated are categorized as either similar or different, relative to each other.

6.2 *Data Issues*

There are several issues that arise with this type of dataset. First, the timing of the events is not fixed. Not only are the cooperative agreements derived from various, inconsistent years but also it is unknown what other factors may have contributed to the cost allocation outcome. The agreement may be directly influenced by the state or federal economic conditions for that year, a severe weather pattern that increased the need for fire service, or the passage of a bill which encouraged cooperation or effected revenue sources. There are an infinite number of details that cannot be controlled for in time series like data.

Another data problem derives from the maturation of time. Older cooperative agreements may have altered their cost sharing arrangements in recent years, thus making the current method the product of learning from past actions. However, while we do have the start date of most collaborations, this does not necessarily imply that learning did or not take place. On one hand, even with a non-original staff, board members would negotiate a new agreement if it appeared to be more financially beneficial than the current one. On the other hand, the costs of negotiation and decision-making are high and many boards may opt for the status quo.

Additionally, these data are not a random sample nor do they comprise the entirety of intergovernmental cooperatives in Michigan. As reported earlier, the cooperating departments in the dataset were collected from two main sources: the Department of Treasury audit reports and the articles of incorporation files at the Office of the Great Seal. While more than the 120 were identified, the analysis was only performed on interlocal agreements which contained enough information for the study.

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In other words, many agreements were identified but their cost allocation strategy was not available in the articles of incorporation or their annual audit.

6.3 *Variable Selection*

Once the data were collected, there were over 15 unique variables from which to choose for inclusion in the analysis. Multicollinearity will bias the results of cluster analysis and needed to be considered. Many of the variables I obtained were highly correlated and thus most of them needed to be eliminated from the testing dataset. The variables for age composition were highly correlated with most other variables, namely population, square miles, and SEV. Since these variables are more directly involved in the cost allocation decision-making process in most cases, age variables were eliminated from the dataset but an average population age for each observation was calculated and used in its place.

Total SEV was also removed as a variable in the analysis despite its inclusion in many of the cost allocation formulas. It was significantly correlated with population, employment, and owner occupancy rates. Instead a SEV per capita figure was calculated[6]. This figure intuitively seems to be a better indicator than total SEV since it is an average rather than a total amount. An average value would help to moderate the impact of population variances. SEV per capita was shown to have a much smaller correlation with other variables as well. In the final datasets, all variables were deemed to have a small or fair amount of correlation with other variables, if not their inclusion was explained below.

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[6] SEV per capita was simply calculated by using the SEV for all the municipalities in the cost sharing agreement and dividing by the total population in all the municipalities.

6.4 *Test One*

After carefully eliminating variables from the dataset that may bias results due to multicollinearity, I ran the first test using twelve variables: 3 categorical and 9 continuous. The analysis distributed 62-percent of the observations to cluster 1 and the remaining to cluster 2. All of the equal cost sharing agreements and those based on fire runs were included in cluster 1 as well as 70-percent of those using property value share and 18-percent of the groups allocating costs using a weighted formula. These results are summarized in Table 4.

The results show that at the 90-percent significance level there were no statistically significant variables determining cluster 1. At a 95-percent significance level the number of participating entities and the coefficient of variation of median home value were significant in cluster 2 as was cost allocation at a 90-percent significance level. In general, cluster 1 consists of mostly lower transaction cost allocation agreements relative to cluster 2, where lower transaction cost sharing agreements consist of equal and property value share arrangements. The conceptual framework tells us that cluster 1 should also harbor more variables that are categorized as similar, referring to a lower mean coefficient of variation within that cluster. With this in mind, we can see in Table 5 that there are an equal amount of similar variables in cluster 1 as in cluster 2 revealing no obvious patterns. However, we can see that observations in cluster 1 had a higher mean year end balance than those in cluster 2 which does correspond to the theory presented earlier that wealthier communities will tend towards lower transaction cost contracts.

Table 4. Frequency of Cost Allocation Agreements
Between Clusters, Test One

	Cluster 1	Cluster 2
Equal	100.0%	.0%
Property Value Share	69.6.0%	30.4%
Fire Runs	100.0%	.0%
Weighted Formula	18.2%	81.8%

Table 5. Summary of Test One Results

		Cluster 1		Cluster 2	
	Variable	Relative Grouping	95 % Signif.	Relative Grouping	95% Signif.
Categorical Variables	Cost Allocation	-	No	-	No (90%)
	# Of Entities per Observation	-	No	-	Yes
	Vote Sharing	-	No	-	No
Continuous Variables	End of Year Balance '06	Larger	No	Smaller	No
	Median Home Value	Different	No	Similar	Yes
	Population Density	Different	No	Similar	No
	Per Capita Income	Different	No	Similar	No
	Poverty Rate	Similar	No	Different	No
	Median Income	Different	No	Similar	No
	% Of White Population	Similar	No	Different	No
	# Of Housing Units	Similar	No	Different	No
	Average Age	Similar	No	Different	No

Even though few variables are significant between the two clusters, we can still
learn something from the relative significance of each variable based on a t test at a 90-
percent significance level as displayed in Figures 3 and 4 (see Appendix 1 for variable
codes). The coefficients of variation for median home value and median income are the
top two variables in terms of importance for both cluster 1 and cluster 2, with the order of
variables changing slightly from that point. From this, we can infer that these two
variables are very similar within the two clusters yet very different between the two
clusters.

