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I am submitting herewith a dissertation written by Paula Dowell entitled "Electric Utilities, Fiscal Illusion and the Provision of Local Public Services." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Economics.

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ELECTRIC UTILITIES, FISCAL ILLUSION AND THE PROVISION OF LOCAL PUBLIC SERVICES

A Dissertation Presented
for the degree of
Doctor of Philosophy
University of Tennessee
Knoxville, Tennessee

Paula Dowell

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DEDICATION

This dissertation is dedicated to my parents

Mr. Paul H. Dowell

and

Mrs. Osa L. Dowell

I have been both blessed and inspired by their
unconditional love, encouragement and commitment.

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There are numerous individuals to whom I am deeply indebted and I would like to take this opportunity to recognize them for the important role they have played in making my tenure in graduate school such a rewarding and gratifying experience. Never have I worked so hard, yet enjoyed it so much.

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ABSTRACT

Restructuring activity in the electric utility industry is threatening a once stable and significant source of revenue for local governments. Potentially declining revenues from electric utilities leaves local policymakers with the unpopular decision of raising taxes or reducing the level of public services provided. This has led to pressure on state governments to introduce legislation aimed at mitigating potential revenue loss for local government due to restructuring activity. However, before imposing such legislation, a better understanding of the potential distortionary effects of internal subsidization by electric utilities is needed.

Two models of the demand for local public services- a structural model using the Stone-Geary utility framework and a reduced form model -are developed in an attempt to model the behavioral responses of local public expenditures to revenue contributions from electric utilities. Empirical analysis of both models is conducted using a panel data set for 242 municipalities in Tennessee from 1988 to 1998. Aggregate spending and expenditures on four specific service functions are examined.

The results provide evidence of a positive flypaper effect. Furthermore, the source of the flypaper effect is attributed to fiscal illusion caused by price distortions. The stimulative effect of electric utility revenue contributions on the level of local public services indicate that a $1.00 change in electric utility subsidies results in a change in local expenditures ranging from $0.22 to $1.32 for the structural model and $1.97 to $2.51 for the reduced form model. The amount of the marginal effect directly attributed to price illusion is estimated to range from $0.04 to $0.85. In addition, the elasticities of

electric utility revenue contributions are estimated to range from 0.05 to 0.90.

The results raise a number of interesting issues regarding municipal ownership of utilities and legislation regarding tax treatment of utilities after restructuring. The fact that the current study suggests that electric utility subsidies give rise to fiscal illusion raises new questions regarding the justification of safeguarding the exclusive franchise of municipally-owned utilities and revenues from electric utilities in the era of restructuring.

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CHAPTER 1

INTRODUCTION

1.1 Overview of Issues

Local governments have long enjoyed a stable, and in some instances significant source of revenue from the operation and taxation of electric utility companies and the services they provide. The National Council on Competition and Electric Industry estimates that local governments collect taxes on utilities that are generally double the effective rate imposed on other industries (Walters and Cornia 1997). The ability to tax utilities so heavily has been a function of their regulated status. Historically, electric utilities were given exclusive franchise to distribution services within a jurisdiction. Along with their franchise status came the expectation that they would be taxed. The utilities have been willing to pay the taxes because they are passed on to final consumers given the terms of rate regulation. Currently, however, the status of such firms is shifting as the regulatory climate in the United States undergoes a revolutionary change. The introduction of retail choice in the electric utility industry challenges the exclusive franchise concept of retail distribution and will potentially lead to declining revenue for local governments. Declining subsidies from electric utilities leaves local policymakers with the unpopular decision of raising taxes or reducing the level of public services provided. This has led to pressure from local governments on state governments to introduce legislation aimed at mitigating potential revenue loss for local governments due to restructuring activity.

By using municipally owned public utilities as tax collectors, local governments can use the revenue received from these entities to supplement their general fund, thus creating an internal subsidization mechanism. Colberg (1955) was among the first to address potential effects of internal subsidization via contributions from municipally owned facilities. In his assessment he writes:

> "In large part, however, this practice appears to have grown as a matter of expediency-it is an easy way to raise revenue; the citizens are unlikely to be fully aware of the amount or even the existence of the indirect tax involved in high utility rates; and monthly bills provide a heavy way of spreading out the impost over the year. Serious social diseconomies and inequities, however are involved in this method..."

The implication of Colberg's statement is that the lack of knowledge regarding the subsidy and the implicit taxes included in electric bill results in the voter's under-calculation of the tax price of local public services, thus giving rise to fiscal illusion.

The potential of fiscal illusion arising from the internal subsidization of local governments by electric utilities raises questions regarding the economic justification of safeguarding these revenues in the era of electric utility restructuring. Even though the issue of the possible distortionary effects of transferring revenue from municipal utilities was first raised by Colberg in 1955, relatively little research has focused on identifying and measuring these effects. However, given the current emphasis on tax implications of electric utility restructuring, a better understanding of the behavioral reactions resulting from revenue contributions from electric utilities is warranted. Articulating the impacts of the contributions in this manner can uncover important insights into their distortionary effects, effects that have potential implications for restructuring legislation regarding the tax treatment of electric utilities.

1.2 Electric Utility Revenue Contributions and Voter Behavior

Revenue contributions made by municipally owned electric utilities represent a sizable potential revenue source to municipal governments. In addition to paying taxes, the majority of municipal electric utilities generate a profit for the owning jurisdiction, which is often used to supplement the general fund. By diverting revenue from the municipal electric utility to the general fund of the local government, policymakers have effectively formed a system of internal subsidization. Internal subsidization may affect behavior of local policymakers by increasing the resources available to provide government services, which will have implications for the provision of those services. Following the standard approach of analyzing intergovernmental aid, the economic analysis of the expected effects of internal subsidization of local governments by electric utilities on the behavior of local policymakers starts with the behavioral effects of the subsidies on the individual (or median) voter.

Funds diverted to a local government's general fund from a municipally owned electric utility represent a lump-sum subsidy from an internally owned entity. The effects of the subsidy can be can be illustrated by Figure 1.1. Assuming the voter is aware of the electric utility's contributions to the local government's general fund, the increase in available resources, which arises from the lump-sum subsidy, will cause the voter's budget constraint to shift from AB to CD. The marginal cost (and the average cost) of providing local services remains unchanged. As a result, demand for local government services increases from g_o to g_1 due to the income effect of the subsidy.

However, if the voter is unaware of the subsidies from electric utilities to local

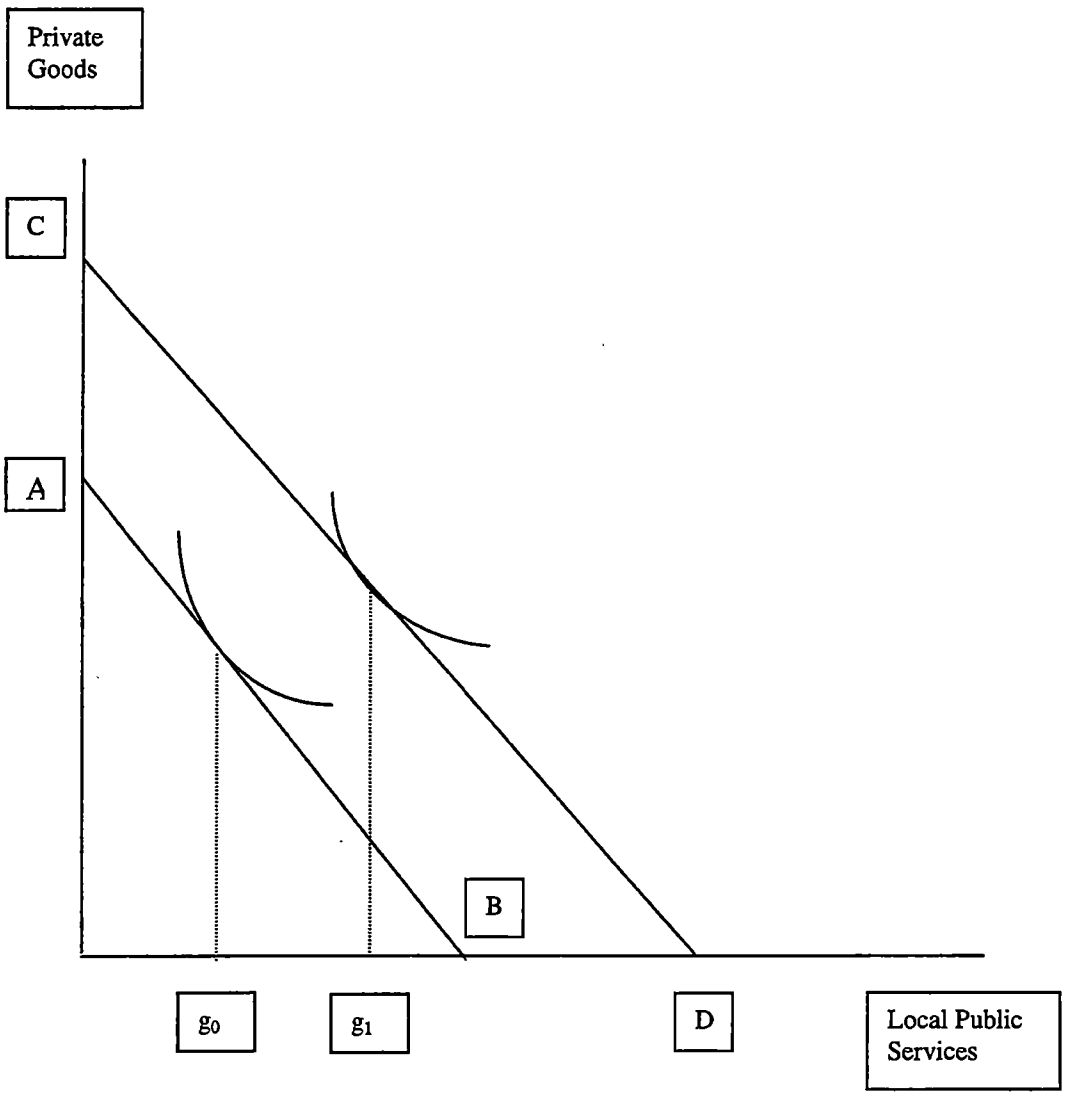


Figure 1.1

Effect of Lump-Sum Subsidy

governments and he bases his expenditure decisions on average price (or cost) of the service rather than marginal price (or cost), fiscal illusion will result due to distortions in the perceived price of public services. Figure 1.2 illustrates the effect of the fiscal illusion. First, the voter bases his expenditure decisions upon his average or perceived price indicating he calculates his perceived price for public services by dividing his tax bill (t) by the total level of public expenditure (E). Hence, average price is equal to t/E. Before the subsidy, average price equals marginal price. Therefore, the voter's actual budget constraint is equal to his perceived constraint and is depicted by segment AB. Receipt of the lump-sum subsidy increases the resources available to the voter thus the voter's *actual* budget constraint shifts outward to CD. The resulting demand for local public services is g_1 where average price of the public service equals marginal price. However, if the voter suffers from price distortions due to imperfect knowledge of the subsidies from electric utilities, his *perceived* budget constraint rotates outward and is depicted by segment AE. The perceived average price decreases, resulting in an expansion in demand for public services to g_2. The difference between g_0 and g_1 represents the increase in demand due to the income effect of the subsidy and the difference between g_2 and g_1 represents the increase in demand attributable to price illusion. The explanation for the more than proportionate increase in demand stemming from a price distortion as opposed to an income effect alone is the basic microeconomic foundation that price effects give rise to both a substitution and an income effect. The fact the electric utility subsidy potentially leads to a larger expansion than an increase in

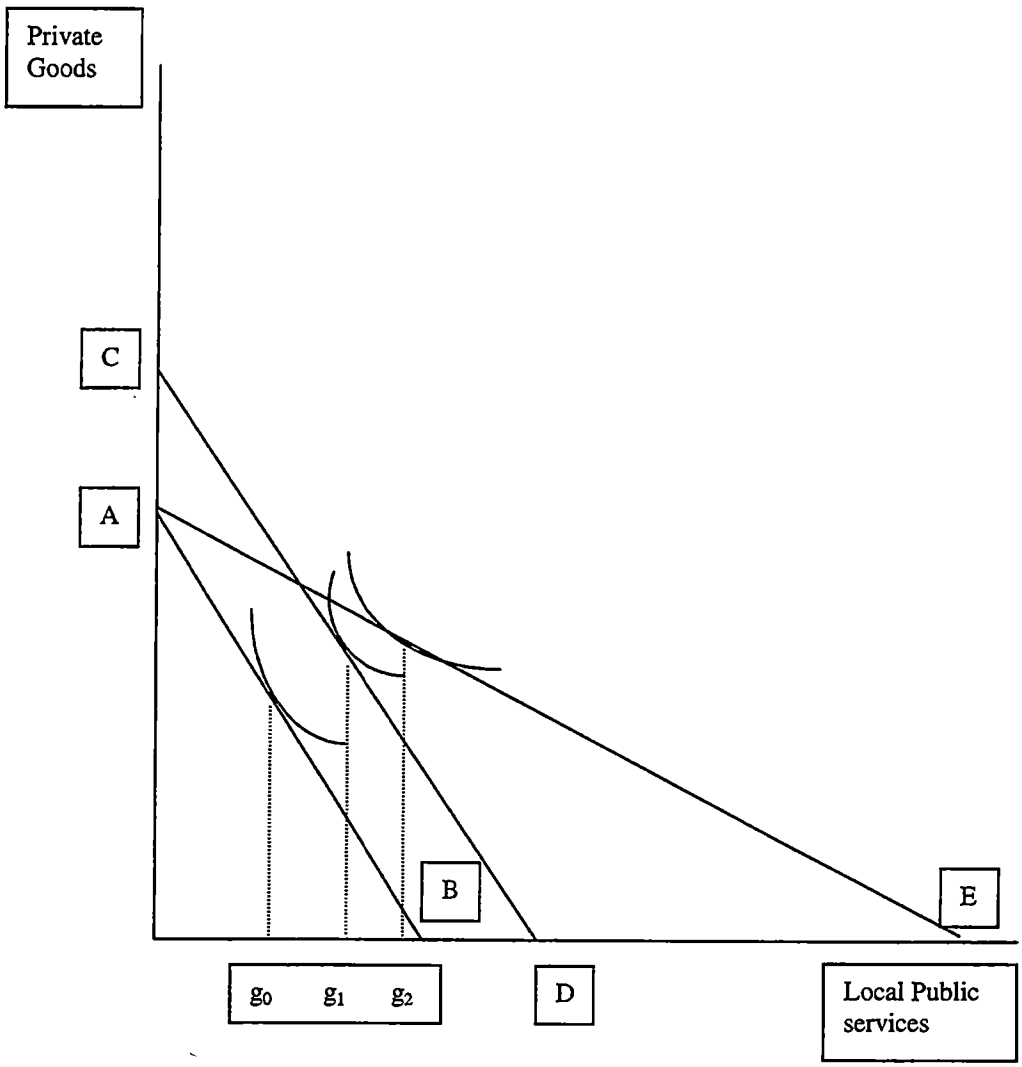


Figure 1.2

Fiscal Illusion Arising from Electric Utility Contribution

income alone suggests that these subsidies give rise to a flypaper effect.[1]

The above analysis implies that price illusion is the source of the fiscal illusion and the resulting flypaper effect. However, income illusion may also contribute to the flypaper effect. Because all applicable federal, state, and local taxes and fees are viewed as part of allowable expenses by regulatory agencies, these operating expenses have historically been included in electric rates and passed onto the utility's customers. Furthermore, since electric bills do not list these tax obligations separately, the general public is likely to be unaware of the tax burden. Failure on the part of the voter to recognize these implicit taxes can potentially lead to both price and income illusion. First, assume the voter has imperfect knowledge of the subsidies received by local government from the electric utility. He is aware of the subsidies but under-estimates the actual level of the contributions. If he bases his expenditure decisions on average price, his perceived price of public services will be less than the actual price. The resulting price illusion leads to an increase in the voter's demand for public services. Second, if he has no or imperfect knowledge of the tax payments used to finance the subsidy, his perceived income will increase. This leads to an increase in his demand for local public services due to income illusion.

The analysis of the potential impact of electric utility subsidies directly follows the analysis of the flypaper effect associated with intergovernmental aid. However, it is plausible that subsidies from municipal electric utilities give rise to a more significant

[1] The flypaper effect refers to the notion that money paid directly to government tends to "stick" in the public sector.

flypaper effect relative to intergovernmental aid. This hypothesis is based on the fact that the subsidies from municipal electric utilities are almost entirely financed by the residents of the community served by the utility through higher electric rates. If the municipal electric utility serves only those consumers residing in the political boundaries of the jurisdiction receiving the subsidy then no exporting of the tax burden occurs. On the other hand, grants from state and federal governments are financed by state and federal taxpayers, thus providing a greater potential for exportation of a portion of the tax burden.

1.3 Contributions of the Current Study

The current study makes contributions to the fiscal illusion literature in two significant areas. First, it contributes to the literature investigating the stimulative effect of municipal electric utility subsidies by; 1) providing empirical evidence of the existence of a flypaper effect, 2) identifying fiscal illusion as the source of the stimulative effect, and 3) providing estimates of the magnitude of the illusion. Additionally, empirical analysis of the stimulative effect of electric utility subsidies is provided for both aggregate local government expenditures and expenditures for specific functions. The second area that the study contributes to is the growing body of more general literature examining fiscal illusion and the flypaper effect. The study advances the work in this area by providing an empirical analysis of the stimulative effect of an *internal* subsidy as opposed to subsidies from state or local governments. Specifically, the current study provides the framework necessary to test the hypothesis of a more significant flypaper effect associated with subsidization by locally owned entities relative to subsidies from higher levels of government or other external entities.