The only significant continuous variable, median home value for cluster 2, has a low relative coefficient of variation, implying that fire cooperatives in cluster 2 have fewer variations between cooperating parties. In other words, participating municipalities have more similar median home values in cluster 2 than in cluster 1 suggesting a possible relationship between departments using a weighted cost allocation formula and those with similarly valued homes, which contradicts the theory presented. However, few concrete conclusions can be drawn from this test because neither cluster can be designated as "more similar" assuming all variables are weighted equally. If variables were weighted according to their importance in cost allocation formulas, where median home value, population density, and number of housing units had a higher weight, then cluster 2 would be considered more similar, thus contradicting the theory presented earlier.

Figure 2: TwoStep Cluster 1, Test One
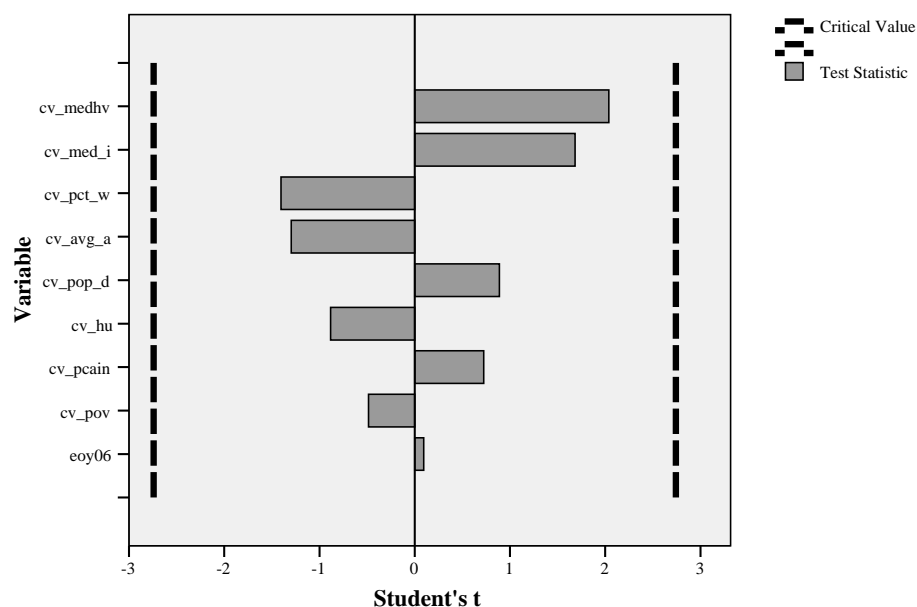
Figure 3: TwoStep Cluster 2, Test One
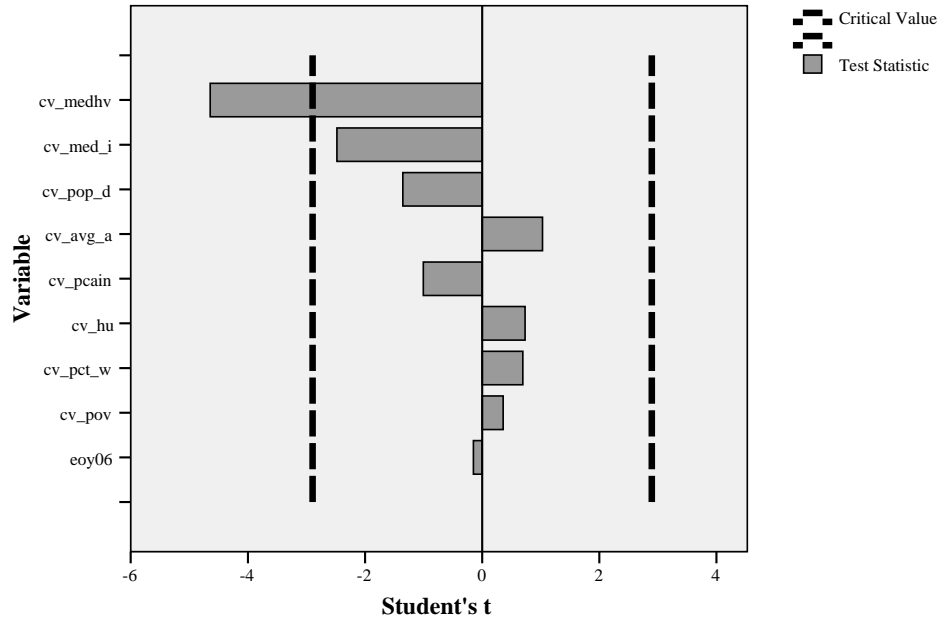
The analysis also revealed frequency patterns for vote sharing and the number of entities involved. The summary for vote sharing distribution among the clusters is summarized in Table 6. Cluster 1 contains the majority of the equal vote sharing groups as well as the entire unequal fixed and variable vote sharing agreements. While theory tells us that there should be a larger share of equal vote fireboards in cluster 1, the prevalence of other vote sharing arrangements does not reveal any obvious patterns among this group of observations.