The study appeals to several areas of literature to establish the theoretical foundations of the conceptual and empirical models used in the analysis. Given the limited literature specific to the stimulative effect of electric utilities on local government spending, the primary source of underlying theory used for the study is from the models of fiscal illusion utilized to investigate the stimulative effect of grants. Other areas of research central to this work include studies investigating local fiscal behavior and demand analysis.

Two models of the demand for local public goods are developed in an attempt to model the behavioral responses of local public expenditures to revenue contributions from electric utilities. The empirical analysis of both models is conducted using data on the aggregate level of local public expenditures and data on expenditures for four specific service functions. The four service functions used in the study include streets and public works, public safety, general government, and social welfare and recreation. Data used for the analysis consist of panel data comprised of a cross-section of 242 municipalities located in Tennessee for the time period spanning from 1988 to 1998.

First, a structural model is developed and empirically estimated. The appeal of the structural model is that it is derived directly from the constrained utility maximization problem of the median voter, thus the model retains the theoretically desirable properties related to demand theory. The structural model chosen for the current study is based on the linear expenditure system (LES) derived from the Stone-Geary (S-G) utility function. Two specifications of the structural model are estimated and presented. Both specifications find support for the existence of fiscal illusion at the aggregate level and

across specific service functions. The source of the illusion is price distortions stemming from the voter's misperceptions regarding the level of contributions the local government receives from electric utilities. The second specification, which assumes independence of electric utility subsidies across local jurisdictions, produces results that are much more consistent and robust across all service categories.

The second model developed and empirically tested is a reduced form model based on the more standard log-linear determinants models of Borcherding and Deacon (1973) and Bergstrom and Goodman (1974). Fiscal illusion stemming from electric utility contributions is analyzed via the inclusion of a single perception parameter, therefore the model does not allow for the separation of fiscal illusion into price and income effects. The empirical results of the log-linear model using municipal level data provide evidence that a positive flypaper effect exists for aggregate level expenditures and for the four specific service functions examined. Further analysis of the flypaper effect implies that the voter routinely underestimates the true marginal price of the public good due to imperfect knowledge of subsidies from electric utilities.

The stimulative effects of electric utility contributions on the level of local public services are examined using two measures: marginal effects and elasticities. The marginal effects yielded by model 2 and the log-linear model indicate a positive relation between changes in expenditures and electric utility contributions for all the specifications. The decrease in expenditures in response to a $1.00 decrease in utility contributions range from $0.22 to $1.32 for the structural model and $1.97 to $2.51 for the reduced form model.

The three models suggest that demand for expenditures across all service functions is relatively inelastic with regards to revenue contributions from electric utilities. For example, the elasticities of electric utility contributions for general fund expenditures range from 0.29 for model 2 to 0.90 for model 1. The estimated elasticities for the four service functions examined range from 0.05 to 0.48.

The purpose of developing the models used in the current study is to understand the relationship between electric utility contributions to the general fund of local governments and the level of local public goods provided. Articulating the impacts of these contributions can uncover some important insights into the manner in which local governments may react to the impact of electric utility restructuring on the level of contributions. Should contributions from electric utilities wane, these reactions include a choice between fiscal retrenchment and fiscal replacement. Using the elasticity results from model 2 of the structural model and the log-linear model, responses to changes in the level of electric utility subsidies are simulated under a number of simple restructuring scenarios. These simulations imply that if electric utility subsidies fall by 10 percent as a result of electric utility restructuring, local general fund expenditures will respond with a proportionately smaller decline ranging from 2.9 percent to 3.2 percent. In comparison, the model suggests that a 10 percent decrease in household median income would lead to a 2.5 percent contraction in local public expenditures.

This research on fiscal illusion associated with internal subsidization of local governments by electric utilities has generated a number of interesting insights regarding both the issue of municipal ownership of utilities and legislation regarding the tax

treatment of electric utilities after restructuring. One of the major issues it raises centers on deciding the level of protection that should be granted to local governments against revenue loss due to increased competition in the electric utility industry. The current trend in states that have implemented competition is to enact legislation aimed at protecting local governments from revenue erosion. However, given that electric utility subsidies have been shown to give rise to a flypaper effect stemming from fiscal illusion potentially raises new questions regarding the economic justification of safeguarding these revenues.

1.4 Organization of the Study

The remainder of the dissertation is organized as follows. The theoretical foundations are discussed in Chapter 2 including relevant literature from the area of fiscal illusion related to both intergovernmental aid and municipal electric utilities. In addition, the conceptual framework for modeling the demand for local public services for both the structural and reduced form models is presented. Chapters 3 and 4 provide the empirical analysis of the structural model and the reduced form model, respectively. Results are presented for both aggregate level expenditures and expenditures by service functions. Along with the estimates from the empirical models, calculations of the marginal effects and elasticities are presented. A detailed comparison of the models is provided in Chapter 5. This chapter discusses model reconciliation based on consistency, robustness, and magnitude of results. In addition, simulations of the impact of changes in the level of electric utility contributions are conducted by employing the elasticities from the study.

The chapter closes with a discussion of policy insights and a summary of the major findings of the study.

CHAPTER 2

THEORETICAL FOUNDATIONS

2.1 Introduction

The current study will appeal to literature from several areas of research to establish the theoretical foundation of the models developed in subsequent chapters. The primary source of theoretical underpinnings is found in the research investigating the phenomenon of fiscal illusion. Until now, fiscal illusion has predominantly been associated with intergovernmental aid with limited extensions to electric utility contributions. Sections 2.2 and 2.3 provide a discussion of relevant literature in the area of fiscal illusion. The remaining sections examine the conceptual framework of modeling the demand for public goods. Section 2.4 provides an introduction to the methods used to model the demand for local public services in the current study. Sections 2.5 and 2.6 examine the linear expenditure system and its application to the current study in more detail. A reduced form log-linear model is presented as an alternative in section 2.7. Finally, section 2.8 provides a summary of the theoretical foundations used in developing the models in the analysis.

2.2 Models of Fiscal Illusion

Theoretically, income and lump sum aid should have the same effect on the level of local public goods provided under the median voter hypothesis (Oates 1979). However, it has been empirically observed that lump sum grants are more stimulative than income on the level of public expenditures. For example, Gramlich and Galper (1973) and Feldstein (1975) find estimates of the marginal propensity to spend from lump

sum grants to be much higher than the estimates of an increase of a dollar in private income. The asymmetry between income and aid that is observed has been dubbed the flypaper effect or "money sticks where it hits."

Fisher (1982) provides a review and comprehensive analysis of the flypaper effect. In all the analyses public goods are assumed to be normal goods. He states that there are four basic explanations of the flypaper effect: 1) some form of fiscal illusion, 2) political institutions, 3) tax substitution, and 4) statistical errors. In his analysis, Fisher addresses the fiscal illusion models of Oates (1979) and Courant, Gramlich and Rubinfeld (1979). He concludes that whether or not this type of fiscal illusion can explain the flypaper effect depends on whether individuals or officials base their spending decisions on some form of average price instead of marginal price. Formulation of spending decisions based on average price can generate price effects from lump sum grants. For example, when a jurisdiction receives a lump sum grant unknown to the voter, the perceived average cost of the public good is reduced. If the voter believes that the average cost is the price, then it appears that the price has been reduced, thus leading to an increase in expenditure. The illusion occurs because the marginal cost of providing the public good is not reduced by a lump sum grant.

The second explanation for the flypaper effect discussed by Fisher is tax substitution. Heins (1971) and Fisher (1979) argue that public expenditures can increase from lump-sum grants even if there is no resource increase in the subnational jurisdiction. It is argued that this phenomenon occurs because the different tax systems used by the different levels of government can create individual income effects. For example, for the

median voter the change in income is the difference between his share of the local grant and his federal tax payment for the grant. The grant leads to a positive income effect if the voter's share of the local grant is greater than his payment for the grant. In this case, the grant will lead to an increase in the level of local public expenditures.

The next contributor to the flypaper effect examined by Fisher is political institutions. Romer and Rosenthal (1978) indicate that certain political institutions, such as bureaucratic monopoly power, can invalidate the "as if" power of the median voter upon which the standard public goods demand model is based. However, Fisher contends that the specific institutions considered in the work of Romer and Rosenthal do not seem to offer alternative theoretical predictions about income and grant effects that are more consistent with the empirical results than those of the standard model. This leads to his final explanation for the flypaper effect—statistical problems. Several authors have identified some statistical difficulties with the treatment in the above models of what are apparently lump-sum grants. Chernick (1979), Goetz (1967), and Fisher (1979) have all identified a problem with grant classification. For example, when investigating formula based grants, it is often the case that the matching rate (in the case of matching grants) or the tax effort measure (in the case of revenue sharing) is treated as exogenous. Chernick (1979) provides an argument that grantors could engage in the allocation of different grants based on price elasticity of demand of the public goods across jurisdictions. In other words, the grantor could maximize output of a specific public good for a given cost by favoring recipient jurisdictions that have a more price elastic demand for that good. In this case, neither the intergovernmental aid nor the matching rate is exogenous to the

recipient government. Other potential statistical problems giving rise to the flypaper effect include the relative variability in income relative to grants, and the exclusion of intergovernmental tax incentives such as deductibility of certain subnational taxes.

The current study will be focus on the examination of the flypaper effect and the role of fiscal illusion. One of the most widely recognized models of fiscal illusion is the Oates model. Oates (1979) finds that changes in lump sum intergovernmental grants have price effects. In other words, they move one along the demand curve for public goods as opposed to a shift of the demand curve resulting from changes in income. Oates provides a model of local fiscal choice in which local policymakers maximize output subject to the constraint that voters' demands be met. Oates also uses the median voter model in his analysis as a means of aggregating voter preferences. He proposes that the voter makes his or her decision based on two pieces of information: the level of output and the resulting tax liability which is known only as the tax price, not necessarily the true cost of the good. In this model, intergovernmental grants allow the local government to provide a given level of services at a lower tax-price to voters, thus giving rise to a price effect. What transpires is that the median voter perceives the average and not the marginal price of the local public good, causing the perceived price to be lower.

Figure 2.1 illustrates the effect of this price misperception on the level of local public goods. Segment AB is the voter's original budget constraint with no intergovernmental aid present. Maximizing the median voter's utility subject to AB yields a public expenditure level of g^0. The introduction of unconditional grants from higher levels of government shifts the actual budget constraint to CD. The level of expenditure

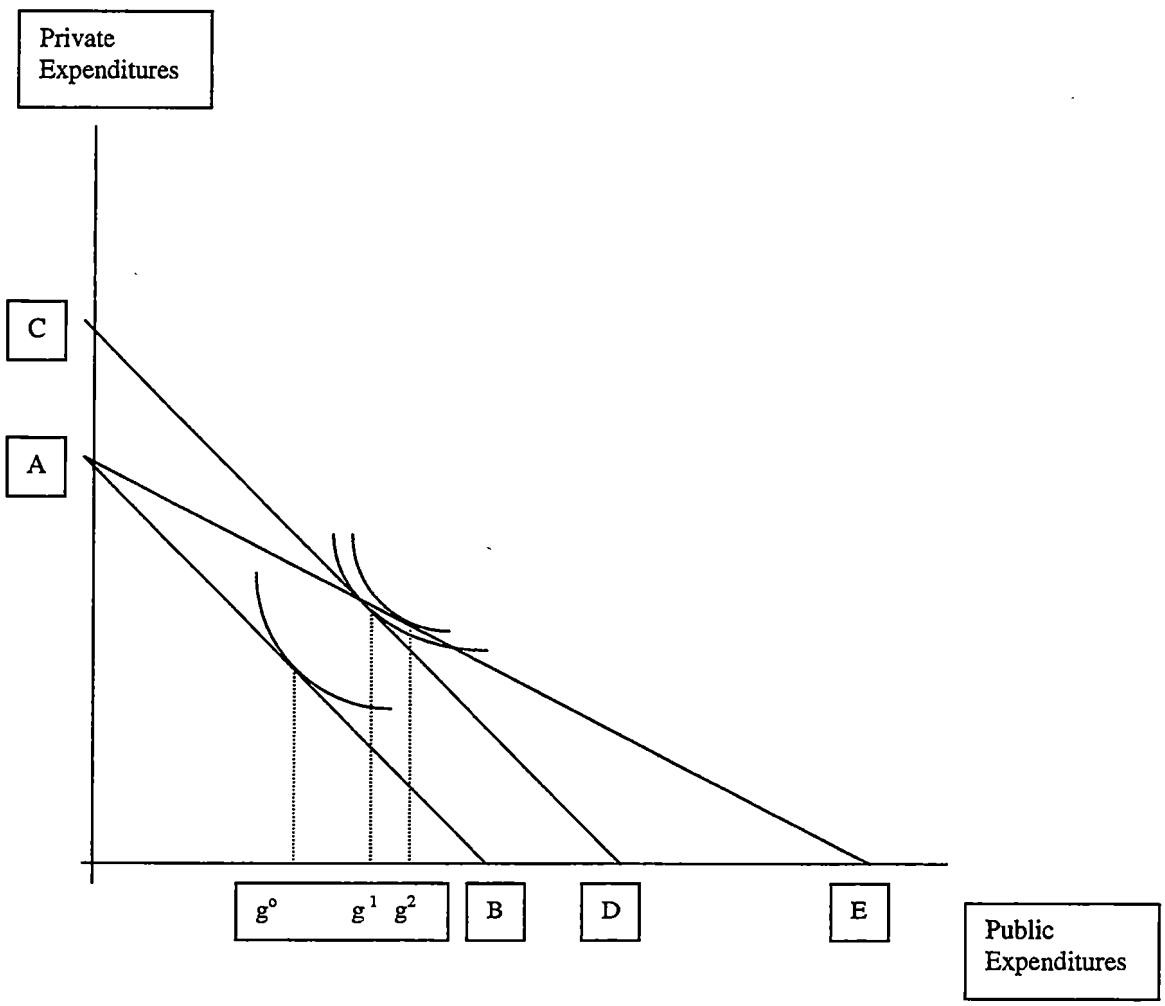


Figure 2.1

Oate's Model of Fiscal Illusion

that results from maximizing the voter's utility increases to g^1. The resulting increase in public expenditures is a result of the income effect. However, if the voter is unaware of the aid, he will misperceive the average for the marginal price of the public good. Since the average price is less than the marginal tax price, the misperception will cause the perceived budget constraint to pivot as given by segment AE. The reduction in the perceived price leads to an increase in expenditures due to both a substitution effect and an income effect, thus leading to a more stimulative effect on the level of expenditures on public goods. The resulting level of public goods is g^2. Increases in the level of income shift the voter's budget constraint from AB to CD, while an increase in intergovernmental aid causes the voter's perceived budget constraint to rotate from AB to AE. The difference between g^1 and g^2 is due to fiscal illusion and demonstrates the asymmetric effects of income and lump sum aid on the level of public expenditures. It is the perception of the average rather than the marginal prices that is the source of the flypaper effect in this model.

Courant, Gramlich and Rubinfeld (1979) also attribute the flypaper effect to fiscal illusion. They provide two modifications to explain the asymmetric effects of income and aid on the level of public expenditures. First, there is a misperception of the marginal tax price by the voter and second, there may be wage effects by public employees that could result in incorrectly perceived relative prices and cause larger real expenditures.

The economic rationale for the flypaper effect is based on the inability of the median voter to perceive the true marginal tax price of the public good in the presence of lump sum aid. In order for symmetry to hold in this model, the level of grants must be

taken into account in the computation of tax shares. If the voter does not compute the intergovernmental aid in the formulation of the tax share, then there will be price effects. Cournant, Gramlich and Rubinfeld (1979) show that a higher level of expenditure is chosen when the government does not incorporate the revenue sharing grant directly into locally taxable income. Price illusion in this model can also occur if a property tax rather than an income tax is used to raise the revenue. This occurs when the non-matching grant is not fully capitalized in property values and not all of the local resources are taxed. However, if the non-matching grant is fully capitalized into the property values, then no price illusion is present.

McGuire (1977) and Filmon, Romer and Rosenthal (1980) present a modified analysis of the Oates fiscal illusion hypothesis and report econometric evidence supporting the flypaper effect. In both models, the median voter perceives the amount of aid to be less than it actually is and selects expenditure levels based on that perception. The contribution of these works is that even when only a *portion* of the grant is unknown, grant illusion still exists. Holsey (1993) applies this innovation in an attempt to provide a unified framework in which both price and income illusion arising from intergovernmental aid can be isolated. She argues that although Winer (1983) and Filmon, Romer and Rosenthal (1982) conclude that grant induced price illusion is a significant determinant of local public expenditure, the role of price illusion remains obscured because they fail to incorporate the simultaneity of grant allocation among jurisdictions. Further, neither study adequately recognizes the potential existence of imperfect information about tax payments to donor governments for grants.