Table 6. Frequency of Vote Sharing Agreements
Between Clusters, Test One

	Cluster 1	Cluster 2
Equal	54.3%	45.7%
Fixed Unequal	100.0%	.0%
Variable Unequal	100.0%	.0%

6.5 *Test Two*

As mentioned above, the correlation matrix revealed that many variables were significantly correlated. To correct for this, many variables were eliminated. However, some variables were interchangeable, such as SEV per capita and median home value, but could not both be included in the dataset. The next few tests examine the outcomes when different, still valid datasets, are used by replacing variables that tend to measure the same thing in different ways.

Test Two is the same as Test One except for the replacement of median home value for an SEV per capita variable. The correlation matrix revealed that these two variables are significantly correlated at the 0.01 level on a two-tailed test. For the sake of this study, it is very possible, and perhaps more likely, that SEV is a better measure to reveal cost allocation patterns.

Tables 7 and 8 below summarize results from this altered two-step cluster analysis, where 60 percent of the observations were assigned to cluster 1. The bolded items represent changes from the previous test. In Test Two, the distribution of cost allocation agreements among clusters is similar to Test One except that more groups who use a weighted formula are now in cluster 2. Also cluster 2's leading significant variable is cost allocation methodology at the 95-percent level followed by the number of participating entities at the 90-percent level. Even though SEV per capita was considered a substitute for median home value, it did not take its place in regards to its significance in cluster determinacy. Thus when SEV per capita replaced the coefficient of variation for median home value, only one collaborative using a weighted formula remained in cluster 1 and percent white became an important cluster-determining variable.

Another interesting result from this test is the importance of similarity of the percent white within fire districts in cluster 1. Additionally, there are slightly more similar variables in cluster 1 than cluster 2 in this test versus the last one. Cluster 1 departments also have a larger year-end balance and a larger SEV per capita, implying that this cluster contains wealthier communities. These results may indicate, as they do in Test One, that cluster 1 is wealthier and has a tendency towards contracts with lower transaction costs, matching the conceptual framework.

Table 7. Frequency of Cost Allocation Agreements
Between Clusters, Test Two

	Cluster 1	Cluster 2
Equal	100.0%	.0%
Property Value Share	69.6%	30.4%
Fire Runs	100.0%	.0%
Weighted Formula	9.1%	90.9%

Table 8. Summary of Test Two Results

		Cluster 1		Cluster 2	
Variable		Relative Grouping	95 % Signif.	Relative Grouping	95% Signif.
Categorical Variables	Cost Allocation	-	No	-	**Yes**
	# Of Entities per Observation	-	No	-	**No (90%)**
	Vote Sharing	-	No	-	No
Continuous Variables	End of Year Balance '06	Larger	No	Smaller	No
	SEV per Capita	Larger	No	Smaller	No
	Population Density	Different	No	Similar	No
	Per Capita Income	Different	No	Similar	No
	Poverty Rate	Similar	No	Different	No
	Median Income	Different	No	Similar	No
	% Of White Population	Similar	**Yes**	Different	No
	# Of Housing Units	Similar	No	Different	No
	Average Age	Similar	No	Different	No

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Figures 4 and 5 below show the results of a t test at the 90-pecernt significance level (see Appendix 1 for variable codes). The relative rank of the variables has changed from Test One where now the coefficient of variation for median income is the only common variable in the top three for both clusters. This pattern change may suggest that there are now more differences between the two clusters as compared to the results of Test One. Regardless, we can conclude from these results that the coefficients of variation for percent white and median income are important in determining these clusters.
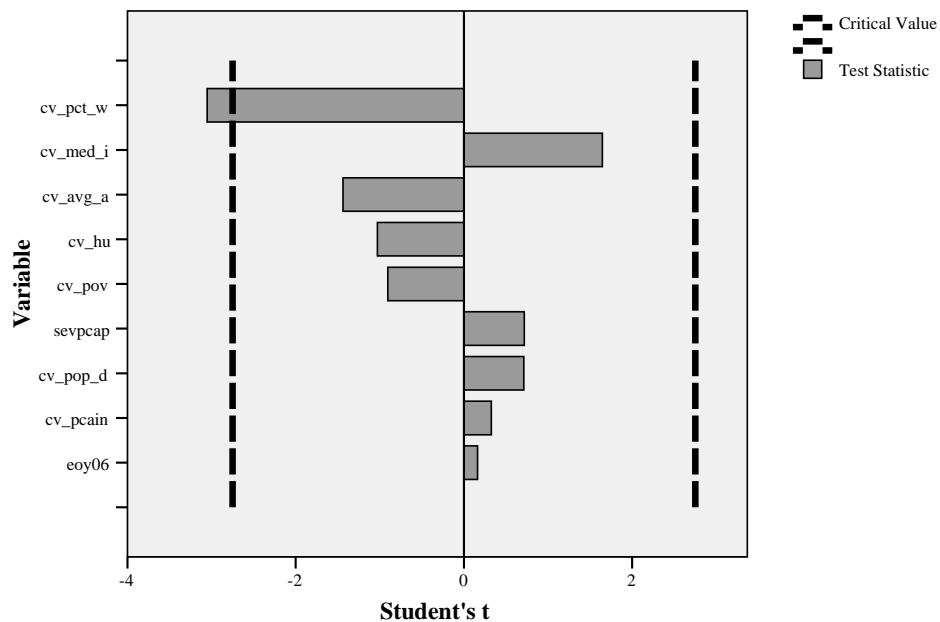
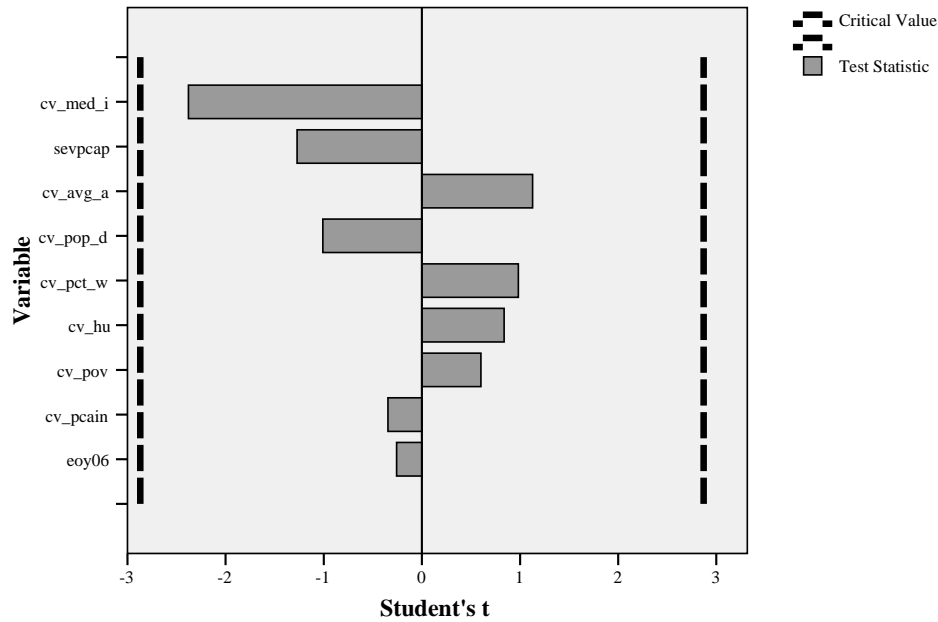**Figure 4: TwoStep Cluster 1, Test Two**

Figure 5: TwoStep Cluster 2, Test Two

6.6 *Test Three*

Test Three builds upon Test Two variables by leaving SEV per capita in the model and substituting the budget's year-end balance variable for expenditure data in the 2006 fiscal year. These two variables are highly and significantly correlated though they measure different parts of the budget. However, having a high year-end balance may imply a lack of financial stress while a high level of expenditures could indicate a higher degree of integration and more fundamental uncertainty.