Holsey labels this source of fiscal illusion, the imperfect information about how much of the donor government tax payments for grants actually comes back to the jurisdiction, as income illusion. This type of illusion stems from the voter's misperceptions about tax payments for the grant combined with the failure to recognize the simultaneity in grant allocation to other localities. Previous models assume a grant tax burden of zero. This model allows such an assumption to be relaxed. The contribution here extends Winer's work by allowing for the modeling of demand such that the effects of simultaneity of grants can be examined. Holsey's work contributes to the growing body of literature examining fiscal illusion by modeling the illusion as a two-dimensional rather than a single dimension issue. Traditional illusion is tax-price illusion, which is caused by the imperfect knowledge about the amount of aid that the local government is receiving. Holsey adds to this by opening up another avenue of imperfect knowledge- not about how much you receive but how much you pay. Even if voters know what their tax bill really is, the question becomes how much of that tax money goes to other jurisdictions. In other words, how much of the voter's tax payment for aid comes back as aid?

2.3 Fiscal Illusion Arising from Municipally-Owned Electric Utilities

To date, research examining the impacts of contributions made by electric utilities is limited and focuses on the effect of the diversion of municipal electric profits to the municipal general fund. Two primary issues are stressed: 1) the substitution effect on own-source tax collections and, 2) the general effect of contributions of utility profits on the level of municipal expenditures. The first issue is initially addressed by Colberg

(1955) who suggests that municipalities use "profits" from electric utilities to substitute for property taxes by diverting these profits to the general fund of the municipality. Strauss and Wertz (1976) are among the first to empirically test Colberg's hypothesis. They examine the impact of municipal electric utility profits on the tax effort of cities in North Carolina. By comparing own-source revenue data of ElectriCities (cities owning an electric utility) and non-ElectriCities, they conclude that per capita own-source revenue in cities with municipal electric utilities was 25 to 45 percent lower than in other cities. Using a reduced form model of own source revenue collections that includes population, income and a dummy variable for ElectriCities they find that owning a municipal electric utility significantly reduces per capita own-source revenue, thus supporting Colberg's hypothesis.

The second issue, the effect of internal subsidization of electric utilities, is also examined only in limited detail. Using two reduced form models of public expenditures and data for fifty-two municipalities in New York, DiLorenzo (1982) tests the effects of internal subsidization of municipally owned electric utilities on the level of local government expenditures. He finds that revenue contributions from municipal utilities lower the tax-price per unit of local public goods as perceived by the residents, and lead to higher levels of public expenditures. This supports his main hypothesis that internal subsidization of local governments by municipal electric utilities can give rise to fiscal illusion. Deno and Mehay (1988) extend DiLorenzo's work by incorporating a model by which expenditures and the probability that an electric utility will make a contribution are determined simultaneously. Using a logit model to examine the probability that an

electric utility would make contributions to the general fund of the municipality, they conclude that annual contributions are discretionary, and explained primarily by the city's fiscal health. Findings also show the existence of a simultaneous relationship between municipal spending and utility contributions. In summary, they conclude that after correcting for simultaneity bias, internal subsidization of local government services from utility revenues has a sizable impact on the level of local spending. Again, these findings support the hypothesis of fiscal illusion.

Previous research focuses on *discretionary* contributions of municipal electric utilities and the impacts of such revenue sources on the total level of local public services and own-source tax revenue. To date, researchers have utilized ad-hoc reduced form models to empirically test Colberg's hypothesis. Findings from these studies are consistent in their support of fiscal illusion associated with revenue contributions of electric utilities. The research developed and presented here will extend previous work in three primary areas. First, it will utilize the more sophisticated models found in the literature examining intergovernmental revenue. This includes an extended specification of the reduced form model and a structural model that has yet to be applied to the analysis of electric utility revenue contributions. Second, the literature to date has examined fiscal illusion associated with discretionary contributions from municipal electric utilities. The current study will examine fiscal illusion associated with mandated contributions. Third, this study will provide analyses of the impact of these revenue contributions on both the level of total municipal spending and the level of spending across specific municipal service categories. Articulating the impacts in this manner will allow for the examination

of differential impacts across the varying service categories, thus potentially providing important policy insight.

2.4 Models of Local Fiscal Behavior

Past research has gone far in identifying innovative approaches to the estimation of demand functions for a wide array of local public goods with much of the recent work focusing on the impacts of intergovernmental aid. This work has led to a proliferation of studies examining the role of fiscal illusion and the flypaper effect on the level of local public expenditures. Much of the recent work that has focused on the existence of fiscal illusion and the flypaper effect has been concerned with using a structural model rather than a reduced form model. The appeal of using a structural model in an effort to disentangle the role fiscal illusion plays in the behavioral responses of local governments to changes in local resources is that, theoretically, it allows for the separation of price and income distortions. However, empirically estimating a structural model and isolating these effects can prove to be a formidable task and often results in estimates that are sensitive to the underlying assumptions of the model.[2] An alternative to the use of a structural model is the more conventional log-linear determinants model of local public expenditure. This reduced form model is relatively straightforward to estimate and has proven to be robust across varying specifications (Oates 1986). However, while an illusion parameter can be incorporated and empirically estimated, separation of income

[2] For example, in her 1993 study using a structural model to estimate price and income distortions arising from grants, Holsey had to aggregate local governments up to the state level to empirically estimate her model. In addition she had to make simplifying assumptions regarding illusion of state grants relative to federal grants to ensure convergence of the empirical model.

and price illusion is not feasible. Both the structural and the reduced from models will be used in the analysis of behavioral responses of local governments to revenue contributions from electric utilities.

2.5 A Basic Linear Expenditure System

In empirical research, it is generally desirable for the model used for estimation to be derived directly from the structural model when possible because the form of a structural model is determined by the underlying economic theory. As a result of this ideology, several researchers examining fiscal illusion associated with intergovernmental aid have employed the use of a linear expenditure system (LES) derived from a Stone-Geary (S-G) utility function.[3] The S-G utility function would appear to be a rational choice in this setting for various reasons. First, it belongs to the class of utility functions that result in demand functions with many of the theoretically desirable properties and from which a linear expenditure system can be derived directly from constrained maximization.[4] A more important feature for the current study is that it also generates expenditure equations that allow for the separation and estimation of the income and price changing components associated with fiscal illusion.[5] In addition, local need variables can be accommodated in a clear-cut systematic fashion within the S-G

[3] For example see McGuire (1978), Logan (1986), O'Brien and Shieh (1990), and Holsey (1993).

[4] For a detailed discussion on the Stone-Geary utility function see Stone (1954) and Goldberger (1987). For more general discussions see Deaton and Muelbauer (1980) and Henderson and Quandt (1980).

[5] There are other functions, such as a quadratic, that allow for the separation of the parameters of interest. However the Stone-Geary utility function is the most straightforward, thus making it a more pragmatic choice.

framework via the subsistence term, thus making it attractive for analysis at the local level. Despite its apparent attractive properties, the S-G utility function is not without criticism. The most notable criticism is that the resulting LES is too restrictive. For example, the marginal budget shares in the LES framework are independent of income, and hence they remain constant as income changes.[6] A more important concern for this study is the critique of the performance of the LES when applied to disaggregate analysis. Researchers concerned with the demand for consumer goods have found the LES to be undesirable when estimating demand for a fine classification of goods.[7] They attribute the poor performance of the model to its' overly restrictive structure. Given that the current study is investigating disaggregate demand for public expenditures across different service functions, the restrictive nature of the LES could cast doubt on the ability to obtain reliable results. For this reason, a reduced form specification also will be empirically estimated for comparison with the S-G structural model.

The Stone-Geary utility function is given by:

$$U = (q_1 - \gamma_1)^{\beta_1}(q_2 - \gamma_2)^{\beta_2} \tag{2.1}$$

where the γ parameters represent minimum subsistence levels of the goods, q_1 and q_2, and the βs represent taste parameters. Taking the natural log represents a monotonic transformation and gives us the following function to maximize:

$$\ln U = \beta_1 \ln(q_1 - \gamma_1) + \beta_2 \ln(q_2 - \gamma_2) \tag{2.2}$$

[6] Given that marginal budget shares only measure the amount of the supernumery income spent on a specific good, the restriction of constant marginal budget shares does not necessarily require constant average budget shares (Goldberger 1987).

subject to the budget constraint I= $p_1 q_1 + p_2 q_2$ where I represents income and p represents the corresponding prices. The resulting first order conditions are given by:

$$\frac{\beta_1}{q_1 - \gamma_1} - \lambda p_1 = 0 \tag{2.3}$$

$$\frac{\beta_2}{q_2 - \gamma_2} - \lambda p_2 = 0 \tag{2.4}$$

$$y - p_1 q_1 - p_2 q_2 = 0 \tag{2.5}$$

where λ represents the marginal utility of income. Solving equations (2.3) and (2.4) for the optimal quantities of q_1 and q_2 yields:

$$q_1 = \gamma_1 + \frac{\beta_1}{p_1}(Y - p_1\gamma_1 - p_2\gamma_2) \tag{2.6}$$

$$q_2 = \gamma_2 + \frac{\beta_2}{p_2}(Y - p_1\gamma_1 - p_2\gamma_2) \tag{2.7}$$

Multiplying equations (2.6) and (2.7) by p_1 and p_2, respectively, yields expenditure equations which are linear in income and prices, and thus suitable for linear regression

[7] For example, see Pollack and Wales (1978).

analysis.[8]

2.6 Application of the LES to Current Study

McGuire (1978) and Holsey (1993) both utilized the above framework to examine the effects of intergovernmental aid on the level of local expenditures. They assumed that local policymakers maximize electoral support or votes subject to a budget constraint. The expected support is assumed to depend positively on the utility of voters derived from the consumption of private and public goods and negatively on the reductions of their income due to taxation and financing of public goods. The current study extends their work by examining the effect of an alternative *own-source* of revenue or *internal subsidization.* Given that contributions from municipally-owned electric utilities often substitute for tax payments that could be received if the services were being provided by a private firm, it is not clear that policymakers would treat these payments in the same manner as intergovernmental aid or other forms of external subsidies.

Based on the discussion in the section 2.5, the utility function of the *i*th voter can be expressed as:

$$U_i = (Y - \tau_Y)^{\beta_Y} (q - \tau_q)^{\beta_q} \tag{2.8}$$

where Y represents the quantity of private goods consumed, q represents the voter's perceived level of local public goods, the β parameters are a measure of the individual's

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[8] Requiring $\Sigma\beta = 1$, imposes the restrictions of homogeneity and symmetry.

tastes for the goods, and the τ parameters represent the voter's minimum subsistence level of each good. The individual's level of local public goods is equal to some share, u_i, of the perceived level of the total quantity, Q. If the public good is a purely public good, $u_i = 1$ and if it is a pure private good, $u_i = 1/N$ (N = local population). The voter will maximize utility subject to his budget constraint, $I = p_Y Y + p_Q q$, where I is equal to his income net of federal and state taxes. The individual's perceived tax price of local public goods is p_Q. The resulting first order conditions are:

$$\frac{\beta_q}{q - \tau_q} - \lambda p_Q = 0 \tag{2.9}$$

$$\frac{\beta_Y}{Y - \tau_Y} - \lambda p_Y = 0 \tag{2.10}$$

where λ again represents the marginal utility of income. Solving for lambda yields:

$$\frac{\beta_q}{p_Q(q - \tau_q)} = \frac{\beta_Y}{p_Y(Y - \tau_Y)} \tag{2.11}$$

which satisfies the familiar condition that marginal utility per dollar spent must be the same for all commodities. Solving (2.11) for q and Y and substituting back into the budget constraint yields a demand function for q given by:

$$q = \frac{\beta_q}{p_Q(\beta_Y + \beta_q)}[I + \frac{\beta_Y p_Q}{\beta_q}\tau_q - p_Y \tau_Y] \quad (2.12)$$

It should be noted that the demand for local goods is going to be based on the voter's perceptions of p_Q (and thus, the local government's budget constraint), which will be different than the actual levels if there are any illusionary effects.

2.7 The Reduced Form Model

One of the most widely used reduced form models in empirical investigations of local public expenditures is the log-linear specification. The majority of these models are based on the work of Borcherding and Deacon (1972) and Bergstrom and Goodman (1973). The demand equations by Borcherding and Deacon and Bergstrom and Goodman of these median voter models is a log-linear relationship between output, income, tax share, intergovernmental aid and other socio-economic variables.

Borcherding and Deacon introduce a model of public spending derived from collective decision making theory and test the significance of certain variables that are deemed important in determining the level of local expenditures. The model requires the aggregation of voter preferences, tastes and opportunity costs. The median voter model is used as the method of aggregation. This permits the estimation of key parameters such as price elasticity and the degree of publicness of the goods via a congestion parameter.

The assumptions employed in the model include: 1) No logrolling[9]; 2)

[9] Logrolling refers the process of trading votes to achieve the majority necessary for approval.

bureaucracy is not present; 3) only non-discriminatory taxes are used; 4) labor and capital are the only inputs used where capital is perfectly mobile and labor is not, implying that the price of capital is the same across all communities but wage differentials can exist across localities; 5) fixed prices of labor and capital; 6) governments are price takers; and 7) the government provides services efficiently using a Cobb-Douglas production function.

Following Borcherding and Deacon (1972), the median voter model is employed in order to be able to aggregate voter tastes and preferences. Using the Cobb-Douglas framework, output is expressed:

$$X = aL^{\beta}K^{1-\beta} \tag{2.13}$$

where X denotes output, L represents labor and K represents capital. Using the assumptions of cost minimization yields the following:

$$w = \frac{\beta C_x X}{L} \tag{2.14}$$

$$r = \frac{(1-\beta)C_x X}{K} \tag{2.15}$$

$$L = \frac{\beta C_x X}{w} \tag{2.16}$$

$$K = \frac{(1-\beta)C_x X}{r} \tag{2.17}$$

where w is the wage rate of L, r is the rental rate of K and C_x is the marginal cost of X. Substituting equations (2.14)-(2.17) into (2.13) yields the following output equation:

$$X = a\left[\frac{\beta C_x X}{w}\right]^{\beta}\left[\frac{(1-\beta)C_x X}{r}\right]^{(1-\beta)} = aC_x X\left(\frac{\beta}{w}\right)^{\beta}\left(\frac{1-\beta}{r}\right)^{(1-\beta)} \tag{2.18}$$

Rearranging (2.18) yields the following expression for marginal cost:

$$C_x = \left(\frac{1}{a}\right)\left(\frac{w}{\beta}\right)^{\beta}\left(\frac{r}{1-\beta}\right)^{(1-\beta)} \tag{2.19}$$

Given the assumption that the rental rate on capital is the same over all units, (2.19) can be restated as:

$$C_x = a' w^{\beta} \tag{2.20}$$

which describes a "unique and horizontal supply function for each unit dependent only on the wage rate, w, in that unit" (Borcherding and Deacon, 1972). The parameter β represents the cost of mobile capital and k is the constant term.

The amount of consumption for the median voter is defined as $q = X/N^a$, where a is the congestion parameter, X is the level of public goods and N is the population. With non-discriminatory taxes, each voter pays an equal share to finance each unit of a public good. The tax share for the median voter is defined as

$$sq = C_x X/N \tag{2.21}$$

which becomes

$$s = C_x N^{\alpha-1} \tag{2.22}$$

where α is the degree of divisibility in the consumption of X. The median voter demand for expenditures is assumed to be log linear in tax share, s, and income, y and is given by

$$q = As^{\eta} y^{\delta} . \tag{2.23}$$

Transformation of equation (2.23) into per-capita expenditures yields

$$e = A' w^{B(\eta+1)} y^{\delta} N^{(a-1)(\eta+1)} . \tag{2.24}$$

Taking the log of (2.24) yields

$$\ln e = lnA' + (\eta+1)\ln w^B + (a+1)(\eta+1)\ln N + \delta \ln y \tag{2.25}$$

which provides an estimable expenditure equation for estimating parameters of interest such as the price elasticity and the degree of publicness of the goods.

Bergstrom and Goodman (1973) develop a model for estimating demand functions of individuals for local public services that allows for predictions about tax structure, scale economies, and changes in economic and demographic variables on quantities of public goods to be supplied. By observing the choices of municipalities, inferences about responsiveness of individual demands for municipal services can be made by employing some assumptions about the political process.

The assumptions of the model include: 1) Municipalities provide services at a constant cost q_j; 2) the ith consumer's tax share, t_i, is a function of wealth and income and does not vary with the size of the expenditure or personal taste; 3) all consumers are aware of the tax price which is equal to $t_i q_j$; 4) the quantity of a good supplied in municipality j is equal to the median quantities demanded by all i consumers in municipality j; and 5) the median of quantities is equal to the quantity demanded by the citizen with the median income. The consumers' price of the local services provided is proportional to the tax share under the assumption of a constant tax share and service cost.

They use a log-linear equation:

$$\log E = c + \log N + \delta \log t + \varepsilon \log Y + \sum_{i}^{k} B_i X_i \qquad (2.26)$$

where expenditure E is a function of population, N, tax share, t, median family income, Y

and a set of socio-economic variables, X. Also employed in this model is the possibility for congestion in the consumption of local goods and services. This is depicted by

$$Z^* = Z / N^a \tag{2.27}$$

where a represents the congestion parameter. Given this the demand for public goods can be defined as

$$Z = cq^{\delta} t_i^{\delta} Y^{\varepsilon} N^{a(1+\delta)} \tag{2.28}$$

where price and income elasticities are constant. Thus, the congestion parameter, *a*, is equivalent to the elasticity of demand with respect to population. The vector of socio-economic variables is included in order to eliminate distortions of price, income, and population elasticity measures.