Table 9. Frequency of Cost Allocation Agreements
Between Clusters, Test Three

	Cluster 1	Cluster 2
Equal	50.0%	50.0%
Property Value Share	95.7%	4.3%
Fire Runs	.0%	100.0%
Weighted Formula	18.2%	81.8%

Table 10. Summary of Test Three Results

		Cluster 1		Cluster 2	
Variable		Relative Grouping	95 % Signif.	Relative Grouping	95% Signif.
Categorical Variables	Cost Allocation	-	**Yes**	-	Yes
	# Of Entities per Observation	-	No	-	**No**
	Vote Sharing	-	No	-	No
Continuous Variables	**Expenditures '06**	Smaller	Yes	Larger	No
	SEV per Capita	Larger	No	Smaller	No
	Population Density	Different	No	Similar	No
	Per Capita Income	**Similar**	No	**Different**	No
	Poverty Rate	Similar	No	Different	No
	Median Income	Different	No	Similar	No
	% Of White Population	**Different**	**No**	**Similar**	No
	# Of Housing Units	Similar	No	Different	No
	Average Age	Similar	No	Different	No

Tables 9 and 10 above reveal that including the expenditure variable leads to a different pattern in the cluster analysis than in previous tests. First, we see a different clustering based on cost allocation, which is now a significant variable in both clusters. Cluster 1 consists predominantly of observations with low transaction cost agreements and cluster 2 is just the opposite. This cluster pattern better parallels the conceptual framework that finds equal and property value share cost allocation mechanisms to be closer in contractual costs than the remaining two cost allocation choices.

Expenditures are a significant variable once added to the analysis, where groups in cluster 2 have higher overall mean expenditures, consistent with the theory regarding expenditures presented earlier. Also interesting is that once expenditures were substituted into the analysis, per capita income became more similar among low transaction cost groups and percent white became more different, contrary to previous

results. Since both cost allocation and expenditures are significant in determining cluster 1 we can infer that patterns of similarity exist between these two variables.

In Figures 6 and 7 below, results from Test Three reveal that both the top three and the bottom three variables are different between the two clusters, but now expenditures and the coefficient of variation for number of housing units is important in both clusters. The number of housing units appears to be more varied among the fire districts in cluster 2 than in cluster 1, signaled by a relatively higher mean coefficient of variation, as well as with poverty rates and average age figures which are also important variables in these clusters. This tends to support the conclusion that fire districts in cluster 2, which tend to employ high transaction cost sharing formulas, will have a higher mean coefficient of variation for community descriptive characteristics.
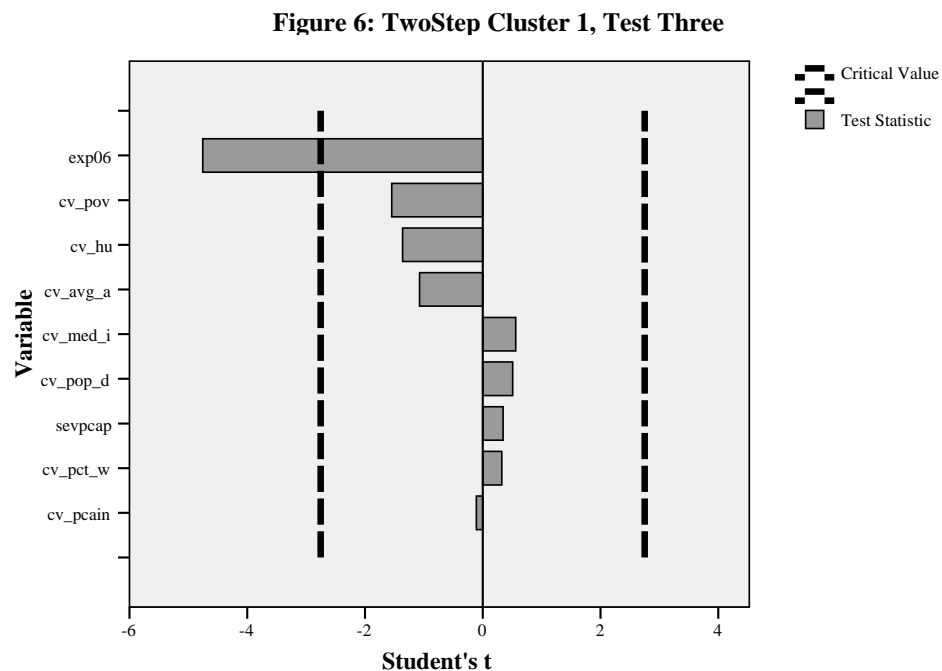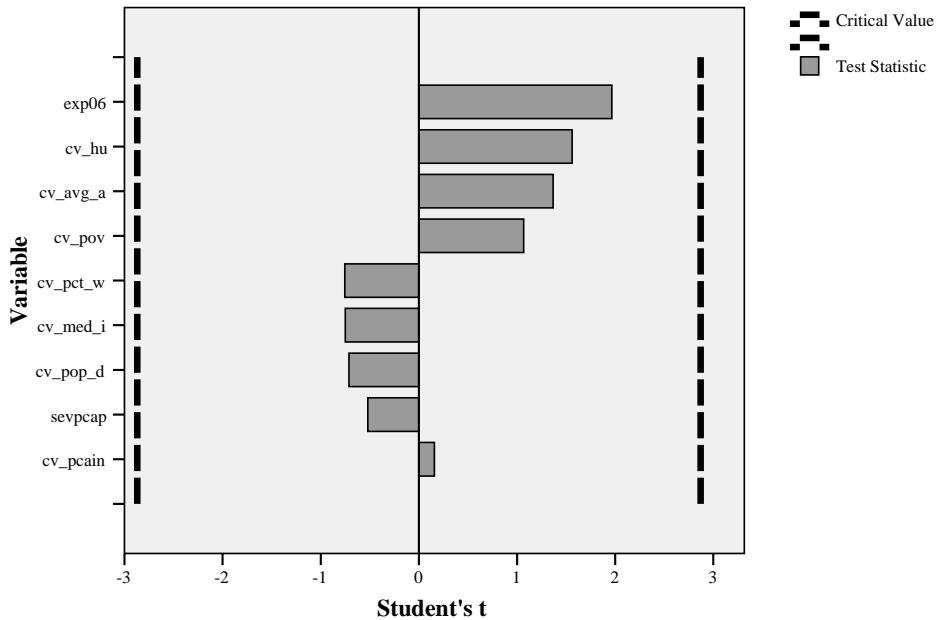
Figure 6: TwoStep Cluster 1, Test Three

Figure 7: TwoStep Cluster 2, Test Three

6.7 *Cost Allocation Distributions*

A summary of the change in cost allocation distribution among the two clusters and between the three tests is graphed in Figures 2 and 3 below. These graphs refer to the total number of each cost allocation type represented rather than the percent makeup of the cluster. By simply alternating between several similar variables, the number of each cost allocation strategy included changed within each cluster, where cluster 1 always represented a lower transaction cost group and cluster 2 was always relatively higher. The most significant change in cluster composition came with Test Three which used an expenditure variable rather than the year-end balance variable and resulted in a large change in property value share and fire runs distributed to each cluster.

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Figure 8: Changes in Cost Allocation Between Tests, Cluster 1
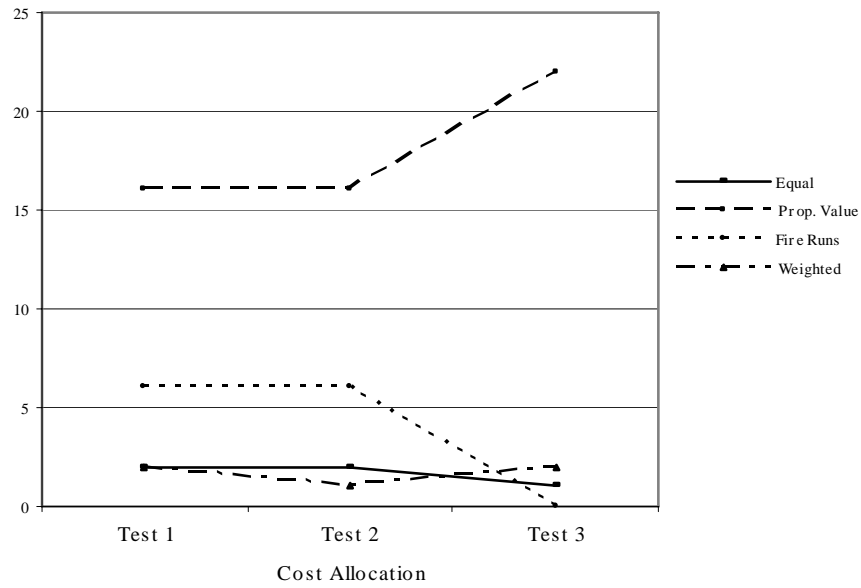
Figure 9: Changes in Cost Allocation Between Tests, Cluster 2
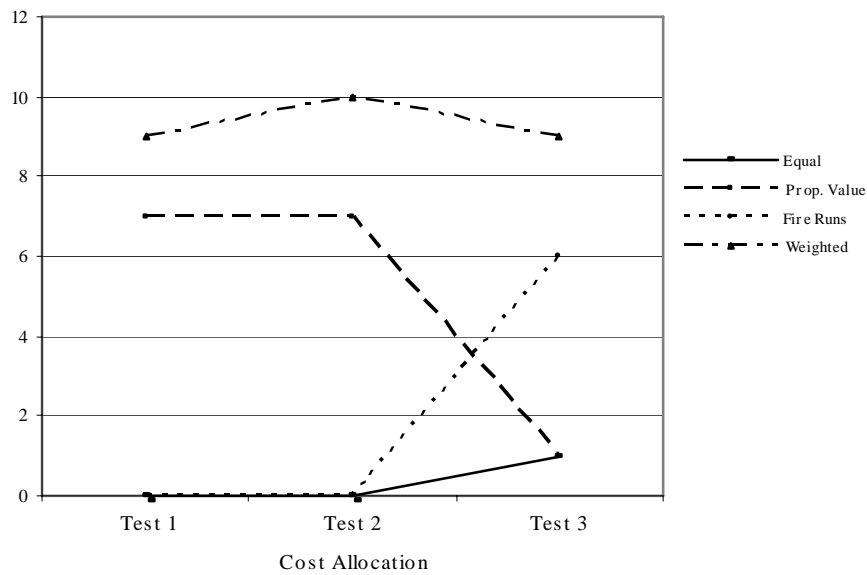
7. Summary and Conclusions