The log-linear determinants model is extended in the current study by including a parameter that measures voter perception of electric utility subsidies, thus providing an alternative to the S-G model. Major advantages of the log-linear model are the relative ease at which the model can be estimated and the robustness of the model in previous studies examining the provision of local public services. The major disadvantage is the inability to directly identify the source of a flypaper effect as price or income illusion.

2.8 Summary

The current study utilizes the more sophisticated models developed in the intergovernmental aid research to examine the behavioral effects of internal subsidization. The source of the internal subsidization is electric utility contributions.

Prior research has suggested that contributions from locally owned electric utilities can give rise to a flypaper effect, however there has been no attempt at disentangling the source of the effect. Following the work of Holsey (1993), a demand equation for local public goods derived directly from the structural model will be empirically analyzed. In addition, the study will estimate alternative specifications based on the more traditional log-linear reduced form. The performance of the two models will be evaluated and the results will be used to simulate responses in local government expenditures to changes in the level of revenue received form electric utilities.

CHAPTER 3

THE STRUCUTRAL MODEL USING THE STONE-GEARY UTILITY FUNCTION

3.1 Introducing PILOTs into the Stone-Geary Framework

Holsey (1993) uses a Stone-Geary framework and derives the median voter's demand function by maximizing the median voter's utility subject to a budget constraint that incorporates imperfect voter information about intergovernmental grants from state and federal agencies. The current study focuses on imperfect voter information regarding revenue contributions from electric utilities to local governments. In Tennessee, the sample region, contributions are regulated by the Tennessee Valley Authority (TVA) and are in the form of payments-in-lieu-of-taxes (PILOTs). Thus, the payments are not discretionary and the level of the payment is exogenous to local government decision-makers. An overview of the electric utility system in Tennessee, including a discussion on the determination of PILOTs, is included in Appendix A. The estimable demand equation allows for the estimation of price illusion due to PILOTs and income illusion due to "tax payments" passed on to consumers via higher electric rates.

Given the Stone-Geary framework, the median voter's utility function can be stated as

$$U = \beta_Y \ln(Y - \tau_Y) + \beta_q \ln(q - \tau_q) \tag{3.1}$$

where the variables are as defined in section 2.6. The voter's perceived level of public goods, q, is equal to some actual share, μ_i[10], of the voter's perceived level of the total quantity of public goods. Thus,

$$q = \mu_i \sigma_Q Q \tag{3.2}$$

where σ_Q represents the proportion of public output known to the voter and Q is the true level. The median voter will maximize his or her utility subject to the following perceived budget constraint:

$$I = P_Y Y + \sigma_L w_L T_L + \sigma_E w_E T_E \tag{3.3}$$

where P_Y is the price of private goods and I is income net of state and federal taxes. w_L and w_E represent the voter's true marginal tax shares where marginal tax shares are assumed equal to average tax shares. T_L denotes the voter's perception of *total* local tax revenue collections and T_E denotes the voter's perception of tax payments required to finance electric utility revenue contributions. Again the σ parameters represent the voter's perceptions of tax shares. Thus $\sigma_L w_L T_L$ is the voter's perceived level of local tax payments and $\sigma_E w_E T_E$ represents the voter's perceived tax payments for PILOTs.

[10] Again, if μ_i =1, this implies that the public good is a pure public good, and, if μ_i =1/N (where N is equal to population), then the public good is a private good.

The voter's perceived total local tax collections, T_L, are equal to the perceived level of expenditures on local public goods minus the perceived level of PILOTs.[11] Thus local tax collections perceived by the voter can be represented by:

$$T_L = \sigma_{P_Q} P_Q \sigma_Q Q - \theta L_E \tag{3.4}$$

where P_Q is the price, σ_{P_Q} represents the proportion of the price of local services known to the voter and L_E represents the PILOTs paid to the jurisdiction. Voter knowledge of PILOTs is measured by θ. The unknown portion, 1-θ, is assumed to be retained in the public coffers, thus reducing the perceived price of the public good and giving rise to price illusion. Thus, the perceived price can be represented as:

$$\hat{P}_Q = \sigma_{P_Q} P_Q (1 - \frac{(1-\theta)L_E}{P_Q Q}) \tag{3.5}$$

The remaining term represents proportionate reduction in the perceived price due to unknown PILOTs and can be more succinctly represented as:[12]

[11] Implicit in this equation is the assumption that the voter has full knowledge of grants-in-aid, i.e., they know that on average $1.00 in intergovernmental aid received is financed by $1.00 in state and federal taxes. Incorporating a full model of illusion associated with intergovernmental aid into the current model is beyond the scope of this study and remains an area for a future research.

[12] The perceived price is only reduced if $\theta < 1$. If $\theta > 1$, the perceived price is greater than the actual price.

$$\alpha_E = \frac{(1-\theta)L_E}{P_Q Q} \tag{3.6}$$

Following Inman (1979) and Holsey (1993), local tax collections can be separated into individual components by substituting (3.5) and (3.6) into (3.4). The resulting expression for the voter's perception of local tax collection is:

$$T_L = (1-\alpha_E)\sigma_{P_Q} P_Q \sigma_Q Q - \theta L_E \tag{3.7}$$

where $(1-\alpha_E)\sigma_{P_Q} P_Q$ is the perceived price of local public goods after the subsidy, $\sigma_Q Q$ is the perceived quantity of public goods, and θL_E is the perceived level of payments made to the local government by electric utilities. If the voter has perfect knowledge of PILOTs, θ is equal to 1 and α_E is equal to 0. If the voter has no knowledge of PILOTs, θ is equal to 0. If the voter underestimates the amount of the PILOT, θ will be less than 1. If, however, the voter over-estimates the magnitude of PILOTs, θ will be greater than 1. θ is not restricted to fall between 0 and 1. A negative value of θ would imply that the voter perceives electric utilities as being subsidized by local governments while a positive value implies that that the voter perception is that the PILOTs are larger than their actual value. It is assumed that θ is constant over all observations and that the voter's knowledge of PILOTs from TVA is equal to his knowledge of PILOTs from

municipal electric utilities.[13] Again, imperfect knowledge on the part of the voter with regard to own PILOTs gives rise to price illusion.

The second source of fiscal illusion, income illusion, arises if the voter fails to realize that his electric bill contains implicit tax payments used to finance PILOTs. In addition, the simultaneity in the allocation of PILOTs across municipalities could give rise to income illusion. Even if the voter has perfect knowledge of own PILOTs and the tax payments used to finance those PILOTs, if he fails to recognize that a portion of his tax payments may be used to finance PILOTs going to other jurisdictions. Income illusion occurs as a result of the financing of PILOTs. Because of the regulated cost-based pricing in the electric utility industry, the PILOTs are financed through higher rates to consumers. The perceived collections for the PILOTs will be referred to as the "tax payments" and can be separated into their individual components as follows:

$$\hat{T}_E = (1+\Gamma\sum_j^m P_E^j)\theta L_E \qquad (3.8)$$

Equation (3.8) takes into consideration the distribution of PILOTs to this and other localities. L_E is the locality's own PILOT and ΣP_E is the sum of the proportion of total PILOTs which is received by the other m localities in the state. The voter's

[13] An alternative to having a constant proportion of PILOTs known to voters would be to allow θ to be specific to each community. In other words, θ would be some function of PILOTs on the grounds that the magnitude of the payments could alter the extent to which the public is informed about them. It is probable that a more prominent physical presence of TVA in a city and/or the ownership of a municipal distributor may influence the voter's perception of revenue contributions by these entities to local governments. An extension of the model in the future could incorporate such a variable.

perception of the proportion of PILOTs allocated to other municipalities is measured by Γ. Actual PILOTs to all other localities is represented by $\Sigma P_E L_E$ while the voter's perception of the total level of PILOTs going to other localities is given by $\Gamma(\Sigma P_E^j)\theta L_E$.

Included in (3.8) are the parameters that reflect voter knowledge of PILOTs received by other localities. Voter knowledge of the amount that other localities receive depends on how much knowledge the voter has of his or her own PILOTs as measured by θ. The Γ parameter measures the voter's knowledge of the proportion of PILOTs that is received by other localities. The voter's perception of the proportion of PILOTs going to other jurisdictions is assumed to be equal to some proportion of the actual amount. If the voter underestimates that proportion Γ will be less than 1, and the perceived tax payment would be lower than the actual tax payment thus leading to a rise in perceived income. If the voter over- estimates the proportion going to other localities, Γ will be greater than 1 and the perceived tax payment is greater then the actual tax payment, thus leading to a decrease in perceived income. Perfect knowledge implies that Γ is equal to 1 and no knowledge implies a value of 0.

3.2 The Budget Constraint

Substituting the expanded terms of (3.7) and (3.8) into (3.3) and rearranging yields the voter's perceived budget constraint:

$$P_Y Y + w_L[(1-\alpha_E)\sigma_P P_Q \sigma_Q Q/\mu_1]q = I + [(w_L\sigma_L\theta) - (w_E\sigma_E\theta)(1+\Gamma\sum_1^m P_s^j)]L_E \qquad (3.9)$$

Output in this equation, Q, is converted into individual quantities, q. The interpretation of the constraint is perceived payments for private goods plus perceived payments for public goods are equal to the consumers' private income, I, plus the perceived net income from PILOTs. The perceived net income from PILOTs is divided into two parts: the perceived amount of the PILOT received minus the perceived payment for the PILOT.

3.3 The Demand Equation

The voter maximizes his or her utility, (3.1), subject to the perceived budget constraint (3.9), which yields the following demand equation for total public expenditure:

$$P_Q Q = B_3 I\delta_L - B_3 P_Y \tau_Y \delta_L + P_Q \tau_Q (1-B_1) - \tau_Q (1-B_1)(1-\theta)L_E / Q + [B_2\theta + (1-\theta)]L_E \\ -(B_2\theta\sigma_{LE} w_E \delta_L)L_E - (B_2\theta\sigma_{EL} w_E \delta_L \Gamma\Sigma P_s^j)L_E \quad (3.10)$$

where $\delta_L = 1/w_L$, $B_1 = \beta_q/(\beta_Y + \beta_q)$, $B_2 = (B_1/\sigma_P\sigma_Q)$, $B_3=(B_2/\sigma_L)$, and $B_4= B_3\tau_Y$. The first term represents the income component and is followed by the private good subsistence term and the expanded version of the public good subsistence term found in traditional linear expenditure systems. These two terms can be interpreted as the minimum expenditure levels for each good, which clearly depend on price. The rest of the equation represents the expanded version of the PILOT term. The expanded PILOT term includes the change in local income due to the PILOT, the change in local income due to "tax" payments for own local PILOTs and the change in income due to tax payments for PILOTs to other localities. The assumption that marginal tax shares equal average tax shares implies that the tax share, w_L, is equal to 1/N, where N is equal to the

population of the municipality. It is also assumed that the increase in electric rates due to PILOTs is borne equally by all individuals in the state, thus w_E is equal to $1/N_S$, where N_S is the population of the state. The private good is assumed to be the numeraire, thus the price is set equal to 1.

Given these assumptions, the estimable equation now becomes:

$$P_Q Q = A - [B_4](N) + [(1-B_1)\tau_Q]P_Q - [(1-B_1)\tau_Q(1-\theta)](L_E/Q) - [B_3]I + [B_2\theta + (1-\theta)]L_E - [B_2\theta\sigma_{LE}](N_s/N)L_E - [B_2\theta\sigma_{EL}\Gamma](\Sigma P_s^j)(N_s/N)L_E \quad (3.11)$$

where the terms inside the brackets are parameters to be estimated. Again, B_1 is equal to $\beta_q/(\beta_Y + \beta_q)$, B_2 is equal to $(B_1/\sigma_P\sigma_Q)$, B_3=(B_2/σ_L), and B_4=$B_3\tau_Y$. L_E represents the combined PILOTs received from TVA and local electric utilities (municipals and co-ops). Output (Q) is derived by dividing the level of expenditures by the average wage of local government employees, P_Q. The sum of the proportion of total PILOTs going to other jurisdictions, ΣP_E^j, is calculated by taking the total PILOT amount less the municipality's level of PILOTs and dividing by the municipal level of PILOTs.

3.4 Data

Data on public services provided at the municipal level are employed for the empirical analysis of fiscal illusion associated with revenue contributions from electric utilities. In many instances there is no published source of data on the disaggregated data necessary for the empirical analysis. The sample region is the State of Tennessee, which has 350 municipalities, and the sample time period is fiscal year 1987-88 to 1997-98.

There are three advantages of choosing Tennessee as the sample region. First, the state's municipal governments are multi-purpose governments, which allows for examination of differential impacts of electric utility revenue across different types of services. Second, because the state is in the TVA service area and its electric utility distributors are subject to TVA oversight, detailed records of payments to local governments by electric utilities are regarded as public records and hence available for empirical analysis. Finally, Tennessee is in the early exploration stage of electric utility restructuring and the analysis can potentially provide insightful policy considerations as the state begins deliberations on restructuring. The choice of the time period is made on pragmatic grounds; the legislation governing the current method of calculating PILOTs for distributors subject to TVA's oversight went into effect in fiscal year 1987-88. Data are collected through 1997-98.

General fund expenditures seemed the appropriate choice for the aggregate measure of local public expenditures as opposed to operating revenues because of the relative consistency of accounting procedures across the municipalities. In addition, PILOTs flow directly into the general fund, making them easy to trace from the electric utility to the municipality.

The choice of the specific service functions to be examined is based on the proportion of total spending. The four service categories that represent the largest shares of spending at the municipal level are streets and public works, general government,

public safety, and social welfare and recreation.[14] On average, these four functions account for 77 percent of the spending by municipal governments from the general fund.

The analysis involves evaluating the effect of PILOTs on the level of total expenditures and expenditures by service functions, therefore disaggregate budget data are required. Because of the detailed level of the data required, no consolidated source exists. Therefore, the data for the dependent variables used in the empirical analysis were obtained directly from audited budgets requested from the municipal governments. As part of this study, telephone calls were made to each municipality to solicit the necessary reports. Formal letters of request were then sent to the municipalities failing to respond to the initial requests. Of the 350 current municipalities in Tennessee, 246 (70%) submitted the requested budget reports. A total of 222 municipalities responded by providing all of the data requested. The remaining 24 municipalities that responded are dropped from the sample due to incomplete data resulting from lost records or lack of tenure as an incorporated municipality. Inclusion of the municipalities with missing observations resulted in an unbalanced panel, which gave rise to computational complications regarding to convergence of the non-linear model.

The non-responding municipalities are primarily smaller communities with a mean population of 1,955 in 1998 compared to 12,929 for the municipalities included in the sample. For the non-respondents, the population in the smallest and largest cities is

[14] Education is excluded because expenditures for education do not always flow through the general fund. In addition, there are several methods by which school systems operate in the State of Tennessee. Primary and secondary education may be provided by municipal governments, county governments, special school districts, or some combination of the three.

94 and 17,357, respectively. For those included in the sample, the smallest is 114 and the largest is 619,391. Even though the response rate is relatively high, drawing inference about the population from a sample with non-response may generate biased results. However, it is arguable that sample selection bias is likely to be negligible in the current study given that the municipalities included in the sample represent, on average, 93 percent of the state's total population. Traditionally, sample selection bias has been dealt with by utilizing variants of the Heckman (1979) two-stage model. However, it is not obvious that the gains from correcting for potential selection bias will be offset by the computational difficulty involved in implementing a bias correction scheme in the non-linear specification of the model. Moreover, maximum likelihood nonlinear estimation yields consistent parameter estimates of the true parameter and as a rule, econometricians are more concerned with consistency than with lack of bias (Goldfeld and Quandt, 1972).

The final data set is a panel consisting of 222 municipalities over the eleven-year period for a total of 2,442 observations. Survey data collected include general fund expenditures of municipal governments both in total and by service category and revenue from PILOTs. Data collected from public sources include median income, population, median government wage, median house values, intergovernmental aid, and total assessed property value. All dollar values are expressed in real terms using the consumer price index for base period 1982-84.[15] Descriptive statistics and sources for the data used in

[15] The non-metropolitan area CPI for the state was used as a proxy for all municipalities with the exception of those municipalities located within a MSA for which annual CPIs are available.

both the structural and reduced form models are presented in Table 3.1. Again, all data on the variables are obtained from audited budget reports submitted upon request by the municipalities. The data for the independent variables are collected from a variety of sources. Unfortunately, the available data at the municipal level on an annual basis are limited. As a result, proxy values are constructed in several instances. Detailed discussions on the construction of the variables follow.

PILOTs

The PILOTs variable represents the total payments-in-lieu-of-taxes received by municipalities from electric utilities. The municipalities receive PILOTs from two sources: TVA and local electric distributors (i.e., either a municipal electric distributor or an electric cooperative). The PILOTs from TVA are paid directly to the State of Tennessee and then apportioned to the local governments. The PILOTs paid by the local distributors are paid either directly to the municipality to which payment is owed, or to the owning jurisdiction which then disburses the payments among the recipients based on a predetermined formula. Sources for the data on PILOTs from TVA include TVA annual reports and the *State of Tennessee, County and Municipal Finances* report from the State's Comptroller's office. The primary source of data for PILOTs from local distributors is the annual audit reports of the electric distributors. Copies of the requested reports were obtained from all the municipal electric distributors and the electric cooperatives throughout the state. Often municipalities receive payments from more than one local electric distributor so the municipal budgets are used as a verification of the total amount of PILOTs received.

Table 3.1

Data
Descriptive Statistics and Sources

	Mean	Median	Range	Source
Dependent Variables				
Total general fund expenditures*	47.77	4.24	2897.93	*Municipal Budgets*
Streets and public works*	6.15	0.96	266.38	*Municipal Budgets*
Public safety*	17.89	1.34	1300.58	*Municipal Budgets*
General government*	7.41	1.11	530.56	*Municipal Budgets*
Social welfare and recreation*	5.13	0.14	510.35	*Municipal Budgets*
Independent Variables				
Municipal population **	12.34	2.103	619.28	*U.S Census, Population Estimates for Places*
State population**	5166.1	5085.7	606.30	*U.S. Census, Population Estimates for States*
Median income**	8.068	7.164	122.65	*U.S. Census, 1990 Census of Population and Housing BEA, Regional Economic Information System*
Median household income**	28.135	24.503	142.58	*Same as above*
Government wage**	15.689	15.333	13.08	*U.S. Census Bureau, Census of the Government*
PILOT*	1.723	1.125	104.36	*TVA Annual Reports, Annual reports of distributors, and municipal budgets*
Intergovernmental aid*	36.473	23.80	4680.28	*State of Tennessee, County and Municipal Finance Report*
Total assessed property*	119.7	131.16	778626.7	*Same as above*
Median house value**	58.505	54.900	161.00	*Tennessee Housing Development Authority*

*Notes: *Expressed in 100,000s*
***Expressed in 1,000s*
The scaling used in the table do not necessarily represent the final scaling used in the estimation.

Personal Income

Two measures of personal income are utilized in the empirical estimation: median individual income and median household income. Given that the only income data available at the municipal level are for the decennial census year, proxy variables are constructed. The first step involves using data from the *U.S. Census Bureau, 1990 Census of Population and Housing* to obtain municipal data on 1989 median household personal income, 1989 per capita income, and 1989 persons per household to construct a ratio of median income to per capita income. Ratios for median individual income as a percentage of per capita income and for median household income as a percentage of personal income are constructed for each municipality. Annual data on per capita personal income by county are available from the *U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System.* Multiplying the ratio constructed in the first step by the per capita income for the county within which a municipality is located provides a proxy of annual median income for that municipality. The resulting calculations assume a constant ratio of median income to per capita income and a constant average persons per household based on 1989 municipal level data. For empirical purposes the variable is expressed in real terms and measured in thousands of dollars.

Government Wage

The price of local public goods is represented by the average annual government wage for the counties in which municipalities are located. Annual data are not available

at the municipal level. An attempt was made to construct a proxy that would more closely capture the actual government wages across municipalities. Available data include annual average earnings by county from the *Bureau of Economic Analysis, County Business Patterns* and city government employment data from the *U.S Census Bureau, Census of Government.* Using 1992 data on average annual earnings of city government employees by service function and population group, a ratio of municipal government wage to average county wage is calculated for each of the service functions to be examined in the empirical analysis.[16] Multiplying the ratio for 1992 by the average annual wage for the county within which a municipality is located provides an approximation for average annual wages for that municipality's government employees. The resulting calculation of annual wages, expressed in real terms and measured in thousands, is used to proxy the price of the local public good. However, the calculated proxy displayed less variation in government wages across municipalities than using the county level wage by itself. Estimations were conducted using both variables with little change in the estimated coefficients. Therefore, the variable used in the reported results is the county level wage.

Tax Share

There are three measures of tax share used in the empirical analysis. The first two are straightforward and based on state and local population. The median voter's tax share

[16] Ratios for the largest metropolitan cities (Memphis, Nashville, Knoxville, and Chattanooga) are calculated using government wage data specific to those cities. Ratios for the remaining municipalities are calculated based on the appropriate population group.

for local public goods is calculated by dividing one by the municipal population. The tax share for PILOTs is calculated by dividing one by the state's population. The construction of the third measure of tax share involves dividing the median house value in a municipality by the municipality's total assessed property value. Annual data on total assessed property value by municipality are obtained from the Tennessee State Board of Equalization, *Tax Aggregate Report of Tennessee.* However, data on annual median house values by municipality are not available. Therefore a proxy is constructed using annual data on the median selling price of all home sales by county, obtained from the Tennessee Housing Development Authority, and the median house value in 1990 by county, obtained from the *U.S. Census Bureau, Census of Housing.* Using these data, a ratio of median selling price as a percentage of median house value for 1990 is constructed. The median house value for a given municipality is then calculated by applying the aforementioned ratio to the median selling price of all homes in the county within which the municipality is located. Dividing median house value by total value of assessed property results in the third measure of tax share.

3.5 Empirical Methodology

This section discusses the empirical implementation of the theoretical demand equation presented in section 3.3. The estimating equation is developed directly from the theoretical equation and is used to examine general fund municipal spending in total, and separately by specific functions.

The empirical specification assumes a least squares dummy variable specification,

which permits pooling of time-series, cross-sectional data.[17] Municipal and time dummy variables are included to capture the effects of unobservable fixed determinants of local government spending. In addition, a variable measuring the flow of funds from federal and state governments to the municipalities is included to control for the effects of intergovernmental aid on expenditure levels. The resulting estimating equation can be stated as:

$$P_Q Q = A - [\beta_4](N) + [(1-\beta_1)\tau_Q]P_Q + [(1-\beta_1)\tau_Q(1-\theta)](L_E/Q) + \beta_3 I + [\beta_2\theta + (1-\theta)]L_E$$
$$-[\beta_2\theta\sigma_{LE}](N_S/N)L_E - [\beta_2\theta\sigma_{EL}\Gamma](\Sigma P_E^j)(N_S/N)L_E + [\beta_5]IA + [\beta_m]M + [\beta_{fe}]FY + \mu \quad (3.12)$$

where the bracketed terms are parameters to be estimated. $\beta_1, \beta_2, \beta_3,$ and β_4 are as defined in the section 3.3. The term IA represents intergovernmental aid, M represents a vector of dummy variables specific to each municipality, and FY represents a vector of dummy variables specific to each year. β_M and β_{fe} represent vectors of coefficients that measure the impact of the municipal and time dummies, respectively. Estimation is conducted using the maximum likelihood procedure that is appropriate for estimation of an empirical specification which is non-linear in parameters and non-linear in the endogenous variable, L_E/Q. It is assumed that the errors are additive and normally distributed.[18]

[17] For a complete discussion of pooling data, see Baltagi 1995.

[18] For a detailed discussion of nonlinear maximum likelihood estimation procedures see Goldfeld and Quandt (1972).

In practice, the full model as described in (3.12) does not converge to a minimum sum of squared errors. Several alternatives involving rescaling of variables were attempted in an effort to reach convergence for the full model. The highly non-linear specification of the model and the existence of high collinearity between some variables are contributing factors to the full model's inability to converge. Thus alternative specifications are attempted by placing restrictions on the perception parameters, Γ and σ. After conducting a grid search of alternative values for the perception parameter, convergence across all service functions occurred with two specifications of the structural model. These two specifications are estimated. The first model used in the analysis assumes that $\sigma_{LE} = \sigma_{EL} = 1$. The assumption implies that the voter's knowledge of his local marginal tax share multiplied by his knowledge of his tax share for PILOTs is equal to one. The assumption of perfect knowledge of tax shares for PILOTs eliminates the ability to isolate the income illusion associated with the voter's imperfect knowledge with regards to financing PILOTs going to his own jurisdiction. In addition it results in only a partial analysis of income illusion regarding PILOTs going to other municipalities. Thus, the resulting estimating equation is:

$$P_Q Q = A - [\beta_4](N) + [(1-\beta_1)\tau_q]P_Q + [(1-\beta_1)\tau_Q(1-\theta)](L_E/Q) + \beta_3 I + [\beta_2\theta + (1-\theta)]L_E$$
$$-[\beta_2\theta](N_S/N)L_E - [\beta_2\Gamma\theta](\Sigma P_E^j)(N_S/N)L_E + [\beta_5]IA + [\beta_m]M + [\beta_T]T + \mu \quad (3.13)$$

where again, the bracketed terms represent estimatable parameters. All parameters are as defined previously. The second specification retains the assumption of perfect knowledge of tax shares for PILOTs and adds the assumption of no knowledge of grants going to other jurisdictions, implying that $\Gamma = 0$. Again, this further diminishes the ability of the

structural model to empirically separate price and income distortions arising from PILOT financing.

3.6 Testing for Price and Income Illusion

As developed theoretically in section 3.1, price illusion results from inaccurate voter knowledge of PILOTs received by own local government, while income illusion occurs if the voter has imperfect knowledge of tax payments required to finance PILOTs due to imperfect knowledge of PILOTs received by other jurisdictions. The empirical specification of the Stone-Geary model measures voter knowledge of own PILOTs through the θ parameter. Voter knowledge of PILOTs going to other local governments is measured by the term $\Gamma\theta$, where Γ measures the voter's knowledge of the proportion of own PILOTs received by other jurisdictions. Therefore, tests of significance of price and income illusion will be based on the estimated values of θ and $\Gamma\theta$.

Two tests of significance are relevant for the first model: i) a test for full illusion and ii) a test for perfect knowledge. For example, if θ is not significantly different than 0 the hypothesis of perfect price illusion cannot be rejected, and if $\Gamma\theta$ is not significantly different than 0 the hypothesis of perfect income illusion cannot be rejected. Likewise, if θ and $\Gamma\theta$ are significantly different than 1, then we can reject the hypotheses of perfect price and income information, respectively. The second model is only concerned with hypothesis tests involving θ. The following sections will apply these tests to determine the significance of price and income illusion to both total general fund expenditures and expenditures on specific service categories by local governments.

3.7 General Fund Expenditure Results in the Stone-Geary Model

Estimation of the expenditure function derived from the Stone-Geary utility function identifies both price and income illusion as significant determinants of voter's behavior. Parameter estimates and t-statistics for the key parameters for both specifications of the model are presented in Table 3.2.[19] The parameter estimates for population, income, and aid are significant, display the expected relationship and are stable across the two models. The fact that the parameter estimates for these variables change by a negligible amount is indicative of the lack of collinearity between the variables and the omitted variable, an observation supported by collinearity diagnostics.

Recalling that the parameter estimate for PILOTs is given by $\beta_2\theta+(1-\theta)$, comparison of the parameter estimates for PILOTs and income, which are .90 and 0.04, respectively, implies that PILOTs are more stimulative than income on the level of general fund expenditures, indicating a positive flypaper effect. The t-statistic for the parameter estimate for PILOTs is 17.57, indicating that the estimate is statistically significant.[20] Analysis of the coefficient on intergovernmental aid reveals a significant

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[19] Due to the voluminous nature of dummy variables required for each specification, parameter estimates for the municipal and year dummies are not reported.

[20] Given that the parameter estimate for PILOTs is a combination of two random variables, β_2 and θ, t-statisitcs had to be calculated to establish the statistical significance of the compound parameter. Following Kmenta (1986), the variance of the compound parameter is calculated using the following formula:

$$Var[\beta_2\theta+(1-\theta)]\cong\left(\frac{\partial P_Q Q}{\partial\theta}\right)^2 Var(\beta_2)+\left(\frac{\partial P_Q Q}{\partial\beta_2}\right)^2+2\left(\frac{\partial P_Q Q}{\partial\theta}\right)\left(\frac{\partial P_Q Q}{\partial\beta_2}\right)Cov(\beta_2,\theta).$$

Standard errors and t-statisitics are then derived from the calculated variance.

Table 3.2

Stone-Geary Model Specification
General Fund Expenditures

	Model 1	Model 2
Constant	0.797	5.384
	(-0.01)	(-0.06)
B4 (Population)	-2.561**	-2.560**
	(-26.15)	(-26.56)
B2 (PILOTs)	0.371**	0.698**
	(17.76)	(119.10)
B3 (Income)	0.042**	0.042**
	(22.50)	(22.47)
θ (PILOT perception)	-12.805**	-3.220**
	(-25.18)	(-60.55)
Γ (Tax perception)	-0.557**	
	(-15.06)	
B5 (Aid)	0.011**	0.013**
	(8.75)	(9.99)
(1-B1) τ	1.004**	0.722**
(Taste/subsistence)	(2.31)	(2.51)

*Notes: ** Indicates significance at the 95% confidence level*
t-statistics are in parenthesis

and positive effect. In addition, the magnitude of the estimate suggests that PILOTs are substantially more stimulative than intergovernmental aid on the level of local public expenditures.[21] Population is highly significant and has the expected positive effect on the level of expenditures.

[21]It should be noted that the relatively small magnitude of the coefficient on intergovernmental aid is in contrast to the findings in the literature. This result could be a result of the disaggregate nature of the data and the fact that at the municipal level, intergovernmental aid is often passed through special or proprietary funds. In addition, since the focus of this study was not on intergovernmental aid, no attempt was made to distinguish between the differing types of aid flowing to the municipal governments.

The proportion of own PILOTs known to the voter, θ, is estimated to be –12.81 and is significantly different from both 0 and 1 in model 1. Thus, the hypotheses of full price illusion and full price information are both rejected. However, the large negative value suggests that the voter actually perceives the electric utility as draining funds from the local government as opposed to making revenue contributions and raises suspicions regarding the reliability of the estimate. The estimate of the perception parameter from model 2 is –3.22 and is significantly different from 0 and 1. The improved estimate of the perception parameter results from the exclusion of the variable measuring the proportion of PILOTs going to other jurisdictions due to the near collinearity with another variable in the model. The inclusion of variables that are too highly correlated prohibits the analysis of the variables' individual effects.

Non-response bias arises if non-respondents differ from respondents in their characteristics that affect their behavior regarding PILOTs. In an attempt to demarcate the existence of potential sample selection bias, the sample was divided into small cities with population less than 10,000 and large cities with population over 10,000. Models for each of these samples are estimated using the model 2 of the S-G specification. The results of the estimation for the small city and large city samples are displayed in Appendix Table B.1 and B.2, respectively. The estimated parameters across the two specifications are relatively consistent and stable. Notable differences include the lack of significance of income in the small city model and the larger coefficients on the aid variables. The larger negative value for the PILOT perception variable for smaller cities suggests that any bias present would result in the impact of PILOTs on local government

expenditures being understated. These results suggest that there is potential for non-response sample selection bias.

A more detailed analysis of the change in general fund expenditure due to price illusion can be analyzed through the partial derivative of general fund expenditure with respect to PILOTs:[22]

$$\frac{\partial P_q Q}{\partial L_E} = (1-\theta)\frac{[P_Q Q-(1-\beta_1)\tau_Q P_Q]}{[P_Q Q-(1-\beta_1)\tau_Q \alpha_E P_Q]} + \frac{P_Q Q}{[P_Q Q-(1-\beta_1)\tau_Q \alpha_E P_Q]}\beta_2\theta[1-(Nw_E)-(Nw_E\Gamma)(\Sigma P_s^j)] \tag{3.14}$$

The increase in general fund expenditures due to price illusion can be demonstrated by comparing the increase in expenditures under perfect PILOT information to the increase in expenditures given the empirical estimate of –12.81 for θ. In order to conduct the analysis of the marginal effects of PILOTs under imperfect information regarding PILOTs, it is assumed that that there is a $1.00 increase in PILOTs to this municipality (and no other municipalities). Given this, the last bracketed term in (3.14) is $1.00. Under perfect PILOT information, $\theta = 1$ and $\alpha = 0$ which implies that $\frac{P_Q Q}{[P_Q Q-(1-\beta_1)\tau_Q \alpha P_Q]}$ is equal to 1. Thus, a $1.00 increase in PILOTs, under perfect

[22] The methodology used for this analysis follows Holsey (1993). Detailed derivations are included in Appendix C.

own PILOT information, produces an increase in expenditures equal to β_2, or \$0.37. However, using the empirical estimates for the perception parameter, $\theta = -12.81$, the change in expenditures given a \$1.00 increase in PILOTs is \$5.29. Thus, under perfect knowledge of own PILOTs, the increase in expenditures is \$0.37 while under imperfect knowledge the increase is \$5.29. The increase in expenditures due to price illusion caused by PILOTs is the difference between the increase given imperfect knowledge and the increase assuming perfect knowledge, or \$4.92. The magnitude of the estimate of price illusion, while suspect, is a direct result of the relatively large negative value of the PILOT perception parameter. The marginal effects calculated using the parameter estimates from model 2 are more plausible and reconcilable with empirical findings in the grant literature. Using the same method employed above, the marginal effect of PILOTs on general fund expenditures under imperfect knowledge is \$1.04. The increase in expenditures under perfect knowledge is calculated to be \$0.70. Thus, the increase attributable to price illusion is \$0.34.

These results are generally consistent with the literature examining fiscal illusion and the stimulative effect of intergovernmental aid in that price illusion exists. The magnitude of the effect of electric utility contributions found in model 2 is in line with the effects associated with intergovernmental aid. For example, Holsey (1993) concluded that the increase in education expenditures due to price illusion is \$0.12 and Filimon et al (1982) concluded that price illusion increases expenditures across different services by \$0.71 to \$1.00 for each \$1.00 increase in per capita grants.