The results for the two-step cluster analyses are not conclusive but they do provide insight into some possible patterns. Theory tells us that similar communities, those with low coefficients of variation, should be included in cluster 1 which is associated with less costly contracting methodologies. Conversely, fire cooperatives exhibiting higher coefficients of variation should be the principal presence in cluster 2. Other variables such as expenditures, year-end balances, and SEV per capita, which are measured by their mean nominal value rather than a coefficient of variation, should follow the principle that wealthier communities will choose less costly transaction methods.

The conceptual framework was based on identifying groups that shared a higher number of similar characteristics and being able to find a pattern among their cost allocation choices, however, this was not always the case. The analyses showed only a few significant patterns of similarities and differences between cooperative entities and their cost allocation choices. The most significant patterns clustered cost allocation mechanisms and variations between median home value, number of municipalities involved in cooperative fire departments, the coefficient of variation for percent of white population, and expenditure levels for the fire district. Results from Test Three most clearly paralleled the conceptual framework where the variables most important to determining the clusters, both the significant and insignificant ones, were consistent with theory.

However, there are many ways this analysis could have been strengthened and the following suggestions should be taken into consideration for future studies. A small

number of complete observations was a major hindrance in this study. There were only 42 usable observations in the end but over 100 have been identified. Future studies will be more conclusive and robust if complete data for these 100 interlocal agreements are found.

There are also other variables that would be valuable to the analysis that were not included in this study for various reasons. Governance, which has been shown to highly influence decision outcomes, may be an important omitted variable and if time and resources allow data should be collected and included. Additionally, data on fire runs or usage rates by fire departments may help identify if differences in these rates lead to usage-based cost sharing methods. A measure of cooperation prior to the agreement, which may indicate that those with higher levels of previous cooperation tend to participate in equal cost sharing methods, is also worth considering for inclusion in the analysis. In terms of analyzing test outcomes, weighting variables may help to prioritize the variables especially as the dataset grows. While it may be important to include certain variables for statistical reasons they do not always offer much insight into patterns.

There is value in determining which variables are associated with various cost allocation methodologies. The main policy directive is to promote the cooperation of similar groups of municipalities. These groups have a higher incentive to select low transaction cost formulas since the benefit of a higher transaction cost formula is much lower than the cost of implementing it. The hope is that this information can be used in conjunction with data on the success and cost savings of these authorities, helping to ease negotiation costs in the future. Internally, cooperative groups can better identify

strategies that offer them the lowest costs of transaction and most savings based on their characteristics. From a statewide perspective, segmenting cooperative group types will help target policies to certain groups in order to increase the likelihood of profitable collaborations among all types of public services.

Appendix 1. Cluster Analysis Figure Codes

The following table identifies the variable which corresponds to the codes in Figures 2, 3, 4, 5, 6, and 7 above.

Table 11. Interpretation of Figure Codes	
Figure Code	**Variable**
eoy06	2006 end of year balance for the fire unit as recorded in the annual audit
exp06	2006 total expenditures for the fire unit as recorded in the annual audit
sevpcap	SEV per capita based on the year prior to the contract start date
cv_medhv	Coefficient of variation for the median home value in the participating units of the fire district as recorded by the U.S. Census prior to the contract start date
cv_med_i	Coefficient of variation for the median income in the participating units of the fire district as recorded by the U.S. Census prior to the contract start date
cv_pct_w	Coefficient of variation for the percent of white population in the participating units of the fire district as recorded by the U.S. Census prior to the contract start date
cv_avg_a	Coefficient of variation for the average age in the participating units of the fire district as recorded by the U.S. Census prior to the contract start date
cv_pop_d	Coefficient of variation for the population density in the participating units of the fire district as recorded by the U.S. Census prior to the contract start date
cv_hu	Coefficient of variation for the number of housing units in the participating units of the fire district as recorded by the U.S. Census prior to the contract start date
cv_pcain	Coefficient of variation for per capita income in the participating units of the fire district as recorded by the U.S. Census prior to the contract start date
cv_pov	Coefficient of variation for the percent of poverty in the participating units of the fire district as recorded by the U.S. Census prior to the contract start date