The next step in analyzing illusion stemming from PILOTs is to examine the parameters measuring voter perceptions about PILOTs going to other municipalities. Voter knowledge about PILOTs going to other localities depends upon the multiplicative effect of voter knowledge of the proportion of PILOTs received by other localities (Γ) and voter knowledge of own PILOTs (θ). The estimate of this multiplicative term for model 1 is 7.13. The hypothesis test reported in Table 3.3 suggests that voters do not have perfect knowledge regarding the level of PILOTs received by other localities in model 1. Recall that model 2 assumes $\Gamma=0$, indicating perfect illusion regarding PILOTs going to other jurisdiction. Theoretically, the increase in general fund expenditures due to income illusion associated with financing PILOTs can be analyzed through the derivative in (3.14). Comparing the effect of a $1.00 increase in PILOTs under perfect PILOT

Table 3.3

Hypothesis Tests for Perception Parameters
General Fund Expenditures

	F-Statistic	*Accept/Reject H_o*
Model 1		
$H_o:\theta=1$	739.19	Reject
$H_o:\Gamma=1$	1773.5	Reject
$H_o:\Gamma\theta=0$	109.35	Reject
$H_o:\Gamma\theta=1$	80.83	Reject
Model 2		
$H_o:\theta=1$	376.51	Reject

information with the increase under full income illusion where $\Gamma\theta = 1$ and, would yield the magnitude of income illusion. However, due to the assumptions made regarding perfect voter knowledge of the tax share for PILOT payment and perfect illusion regarding PILOTs going to other jurisdictions, income illusion arising from the financing of PILOTs cannot be empirically isolated.

In summary, the increase in general fund expenditures given a $1.00 increase in PILOTs is estimated to be $5.29 in model 1 and $0.34 in model 2. The uncharacteristically large estimated effect in model 1 is unrealistic and stems from the inability to precisely estimate the individual effects of the variables measuring tax payments for own PILOTs and tax payments for PILOTs going to other jurisdictions. This is likely due to the highly collinear nature of the two variables. Model 2 produces more reliable estimates of the effects of PILOTs by restricting Γ to equal zero, thus eliminating one of the nearly collinear variables. Similar analyses examining the stimulative effects of intergovernmental aid have yielded price illusion estimates from $0.12 to $1.00 [Holsey (1993) and Filimon et al. (1982)] and income illusion estimates of $0.39 (Holsey, 1993).

3.8 Expenditures by Service Category using the Stone-Geary Model

Estimation of the expenditure function in (3.13) is conducted for four specific categories of local public spending. Parameter estimates and t-statistics for key variables for public safety, streets and public works, general government, and social welfare and recreation are presented in Table 3.4. Hypothesis tests for the perception parameters for the service categories are presented in Table 3.5.

Table 3.4

Stone-Geary Model Specification-Service Categories

	Streets and Public Works	Public Safety	General Government	Social Welfare and Recreation
Model 1				
Constant	2.372	-1.143	0.194	-0.272
	(0.13)	(-0.02)	(0.02)	(-0.01)
B4 (population)	-0.587**	-1.950**	-0.820**	-0.339**
	(-20.47)	(-32.77)	(-51.36)	(-18.89)
B2 (PILOT)	-3.870**	0.194**	0.253**	0.200**
	(-8.67)	(11.28)	(36.34)	(16.05)
B3 (Income)	-0.008**	0.091**	0.008**	0.029**
	(-11.93)	(139.55)	(25.45)	(134.25)
θ (PILOT perception)	0.838**	-11.500**	4.49**	-5.686**
	(8.90)	(-40.85)	(67.91)	(-55.76)
Γ (tax perception)	-0.807**	-0.413**	-1.193**	-0.403**
	(-131.53)	(-6.50)	(-123.26)	(-8.64)
B5 (Aid)	0.001**	0.007**	0.011**	0.001
	(5.91)	(9.19)	(62.11)	(1.18)
(1-B1) τ	1.152**	1.018**	0.976**	1.016**
	(2.86)	(4.14)	(6.25)	(10.97)
Model 2				
Constant	2.739	-0.561	-2.623	-0.500
	(0.16)	(-0.01)	(-0.31)	(-0.03)
B4 (population)	-0.580**	-1.945**	-0.825**	-0.337**
	(-23.18)	(-30.12)	(-51.58)	(-18.52)
B2 (PILOT)	0.374**	0.592**	0.182**	0.417**
	(78.82)	(110.42)	(38.48)	(120.02)
B3 (Income)	-0.008**	0.092**	0.008**	0.029**
	(-12.42)	(136.17)	(25.46)	(129.18)
θ (PILOT perception)	-1.642**	-2.196**	-1.253**	-1.620**
	(-142.22)	(-84.53)	(-183.34)	(-184.05)
B5 (Aid)	-0.02E-2	0.008**	0.011**	-2.72E-6
	(-0.76)	(9.88)	(74.62)	(-0.01)
(1-B1) τ	1.174**	1.053*	0.803**	1.002**
	(2.79)	(1.64)	(3.66)	(4.69)

Notes: * *Indicates significance at the 90% confidence level*
** *Indicates significance at the 95% confidence level*
t-statistics are in parenthesis

Table 3.5

Hypothesis Tests for Perception Parameters-Service Categories

	Streets and Public Works	*Public Safety*	*General Government*	*Social Welfare and Recreation*
Model 1				
$H_o: \theta = 1$	3.06	1959.1	2786.7	431.14
	(0.08)	(<.0001)	(<.0001)	(<.0001)
$H_o: \Gamma = 1$	869.04	491.64	513.30	908.15
	(<.0001))	(<.0001)	(<.0001)	(<.0001)
$H_o: \Gamma\theta = 0$	75.37	33.16	128.13	61.12
	(<.0001)	(<.0001)	(<.0001)	(<.0001)
$H_o: \Gamma\theta = 1$	465.51	20.67	180.41	19.44
	(<.0001)	(<.0001)	(<.0001)	(<.0001)
Model 2				
$H_o: \theta = 1$	-554.81	-272.81	-578.04	-1058.63
	(<.0001)	(<.0001)	(<.0001)	(<.0001)

Notes: P-values are in parenthesis

examination of Table 3.4 indicates that model 1 provides unstable estimates of the own-PILOT perception parameter in terms of both sign and magnitude. Alternatively, model 2 results in stable and more plausible estimates of the perception parameter. Again, the highly collinear nature of the variables is likely culpable. Supporting this interpretation is the absence of any appreciable change in the estimated coefficients for variables not subject to collinearity.

In general the results from the different models were fairly consistent and stable across the specifications. A positive and significant relationship between income (B3) and the level of expenditures for all the service functions is present with the exception of

streets and public works.[23] The parameter estimates for income for the remaining three divisions are relatively stable and range from .008 to .092. The coefficients are not elasticities. Before making a comparison of these coefficients to elasticities in the literature, the coefficients must first be transformed. The calculated elasticities for income range from 0.20 for social welfare and recreation to 0.58 for public safety which within the range of the estimates reported in previous literature (Oates 1987).

The coefficient for population is significant and bears the anticipated sign for all four service categories. The magnitude of the coefficients suggests that growth in population is the most stimulative to public safety and general government expenditures and is least stimulative to spending on social welfare and recreation. The estimates, ranging from .339 to 1.950, are smaller than those reported for total general fund expenditures (2.561). The range in the estimates is likely to be a result of the varying degrees of "publicness" (i.e., congestion) across the different service functions. For example, these results suggest that increased population exerts a larger strain on public safety than it does on recreational activity, which is consistent with the findings of Ehrenburg (1973).

The coefficients for intergovernmental aid display the most volatility. Aid has significant and positive effects on streets and public works and general government, a significant and negative effect on public safety, and an insignificant effect on social

[23] Significant relationships with respect to income were found only when using the median household income measure. The model specified using median individual income resulted in an insignificant coefficient on income for all service functions. The remaining parameters in the model were not significantly affected by the different measures of income.

welfare and recreation. Again, one might expect some inconsistencies in the coefficients for intergovernmental aid given the disaggregate level of the expenditure data and the aggregate nature of the aid data used in this study. Alternatively, the contrasting relationships may result from differences in tastes and preferences across the alternative public services.

3.9 Examination of the Perception Parameters

By comparing the parameter estimates for income with those for PILOTs, general conclusions can be drawn regarding the stimulative effect of PILOTs. The comparisons for both models are displayed in Table 3.6. In model 1 these comparisons reveal differing conclusions across the service categories. The specifications for public safety and social welfare and recreation reveal that PILOTs have a more stimulative effect on the level of expenditure relative to income, indicating a positive flypaper effect. However, the models for streets and public works and general government indicate that a negative flypaper effect exists for these categories. In other words, PILOTs are less stimulative to the level of expenditures than income. The lack of consistency in both sign and magnitude of the coefficients for PILOTs escapes plausible justification, again tainting the reliability of model 1. However, examination of the comparisons for model 2 reveals more compelling evidence of a positive flypaper effect relating to PILOTs. The coefficients for PILOTs are consistently greater then those for income and the magnitudes are stable across all service functions.

Conclusions regarding the extent of fiscal illusion with respect to PILOTs across the varying service categories can be drawn by examining the perception parameters,

θ and Γ. First, as shown in Table 3.4, all specifications of model 1 display a negative parameter estimate for Γ, which measures the voter's knowledge of the proportion of PILOTs going to other municipalities. The estimates range from –0.403 to –1.193 and are all significantly different from zero. In addition, Table 3.6 indicates that the hypothesis of perfect knowledge of the proportion of PILOTs going to other jurisdictions

Table 3.6

Stone-Geary Model Specification
Comparison of the PILOT and Income Coefficients

	PILOT	***Income***
Model 1		
General Fund	0.90	0.04
	(17.57)	(22.50)
Streets and Public Works	-0.31	-0.01
	(2.46)	(-11.93)
Public Safety	1.03	0.09
	(8.31)	(139.55)
General Government	-0.24	0.01
	(42.73)	(25.45)
Social Welfare and Recreation	0.56	0.03
	(7.78)	(134.25)
Model 2		
General Fund	0.20	0.04
	(14.18)	(22.47)
Streets and Public Works	0.20	-0.01
	(36.36)	(-12.42)
Public Safety	0.19	0.09
	(4.33)	(136.17)
General Government	0.20	0.01
	(71.43)	(25.46)
Social Welfare and Recreation	0.19	0.03
	(95.01)	(129.18)

Notes: t-statistics are in parenthesis

($H_o : \Gamma = 1$) can be rejected for all categories. In general, given that Γ is significantly different from both 0 and 1, the conclusion is that the voter has neither perfect knowledge nor perfect illusion regarding the proportion of PILOTs going to other jurisdictions. As a result, the voter is unable to accurately calculate the proportion of his tax payment for PILOTs that is returned to his local jurisdiction. If he perceives his proportion returned to be greater than his total payment, expenditures are likely to expand as a result of increases in perceived income. Given the inability to isolate the parameter estimate for σ_E and the poor performance of model 1, which included estimates of Γ, the voter's perception of net tax payment cannot be empirically isolated. Therefore, the analysis of illusion will focus on the estimate of θ.

The estimates for the perception parameter with regard to the voter's own PILOTs, θ, displays substantial volatility across the different specifications for model 1. The estimates are significantly different from 0 in all models, thus rejecting the hypothesis of perfect illusion regarding the level of PILOTs going to the voter's own local government. However, as shown in Table 3.5, the hypothesis of perfect knowledge ($\theta = 1$) cannot be rejected at the 95% confidence level for streets and public works. Furthermore, θ is negative for public safety and social welfare and recreation while it is positive for general government and streets and public works. This implies an underestimation of own PILOTs with regard to spending for public safety and social produces estimates of θ that are consistent in sign, highly ignificant and range from –1.253 to –2.196. Furthermore, the hypothesis tests reported in Table 3.6 reveal that θ is significantly different from 1, supporting the fact that the voter does not have perfect

knowledge of PILOTS. Thus, the evidence suggests that the voter consistently underestimates the level of electric utility contributions going to local governments, thus giving rise to price distortions.

After establishing existence of imperfect perceptions via the significance tests, the next step is to measure the magnitude of illusion arising from the misperceptions. Following the same procedure used for aggregate expenditures, the change in expenditures given a change in PILOTs can be analyzed for each of the service categories through examination of the partial derivative given by (3.14). The results of this exercise for both models are displayed in Table 3.7. However, given the problematic results emanating from model 1, the subsequent discussion will focus on model 2. The marginal effects calculated using the parameter estimates from model 2 given both assumptions of perfect and imperfect PILOT knowledge reveal that illusion is present in all the model specifications. The measures of fiscal illusion range from $0.04 for general government to $0.85 for streets and public works. Again, the calculated illusion captures only the price distortions created by underestimating the level of revenue local governments receive from electric utilities, therefore only a partial analysis of the actual distortions that may arise is represented. In other words, the illusion calculations are negatively biased to the extent that misperceptions regarding tax payments in the form of higher electric rates create additional income distortions. For example, if the voter incorrectly perceives his portion of the PILOTs to be greater than his resultant tax payment, his perceived income has risen relative to his actual income resulting in an expansion in the provision of public

Table 3.7
Stone-Geary Model Specification
Estimates of Fiscal Illusion
(per $1 increase in PILOTs)

	Imperfect Pilot Knowledge	*Perfect Pilot Knowledge*	*Illusion*
Model 1			
General Fund	$5.29	$0.37	$4.92
Streets and Public Works	-$2.99	-$3.87	$0.88
Public Safety	$6.06	$0.19	$5.87
General Government	$3.49	$0.25	$3.24
Social Welfare and Recreation	$2.63	$0.20	$2.43
Model 2			
General Fund	$1.04	$0.70	$0.34
Streets and Public Works	$1.22	$0.37	$0.85
Public Safety	$1.32	$0.59	$0.73
General Government	$0.22	$0.18	$0.04
Social Welfare and Recreation	$1.19	$0.42	$0.77

services due to income distortions. The effects on public expenditures arising from this income illusion are not accounted for in the calculations presented in Table 3.7.

3.10 Elasticity Measures

Elasticity measures provide a valuable tool to policymakers by providing insight into the manner in which local government expenditures might potentially be impacted by changes in the level of revenue contributions from electric utilities. Examining the

elasticity of expenditures with regard to PILOTs can help put the above results in context. The elasticity measure can be stated formally as:

$$E_{(L_E,Q)} = \left(\frac{\partial P_Q Q}{\partial L_E}\right)\left(\frac{L_E}{P_Q Q}\right) \tag{3.15}$$

The results of these calculations for both models are reported in Table 3.8. *A priori*, one would expect positive elasticities, assuming that all service functions are normal goods. This expectation holds with the exception of streets and public works in model 1, which has an estimated elasticity of –0.84. However, due to the unreliability of the marginal effects stemming from model 1 it follows that the resulting elasticities will also be suspect. Therefore, the remainder of the discussion focuses on model 2. The elasticity measures for model 2 range in magnitude from 0.05 for general government expenditures to 0.40 for social welfare and recreation, implying relatively inelastic responses with respect to changes in the level of PILOTs across the different local service functions. The implications of the elasticities are that for a 1 percent increase in the level of PILOTs, expenditures on general government and social welfare and recreation would increase by 0.05 percent and 0.40 percent, respectively. The variation in the magnitude of the effects is a function of the perception parameters and the share of expenditures represented by PILOTs. A more complete discussion of policy implications stemming from simulations using these elasticites is addressed in Chapter 5.

Table 3.8

PILOT Elasticity Measures
Stone-Geary Model Specification

	Model 1	*Model 2*
Total General Fund Expenditures	0.90	0.29
Streets and Public Works	-0.84	0.34
Public Safety	0.58	0.48
General Government	0.81	0.05
Social Welfare and Recreation	0.88	0.40

3.11 Summary

Stone-Geary estimates are employed to describe the reaction of local public expenditures to changes in the level of revenue contributions for local electric utilities, or PILOTs. The S-G utility function provides a relatively straightforward framework that can be used to examine the demand for public goods that permits incorporation of parameters necessary for the analysis of fiscal illusion. However, its restrictive nature often leads to requiring simplifying assumptions to make the model more conducive to empirical estimation. In summary, PILOTs are found to be more stimulative than income on the level of general expenditures and the level of expenditures on different categories of local public services. This implies that a flypaper effect exists. Furthermore, the analysis suggests that the source of the flypaper effect is fiscal illusion, which stems from price distortions. Price distortions arise from the voter's under-estimation of the level of electric utility contributions to the general fund of local governments.

The results emanating from the first specification of the structural model are problematic. While the qualitative conclusions regarding the direction of the flypaper effect and the existence of fiscal illusion are encouraging in most models, the magnitudes of the point estimates of the perception parameters and the price illusion are suspect. This result is not totally unexpected given the criticism of the LES derived from the S-G framework and the high degree of collinearity between the variables. Hence while model 1 provides some insights into the general manner in which PILOTs factor into decision making at the local level, one should remain cautious about placing too much confidence on the specific findings.

Model 2 assumes that voter knowledge of PILOTs going to other jurisdictions is equal to zero, thus eliminating one of the terms in the estimating equation. Empirically, this assumption has the effect of eliminating a variable identified as nearly collinear in the collinearity diagnostics. Theoretically, the assumption is equivalent to ignoring electric utility subsidies going to other jurisdictions. However, the assumption is not as contentious in the setting of the current study as it may be in the treatment of other types of subsidies such as grants. The reasoning is that all jurisdictions receive PILOTs based on the same apportionment formula and the tax payment built into electric rates is the same across jurisdictions due to regulated rates. Thus it is plausible that the allocation of PILOTs is independent across jurisdictions. Model 2 performs much better than model 1. The results from model 2 are stable, robust and provide plausible estimates of the impact of utility contributions on the level of local public expenditures. Furthermore, the model provides evidence of a flypaper effect due to fiscal illusion for all service categories

examined. The marginal effects indicate that PILOTs have the most significant impact on social welfare and recreation while having the least effect on general government expenditures. The elasticities reinforce these findings. Given the performance of the two models, model 2 is deemed to be the more appropriate specification of the structural model to use in the evaluation of fiscal illusion associated with internal subsidization of local government via electric utilities.

CHAPTER 4

THE REDUCED FROM MODEL USING THE LOG-LINEAR SPECIFICATION

4.1 An Alternative to the Structural Model

Much of the literature examining fiscal illusion associated with intergovernmental aid has employed the use of a reduced-form model.[24] One contribution of this paper is the use of a reduced form approach to analyze illusion resulting from revenue contributions of electric utilities to local government budgets. Following Turnbull (1993) and Mitias (1997), this section of the paper exploits the log-linear model as an alternative to the structural Stone-Geary model. The demand equation derived from the log-linear model allows for the direct estimation of the voter's perception about the level of PILOTs received. The elasticity estimates from the empirical model can be used to calculate the direction of the flypaper effect and when compared with the perception parameter, will allow for the indirect determination of the price distortions.

Using the variable definitions from Chapter 3, the perceived marginal local tax share of the median voter is represented by:

$$\hat{w}_L = w_L(1-\frac{(1-\theta)L_E}{P_Q Q}) \tag{4.1}$$

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[24] For example, see Wyckoff (1989), Heyndels and Smolders (1993), and Turnbull (1993).

where w_L is the voter's actual marginal tax share, $P_Q Q$ is the actual total expenditure on public goods, and $(1-\theta)L_E$ is the level of unperceived PILOTs. Under perfect information $\theta = 1$ and the perceived tax share reduces to the actual marginal tax share. When the voter underestimates the level of PILOTs, $\theta < 1$ and the perceived price is lower than the actual price of the public goods. Likewise, if the voter overestimates the PILOTs, $\theta > 1$ and the perceived price is higher than the actual tax price. Given (4.1), the perceived net PILOT component of the budget constraint is:

$$\hat{L}_E = w_L(1-\frac{(1-\theta)L_E}{P_Q Q})\theta L_E - w_L(1-\frac{(1-\theta)L_E}{P_Q Q})(1+\Gamma)\theta L_E \tag{4.2}$$

where the first term is the perceived tax price multiplied by the perceived PILOTs and the second term represents the perceived tax payment for the PILOT. Incorporated in the tax payment term is the perception of the level of PILOTs going to other municipalities.

The general *individual* demand function for local public goods is defined as:

$$q = f(\alpha_o, I, N, \hat{P}_Q, \hat{L}_E, A) \tag{4.3}$$

where the median voter's demand for local public goods, q, is a function of income, I, local population, N, the perceived price of local public goods, the perceived net PILOT received, and intergovernmental aid, A. Equation (4.3) can be stated more formally in an exponential functional form. Assuming a multiplicative form and expressing individual output, q, as $q = \mu Q$ (where μ represents the congestion parameter) yields:

$$\mu Q = \alpha_o I^{\alpha_1} N^{\alpha_2} \hat{P}_Q^{\alpha_3} \hat{L}_E^{\alpha_4} A^{\alpha_5} \tag{4.4}$$

Multiplying (4.4) by P_Q / μ and rearranging terms yields the following expression for the *total* demand for local public goods:

$$P_Q Q = (\alpha_o I^{\alpha_1} N^{\alpha_2} \hat{P}_Q^{\alpha_3} \hat{L}_E^{\alpha_4} A^{\alpha_5} P_Q) / \mu \tag{4.5}$$

Substituting (4.2) into (4.5) yields:

$$P_Q Q = [\alpha_o I^{\alpha_1} N^{\alpha_2} w_L^{(\alpha_3+\alpha_4)} P_Q^{(1+\alpha_3)} (1 - \frac{(1-\theta)L_E}{P_Q Q})^{(\alpha_3+\alpha_4)} \theta L_E (1-(1+\Gamma))^{\alpha_4} A^{\alpha_5}] / \mu \tag{4.6}$$

Taking the logarithms of both sides of (4.6) and collecting terms yields an estimable equation for the demand for local public goods and is expressed as:

$$\begin{aligned} LnP_Q Q &= C_o + \alpha_1 LnI + \alpha_2 LnN + (\alpha_3 + \alpha_4) Lnw_L + (1+\alpha_3) LnP_Q \\ &+ (\alpha_3 + \alpha_4) Ln(1 - \frac{(1-\theta)L_E}{P_Q Q}) + \alpha_4 LnL_E + \alpha_5 LnA \end{aligned} \tag{4.7}$$

where the constant $C_o = \alpha_o + \alpha_4 Ln\theta + \alpha_4 Ln(1-(1+\Gamma)) - Ln\mu$.

4.2 Estimation Methodology

Equation (4.7) is nonlinear in the parameters so estimation is conducted using a maximum likelihood method. Dummy variables were included to control for municipality and year effects. It is assumed that errors are additive and normally distributed. The data used in the estimation are municipal general fund expenditures (P_QQ), median family income (I), and municipal population (N). The price of public goods is proxied by the average wage of government employees of the county in which the municipality is located. The median voter tax share, w_L, is assumed to be the median house value divided by the total property tax base in the municipality. These definitions of the variables are frequently used in local public expenditure studies [Turnbull (1993), Turnbull (1994), and Holsey (1993)]. Descriptive statistics and sources for the variables used in the estimation are given in Table 3.1. A detailed discussion of the sample data is provided in section 3.4.

This study estimates both the total general fund expenditure function and specific service functions at the municipal level. Four service categories are examined: public safety, streets and public works, general government, and social services and recreation. The estimation of (4.7) for the service categories substitutes the total expenditures for each category as a measure of the dependent variable, P_QQ.[25]

[25] For the purpose of the current study, identical demand equations are being used to model the total demand for local public services as well as the demand for specific local public service categories. It is possible that re-optimization for specific service functions would yield different equations. However, it is also probable that the differences would primarily consist of additional socio-demographic variables, which could potentially impact demand for specific services. The municipal and time dummy fixed effects will capture the effects of such variables across the different models.

4.3 General Fund Expenditure Results

Estimates of the log-linear reduced form model for municipal general fund expenditures are reported in Table 4.1. Included in the tables are the estimates of both the restricted log-linear model under the assumption that the median voter has perfect information about the level of PILOTs received ($\theta = 1$) and those from an unrestricted model. Qualitatively, the two models produce similar findings. Using a likelihood ratio test, the hypothesis that the median voter has perfect knowledge of PILOTs is rejected at the 95% confidence interval (with an F-statistic of 118.0). Given this, the remainder of this section will focus on the results for the unrestricted model.

Examination of the results for the unrestricted model indicates an insignificant relationship between the median voter's income and general fund expenditures. The result is inconsistent with income effects reported in the literature. For example, Ehrenburg (1973) uses total local government employment data at the municipal level and reports an income elasticity of 0.75. Heyndels and Smolders (1993) report an income elasticity of 1.36 using data from Flemish municipalities. In an effort to reconcile this inconsistency the model was estimated using median individual income as an alternative to median household income. There was no significant change in any of the results.

The intergovernmental aid elasticity (A5) is positive and significant in relation to general fund expenditures. The estimate of 0.09 is smaller then Ehrenburg's (1973) estimate of 0.22 and Turnbull's (1993) estimates ranging from 0.48 to 0.78. However, it is consistent with the estimate of 0.04 reported by Wyckoff (1991).

Table 4.1

Log-Linear Model Specification
General Fund Expenditures

	Unrestricted Model	Restricted Model
Constant (A0)	0.966**	0.813**
	(9.49)	(7.76)
Income (A1)	-0.009	0.011
	(-0.09)	(0.12)
Population (A2)	0.884**	0.777**
	(10.96)	(8.81)
Price Elasticity (A3)	-0.142**	-0.225**
	(-4.50)	(-6.39)
Pilots (A4)	0.320**	0.201**
	(9.47)	(5.77)
Intergovernmental Aid	0.089**	0.089**
(A5)	(8.48)	(8.07)
Pilot Perception (θ)	-0.962**	
	(-22.72)	
F-statistic		
Ho: θ=1		140.0

*Notes: ** Indicates significance at the 95% confidence level*
t-statistics are in parenthesis

The elasticity with respect to population is highly significant with the expected positive sign, indicating congestion is a factor.

Examination of the parameter estimate for the elasticity related to PILOTs reveals a positive and significant relationship with respect to general fund expenditures with a point estimate of 0.32. Analysis of the θ parameter allows assessment of the degrees of price and income illusion associated with the level of general fund expenditures. The

estimate for the level of PILOTs perceived by the median voter is -0.96 and significantly different from zero. This estimate implies that the voter underestimates the amount of PILOTs paid to local government by electric utilities. If the median voter underestimates the level of PILOTs, as the results indicate, then the median voter will underestimate the tax price of the public good. This price distortion causes an expansion of the level of public goods provided.

Comparing the differences in the marginal effects of income and PILOTs on the level of expenditures gives the direction of the flypaper effect and indirectly yields the source of illusion. PILOTs that are marginally more stimulative than income on the level of public expenditures are indicative of a positive flypaper effect. The coefficients estimated using the log-linear approach yield elasticitites and cannot be used directly to analyze marginal effects. However, we can calculate the direction of the flypaper effect by making the appropriate transformations.

Following the analysis of intergovernmental aid by Inman (1979) and Mitias (1997), this relationship can be stated more formally as:

$$\frac{\partial(P_Q Q)}{\partial I} < \frac{\partial(P_Q Q)}{\partial(wL_E)} \tag{4.8}$$

Multiplying both sides by I/P_qQ yields:

$$\left(\frac{\partial(P_Q Q)}{\partial I}\right)\left(\frac{I}{P_Q Q}\right) < \left(\frac{\partial(P_Q Q)}{\partial(wL_E)}\right)\left(\frac{I}{P_Q Q}\right) \tag{4.9}$$

Multiplying the right hand side of (4.9) by 1(wL_E/wL_E) and rearranging terms yields:

$$\left(\frac{\partial(P_qQ)}{\partial I}\right)\left(\frac{I}{P_qQ}\right)<\left(\frac{\partial(P_qQ)}{\partial(wL_E)}\right)\left(\frac{wL_E}{P_qQ}\right)\left(\frac{I}{wL_E}\right) \tag{4.10}$$

This can be written as:

$$E_{(I,Q)} < E_{(wL_E,Q)}\frac{I}{wL_E} \tag{4.11}$$

where $E_{(I,Q)}$ is the income elasticity and $E_{(wL_E,Q)}$ is the PILOT elasticity. Therefore by multiplying the PILOT elasticity by the ratio of the median voter's income to his share of PILOTs, one can determine if PILOTs are marginally more stimulative than income. Conducting the transformation reveals a stimulative effect equal to 0.05 for PILOTs. Thus, the comparative effect of PILOTs on general fund expenditures is greater than the income elasticity, showing that PILOTs are more stimulative than income. More specifically, this result supports the theoretical results that an underestimation of the level of PILOTs lowers the perceived price of the public good and leads to a higher level of public expenditures. The positive flypaper effect resulting from the voter's underestimation of the level of PILOTs suggests that he suffers from fiscal illusion. This underestimation of PILOTs is supported by the estimate of θ being less than one.

The analysis of the marginal effect of PILOTs on the level of local public expenditures reveals the increase in local government expenditures given a one dollar increase in PILOTs. The calculated marginal effects indicate that a dollar increase in PILOTs increases general fund expenditures by $1.97 which includes the increase attributable to price and income distortions. In comparison the marginal effect of intergovernmental aid for the log-linear model is $1.17.[26] These results generally suggest that PILOTs give rise to a higher degree of price and income distortions relative to intergovernmental aid. However, a model that incorporates a more detailed treatment of aid is necessary to make any comparisons beyond these general conclusions.

4.4 Service Category Results

An important contribution of this work is the use of municipal level data to examine the effect of revenue contributions from electric utilities on the level of specific categories of local public goods provided. This section analyzes the provision of the same four specific categories of services used in the estimation of the structural model in Chapter 3. Estimation of the expenditure functions indicates that the median voter suffers from fiscal illusion stemming from the underestimation of the level of revenue contributions received from TVA and local electric utilities. In all four service categories, PILOTs are more stimulative than income on the level of expenditures.

A restricted model for each of the service categories was estimated under the assumption of perfect knowledge of own PILOTs was estimated. The results are reported

[26] The marginal effect of aid is calculated by multiplying the aid elasticity by the mean general fund expenditures divided by mean aid.

in Table 4.2. The parameter estimates for population, price, and PILOTs are all highly significant and have the anticipated sign. Income was insignificant across all models for both median individual income and median household income. The results reported are for the model using median household income. The hypothesis that the voter has perfect knowledge regarding the level of PILOTs, $\theta=1$, is tested and rejected at the 95% confidence level for all four categories of public goods.

Given that perfect knowledge of PILOTs does not exist, the next step is to estimate unrestricted models. Table 4.3 displays the estimates of the log-linear expenditure function for the four service categories. The income elasticity estimates for all service categories are insignificant for both measures of income. The results reported reflect the specification that utilizes median household income. The insignificance of income is not consistent with the literature, which generally reports a positive and significant relationship between income and the level of public expenditures. A potential explanation is the dissagregated level of the analysis. Most studies examining income elasticity of public goods at the local level use county level data whereas the current study uses municipal level data. Also, as discussed in a section 3.4, annual income data at the municipal level are not available so a proxy was constructed based on county level data.

Further examination of the estimates in Table 4.3 reveals a positive and significant relationship between intergovernmental aid and the level of expenditures. Although the estimates appear consistent across all four service categories, ranging from 0.025 for social services and recreation to 0.079 for streets and public works, they

Table 4.2

Log-Linear Model Specification-Restricted Public Service Categories

	Streets and Public works	*Public Safety*	*General Government*	*Social Welfare and Recreation*
Constant (A0)	0.104	0.158	0.490**	-0.585
	(0.42)	(0.71)	(2.26)	(-1.50)
Income (A1)	-0.053	0.061	0.018	0.224
	(-0.23)	(0.30)	(0.11)	(0.90)
Population (A2)	0.915**	0.576**	0.603**	0.794**
	(5.70)	(3.76)	(5.74)	(4.85)
Price Elasticity (A3)	-0.354**	-0.407**	-0.373**	-0.400**
	(-6.08)	(-6.77)	(-9.50)	(-4.70)
Pilots (A4)	0.263**	0.314**	0.325**	0.385**
	(5.71)	(6.77)	(11.48)	(6.14)
Intergovernmental	0.078**	0.050**	0.035	0.026
Aid (A5)	(2.31)	(2.00)	(1.69)	(0.60)
F-statistic				
H_o: $\theta = 1$	8.77	11.63	209.08	13.75

Notes: ** *Indicates significance at the 95% confidence level*
t-statistics are in parenthesis

Table 4.3

Log-Linear Model Specification- Unrestricted Public Service Categories

	Streets and Public works	*Public Safety*	*General Government*	*Social Welfare and Recreation*
Constant (A0)	0.223	0.234	0.580**	-0.495**
	(0.90)	(1.04)	(5.17)	(-2.24)
Income (A1)	-0.074	0.045	0.005	0.224
	(-0.31)	(0.22)	(0.06)	(1.38)
Population (A2)	1.040**	0.676**	0.686**	0.852**
	(6.75)	(4.59)	(6.40)	(4.03)
Price Elasticity	-0.244**	-0.312**	-0.310**	-0.356**
(A3)	(-4.69)	(-5.95)	(-7.32)	(-4.24)
Pilots (A4)	0.355**	0.364**	0.394**	0.456**
	(6.86)	(7.17)	(8.73)	(5.15)
Intergovernmental	0.079**	0.050**	0.035**	0.025
Aid (A5)	(2.27)	(1.99)	(1.99)	(0.72)
Pilot Perception	-0.972**	-0.904**	-0.991**	-0.987**
(θ)	(-3.83)	(-5.26)	(-12.80)	(-56.62)

Notes: ** *Indicates significance at the 95% confidence level*
t-statistics are in parenthesis

are smaller than the elasticities generally reported in the literature. One possible explanation for the smaller aid elasticities is the disaggregated nature of the data. Again, much of the intergovernmental aid received at the municipal level is earmarked for specific services or projects and often does not flow into the general fund expenditures from which the revenue for the service categories examined are drawn.

Analysis of the PILOT elasticities for the service categories reveals a positive and significant relationship between the level of PILOTs and the level of expenditures. The estimates are very stable across categories, ranging from 0.355 for streets and public works to 0.456 for social welfare and recreation. These estimates indicate that PILOTs are more stimulative on the level of local public expenditures than income and intergovernmental aid. One explanation for the higher PILOT elasticities is the fact that PILOTs flow directly into the local government's general funds and are not earmarked for specific use.