Appendix 2. List of Michigan Fire Authorities in Small Dataset

Standish Area Fire Authority, Arenac
1. City of Standish
2. Township of Lincoln
3. Township of Standish

The AuGres, Sims, Whitney Fire & Rescue
Authority, Arenac
1. City of AuGres
2. Township of Sims
3. Township of AuGres
4. Township of Whitney

Fowlerville Area Fire Authority, Livingston
1. Village of Fowlerville
2. Township of Conway
3. Township of Handy
4. Township of Iosco

Chelsea Area Fire Authority, Washtenaw
1. Village of Chelsea
2. Township of Lima
3. Township of Lyndon
4. Township of Sylvan
5. Township of Waterloo

ABB Joint Fire Board, Van Buren
1. Arlington Township
2. Bangor Township
3. City of Bangor

Brighton Area Fire Authority, Livingston
1. City of Brighton
2. Brighton Township
3. Genoa Township

Suttons Bay-Bingham Fire & Rescue
Department, Leelanau
1. Suttons Bay Township
2. Bingham Township

Sunfield, Sebwa & Danby Fire Association
District, Eaton
1. Village of Sunfield
2. Sunfield Township
3. Sebewa Township
4. Danby Township

Marshall Area Fire Fighters Ambulance
Authority, Calhoun
1. Township of Burlington
2. Township of Clarendon
3. Township of Convis
4. Township of Eckford
5. Township of Fredonia
6. Township of Lee
7. Township of Marshall
8. Township of Tekonsha
9. City of Marshall
10. Township of Marengo

Howell Area Fire Authority, Livingston
1. City of Howell
2. Township of Cohoctah
3. Township of Marion
4. Township of Oceola

Hartland Deerfield Tyrone Fire Authority,
Livingston
1. Hartland Township
2. Deerfield Township

Coloma-Hager Joint Fire Board, Berrien
1. City of Coloma
2. Coloma Township

Clinton Area Fire and Rescue, Clinton
1. Bingham Township
2. Greenbush Township
3. Victor Township

Lawton Fire Department, Van Buren
1. Village of Lawton
2. Township of Antwerp
3. Township of Porter

Decatur-Hamilton Joint Fire Department,
Van Buren
1. Decatur Township
2. Hamilton Township

Tri-Town Fire Department, Oscoda
1. Big Creek Township
2. Elmer Township
3. Mentor Township

South Kalamazoo County Fire Authority, Kalamazoo
1. Village of Schoolcraft
2. Village of Vicksburg
3. Township of Brady
4. Township of Prarie Ronde
5. Township of Schoolcraft
6. Township of Wakeshma

GRAAFSCHAP Fire Department, Allegan
1. Fillmore Township
2. Laketown Township

Caspian-Gaastra Fire Authority, Iron
1. City of Caspian
2. City of Gaastra

Saline Area Fire Department, Washtenaw
1. City of Saline
2. Lodi Township
3. Saline Township
4. York Township

Watervaliet Joint Fire Board, Berrien
1. Township of Watervaliet
2. City of Watervaliet

Litchfield Fire Department, Hillsdale
1. City of Litchfield
2. Litchfield Township
3. Part of Scipio Township
4. Part of Butler Township

Menominee & Ingallston Township Fire Department, Menominee
1. Menominee Township
2. Ingallston Township

Hart Area Fire Administrative Board, Oceana
1. City of Hart
2. Golden Township
3. Hart Township
4. Weare Township

Quincy Fire Association, Branch
1. Village of Quincy
2. Quincy Township
3. Algansee Township

4. Butler Township

Beaverton Area Fire Protection District, Gladwin
1. City of Beaverton
2. Beaverton Township
3. Tobacco Township

Caseville Area Fire Protection Association, Huron
1. Caseville Township
2. Lake Township

Addison Fire Department and Emergency Medical Service, Lenawee
1. Village of Addison
2. Township of Rollin
3. Wheatland Township
4. Woodstock Township
5. Village of Cement City

White Cloud Area Fire Department, Newaygo
1. City of White Cloud
2. Township of Everett
3. Lincoln Township
4. Sherman Township
5. Wilcox Township

Chesaning-Brady Fire Administrative Board, Saginaw
1. Chesaning Township
2. Chapin Township
3. Brady Township
4. Village of Chesaning

Brown City Area Fire Authority, Sanilac
1. City of Brown City
2. Burnside Township
3. Flynn Township
4. Lynn Township
5. Maple Valley Township

Sandusky Community Fire Department Association, Sanilac
1. City of Sandusky
2. Watertown Township
3. Custer Township
4. Elmer Township

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