Examination of the PILOT perception parameter (θ) allows for the assessment of the degree of price illusion on the level of spending in the four categories included in the study. The estimates presented in Table 4.3 indicate that the median voter underestimates the amount of PILOTs received by local government for all four service categories. All of the estimates of the perception parameter are significantly different than zero and less than one. They are stable across all categories and range from -0.904 for public safety to -0.991 for general government. This implies that PILOTs allow for expenditures on general government to expand more than those for the other service categories. The underestimation of the level of PILOTs received leads to an underestimation of the tax

price by the median voter and causes an expansion in the level of expenditures.

Using the transformations discussed in the previous section, the direction of the flypaper effect can be confirmed for the four service groups. Comparison of the marginal effects of PILOTs and income on the level of expenditure can be facilitated by multiplying the estimates for the PILOT elasticity by the income to PILOT tax share ratio and comparing this with the income elasticity. Comparisons of the stimulative effects relative to income for the service categories are displayed in Table 4.4. The stimulative effects are stable across service functions and range from 0.05 to 0.07. The calculated marginal effects reveal that PILOTs are marginally more stimulative than income for all categories, thus all four municipal level service functions exhibit a positive flypaper effect associated with PILOTs.[27] Therefore, the conclusion is that the median voter suffers from fiscal illusion caused by the underestimation of PILOT levels for these four categories of local public goods and leads to an expansion in the level of expenditures.

The marginal effects, displayed in Table 4.5, give the change in expenditure given a dollar change in PILOTs. For example, if PILOTs decreased by one dollar, the decrease in general government expenditures would be $2.43. The marginal effects suggest that PILOTs are most stimulative to the level of spending on social welfare and recreation and general government while they are less stimulative on the level of spending for public safety and streets and public works. While the general results on the existence and direction of the flypaper effect support the findings from the structural models, the specific findings on magnitude across service categories are greater compared to the

[27] Recall that the income elasticity was not significantly different from 0 for any of the models estimated.

Table 4.4

Log-Linear Model Specification
Stimulative Effects of Pilots Relative to Income

	$E_{(L_E,Q)}\frac{I}{wL_E}$
General Fund	0.05
Streets and Public Works	0.06
Public Safety	0.06
General Government	0.06
Social Welfare and Recreation	0.07

Table 4.5

Log-Linear Model
Marginal Effects of PILOTs on Expenditures
(per $1.00 decrease)

	$\frac{\partial P_Q Q}{\partial L_E} = E_{(L_E,P_Q Q)}\left(P_Q Q / L_E\right)$
Total General Fund	-$1.97
Streets and Public Works	-$2.19
Public Safety	-$2.25
General Government	-$2.43
Social Welfare and Recreation	-$2.51

findings of model 2 of the structural model.

4.5 Summary of Results

The positive flypaper effects found with regards to general fund expenditures and the four specific categories of local services indicate that PILOTs are more stimulative than income on the level of expenditures. The consistency of the flypaper effect implies that the median voter routinely underestimates the true marginal tax price of public goods. The consistent underestimation or lack of knowledge of PILOTs as measured by θ is the source of the price distortion.

In summary, the empirical results indicate that the median voter suffers from fiscal illusion. The source of the illusion stems from the lack of knowledge regarding the amount of payments local governments receive from TVA and local electric utilities. This underestimation of PILOTs leads to an underestimation of the price of local public goods, thus leading to an expansion in the level of local government expenditures. All the elasticities resulting from the log-linear model are positive and relatively consistent across all the service categories.

The relative consistency of the reduced-form model makes it an attractive alternative to the more restrictive structural form. The model is stable across alternative specifications and the coefficients are directly interpreted as elasticities. However, despite these advantages, there remains a major disadvantage. The log-linear model does not allow for the separation of the source of fiscal illusion into price and income distorting components.

CHAPTER 5

MODEL COMPARISONS, SIMULATIONS AND POLICY IMPLICATIONS

5.1 Comparison of the Structural and Reduced Form Models

Two specifications of the model for the demand for local public goods are developed in an attempt to model the behavioral responses of local public expenditures to revenue contributions from electric utilities. First, a structural model is developed and empirically estimated. The appeal of the structural model is that it is derived directly from the constrained utility maximization problem of the median voter, thus the model retains the theoretically desirable properties related to demand theory. The structural model chosen for the current study is based on the linear expenditure system (LES) derived from the Stone-Geary (S-G) utility function. The primary advantage of the S-G framework is that it *theoretically* allows for the separation of price and income distortions related to fiscal illusion in a relatively straightforward manner. In other words, the model not only allows for the existence of fiscal illusion, but it also provides a method of directly analyzing the source of the illusion. However, as previously noted, the LES is subject to several criticisms. The primary argument against the use of the S-G expenditure system stems from its restrictive properties including the assumptions of marginal budget shares that are independent of income and the exclusion of the possibility of complementary goods (i.e., all goods are substitutes). For example, if the demand for local public goods were estimated as a system of expenditure share equations the LES would require all service functions such as public safety and streets to be

substitutes. An increase in the price of public safety, *ceteris paribus*, would result in a decrease in public safety expenditures and an increase in spending on streets. Furthermore, once the subsistence expenditure for all goods has been met, the marginal changes in expenditures on specific service functions stemming from changes in income would be allocated in fixed proportion due to constant marginal budget shares. Given that the average budget shares are a weighted average of the subsistence budget shares and the marginal budget shares, as income grows indefinitely large, the average budget shares approach the marginal budget shares (Goldberger, 1967). Therefore, the LES may not be an appropriate specification for investigating the effect of PILOTs on the share of the budget comprised by different service functions. However, the current study investigates the impact of PILOTs on the actual level of spending across different services and is not focused on shifts in budget shares, thus the limitation is not as serious as it may first appear.

In practice, the ability to empirically separate the distortions arising from fiscal illusion using the S-G based structural model is a formidable task and often infeasible without making some concessions due to the highly nonlinear nature of the parameters. The current study is no exception. Two specifications of the S-G model are estimated. In the first specification, the primary concession made is the assumption that the median voter has perfect knowledge of his or her marginal tax share. This assumption prohibits the ability to fully separate the illusion arising from PILOTs into price and income effects due to the inability to fully estimate the voter's perception of tax payments for PILOTs. However, the model still retains the ability to partially decompose the total effect into its

price and income distorting components through parameters representing the voter's perception of PILOTs received by his own local jurisdiction and his perception of PILOTs received by other local jurisdictions. In other words, distortions arising as a result of under-estimation or over-estimation of tax share by the voter are not captured. These distortions are potentially significant given that it is likely that the voter does not have perfect knowledge of his tax share for electric utility payments due to the industry practice of bundling prices for electricity. If the voter under-estimates his tax share, the estimates of illusion derived from the structural model will be negatively biased.

Model 2 retains the assumption of the first model and adds the assumption of no knowledge of simultaneity of PILOT allocations. Ignoring the simultaneity of PILOT allocations results in treating PILOTs in the tradition of lump-sum grants. Given the method used to calculate PILOTs, which is out of the hands of local policymakers, ignoring the simultaneity of payment allocation is not regarded as a major limitation for the current study.

The reduced from model is based on the more standard log-linear determinants models of Borcherding and Deacon (1973) and Bergstrom and Goodman (1974). Fiscal illusion stemming from electric utility contributions is analyzed via the inclusion of a single perception parameter, therefore the model does not allow for the separation of fiscal illusion into price and income effects. However, given the inability to fully isolate these effects empirically using the structural model, the argument against using the reduced form model based on this limitation is not as compelling as previously speculated. Moreover, the log-linear model proves to be consistent and robust across all

specifications and remains relatively computationally straightforward to estimate.

Generally, the results obtained from the empirical estimation of both of the specifications of the structural model and the reduced form model are supportive of the existence of fiscal illusion related to PILOTs. While the magnitudes of the coefficients emanating from the first structural model are suspect, the qualitative conclusions of the model are somewhat encouraging as it yields highly significant coefficients for all the parameters of interest with the exception of the aid coefficient in the social welfare and recreation model. In addition, all but two of the coefficients for population, income, and intergovernmental aid display the sign prescribed by underlying economic theory. Unfortunately, the estimated perception parameters are not as consistent. Model 1 of the S-G model results in a negative own-PILOT perception parameter estimate in two of the specifications and a positive estimate for the remaining three specifications. The inconsistency in the signs on the perception parameters gives rise to inconsistency in the existence and direction of a flypaper effect. Nonetheless, model 1 supports the existence of a positive flypaper effect for three of the five expenditure functions examined.

The second specification of the Stone-Geary model, which assumes independence of PILOT allocations across jurisdictions, produces results that are much more consistent and robust across all service functions. An exception is the aid variable, which is significant in three of the five specifications. The coefficients for population and income are significant and have the anticipated sign across the service functions. Moreover, the magnitude of the findings relating to price and income distortions are more reconcilable with empirical evidence relating to intergovernmental grants and thus, more credible.

The reduced form model also produces results that are consistent with economic theory. For example, the population elasticities and intergovernmental aid elasticities are all positive while the price elasticities are negative. Moreover, the magnitudes of the elasticities are relatively consistent across specifications and with elasticities reported in previous studies. Perhaps the most encouraging results obtained from the reduced form model are those related to PILOTs and fiscal illusion. The elasticity measure for PILOTs is positive and significant across all specifications, thus suggesting PILOTs have a stimulative effect on expenditures for all the service functions examined. The PILOT perception parameter is significant, negative, and displays consistency in magnitude in each of the estimations. This finding lends support to the hypothesis that PILOTs result in fiscal illusion, thus giving rise to a flypaper effect. The one result dissenting from previous research is the insignificant parameter estimate for income across all the models. As discussed previously, the lack of significance is potentially due to deficient data on annual median income at the municipal level.

The results emanating from the empirical estimation of model 1 of the structural model cast doubt on its effectiveness in the context of the current study. Plausible arguments for the model's poor performance include data limitations, the highly non-linear specification of the parameters and the near collinearity of some of the variables. Model 1 does, however, lend support to the results on the existence of a flypaper effect due to fiscal illusion obtained from the better performing model 2. Based on performance as measured by the consistency, robustness, and plausibility of the parameter estimates, model 2 is deemed to be the more convincing representation of the effect of PILOTs on

local public expenditures

The reduced form model also performs well and reinforces the results produced by model 2. The inability to fully isolate income and price distortions in the structural model due to estimation complications somewhat diminishes the perceived shortcomings of the log-linear specification. Thus, due to its simplicity and robustness, the log-linear specification provides an appealing alternative for evaluating the impact of revenue contributions from electric utilities on the level of local public expenditures. Based on the above observations, model 2 of the S-G model and the log-linear model provide the most compelling evidence regarding the existence of a flypaper effect associated with internal subsidization of local governments by electric utilities.

5.2 Comparison of the Stimulative Effect of Electric Utility Contributions

The stimulative effects of electric utility contributions on the level of local public services are examined using two measures: marginal effects and elasticities. Marginal effects illustrate the incremental increase in expenditures given a one-dollar increase in the level of contributions. The elasticity of expenditures with respect to PILOTs is measured as the percentage change in the level of expenditures given a percentage change in the level of electric utility contributions and thus is not unit specific. Comparison of the marginal effects and elasticities stemming from the structural and reduced from models is presented in Tables 5.1 and 5.2, respectively.

Given the discussion in section 5.1, it is not surprising that the marginal effects calculated using the parameter estimates from model 2 and the log-linear model are more attuned with expectations than those from model 1 of the structural model. Nonetheless,

Table 5.1

Comparison of Marginal Effects
Structural and Reduced Form Models
(Per $1.00 increase in PILOTs)

	Structural Model		Reduced Form Model
	Model 1	*Model 2*	
Total General Fund Expenditures	$5.29	$1.04	$1.97
Streets and Public Works	-$2.99	$1.22	$2.19
Public Safety	$6.06	$1.32	$2.25
General Government	$3.49	$0.22	$2.43
Social Welfare and Recreation	$2.63	$1.19	$2.51

Table 5.2

Comparison of PILOT Elasticity Measures
Structural and Reduced Form Models

	Structural Model		Reduced Form Model
	Model 1	*Model 2*	
Total General Fund Expenditures	0.90	0.29	0.32
Streets and Public Works	-0.84	0.34	0.36
Public Safety	0.58	0.49	0.36
General Government	0.81	0.08	0.39
Social Welfare and Recreation	0.88	0.40	0.46

model 1 does offer results that are qualitatively supportive of the results from the other models. For example, a decrease in the level of PILOTs going to a municipality contracts the level of general fund expenditures and the expenditures on specific service functions with the exception of streets and public works. However, the magnitude of the results casts doubt on the reliability of the calculations given that the increase in expenditures resulting from a $1.00 change in PILOTs ranges from -$2.99 to $6.06.

Alternatively, the marginal effects yielded by model 2 and the log-linear model indicate a positive relation between changes in expenditures and PILOTs for all the specifications, and the increase in expenditures in response to a $1.00 increase in PILOTs is relatively consistent across functions. The marginal effects range from $0.22 to $1.32 for model 2 and $1.97 to $2.51 for the reduced form model.

Comparison of the elasticities across the models reveals that model 2 and the reduced form model perform the most consistently. The three models suggest that demand for expenditures across all model specifications is relatively inelastic with regards to revenue contributions from electric utilities. For example, the PILOT elasticities for general fund expenditures range from 0.29 for model 2 to 0.90 for model 1. These results indicate that a 10 percent decrease in revenue from electric utilities would result in a 2.9 to 9.0 percent decrease in general fund expenditures. The elasticities derived from model 1 of the S-G framework are inconsistent as they range from -0.84 to 0.90 and given the poor performance of the model, appear to be unreliable. On the other hand, model 2 gives rise to elasticities that are consistent across all service categories and

range from 0.05 to 0.48.

The estimated coefficients obtained in the log-linear model are directly interpretable as elasticities. The resulting elasticities are stable across specifications and range from 0.32 for general fund expenditures to 0.46 for spending on social welfare and recreation. These findings indicate that a 10 percent increase in PILOTs will result in an expansion in public expenditures ranging from 3.2 percent to 4.6 percent depending on the specific service function. Given that a primary goals of the current study is to provide one of the first detailed analyses of price and income distortions arising from electric utility contributions, directly comparable results from previous literature are not available. To date, the examination of the impact of utilities has involved testing for the significance of internal subsidization from an electric utility through the use of a dummy variable indicating whether or not a municipality practiced internal subsidization. While these studies provide evidence that internal subsidization from electric utilities has a positive and significant effect on the level of local public expenditures, no attempt to is made to measure the magnitude of the impact (Dilorenzo 1982, and Dollery and Worthington 1999).

Alternatively, comparisons with estimated elasticities for lump-sum grants provide some insight into the relative feasibility of the estimates of electric utility subsidies in the current study. In his 1973 study of the effect of grants on total general expenditures and employment, Ehrenburg estimates grant elasticity to be 0.22. Grant elasticity estimates found in similar studies focusing on education expenditures range

from 0.03 (Ladd 1975) to 0.71 (Inman 1971). These comparisons suggest that the elasticities from model 2 of the structural model combined with those from the log-linear model provide a feasible range of response of local governments to changes in the level of electric utility contributions.

5.3 Simulation of Responses to Changes in the Level of PILOTs

The purpose of developing the models used in the current study is to understand the relationship between electric utility contributions to the general fund of local governments and the level of local public goods provided. Articulating the impacts of these contributions can uncover some important insights into the manner in which local governments may react to the impact of electric utility restructuring on the level of contributions. Should contributions from electric utilities wane, these reactions include a choice between fiscal retrenchment and fiscal replacement. Using the elasticity results from model 2 of the structural model and the log-linear model, responses to changes in the level of PILOTs are simulated. Simulation analysis will provide a better understanding of the implications of the estimated impacts of utility subsidies on the magnitude of the potential fiscal replacement or retrenchment choice policymakers will face.

Due to the interaction of several potentially offsetting forces, the effect of electric utility restructuring on the level of PILOTs is ambiguous. For example, if prices for electricity decrease as a result of restructuring, it is plausible that payments paid by electric utilities based on gross receipts, such as TVA PILOTs, will decrease. However, if consumers substitute away from other sources of energy (i.e., natural gas) due to lower

prices of electricity, gross receipts taxes paid by TVA could increase, thus increasing PILOTs to local governments. Perhaps a more important issue for municipalities in Tennessee is that TVA will potentially no longer have regulatory oversight of the local distributors. Without the oversight, it is likely that the manner in which local distributors contribute to the general fund of local governments will be altered. In the absence of any state mandates on utility contributions, the changes could make it possible for local policymakers to increase the level of internal subsidization by local electric utilities or vice versa. Given the numerous factors to be considered and the early stage of restructuring in Tennessee, it is beyond the scope of the current study to forecast specific changes in the levels of electric utility contributions due to restructuring. Therefore, the simulations utilized here provide predictions about responses in the level of spending based on "as if" changes in the level of PILOTs.

During the period examined in the empirical analysis, both local government expenditures and PILOTs were generally increasing across all municipalities. Therefore, from a practical perspective, the elasticities represent the percentage increase in expenditures given a percentage increase in PILOTs. It is important to note that the simulations assume symmetrical responses to changes in the level of PILOTs. Specifically, it is assumed that the local spending will be equally responsive to both increases and decreases in the level of PILOTs. Given that the time period used in the empirical estimation generally reflects increases in PILOTS, it is not clear that the assumption of symmetry will persist in the event that restructuring results in contractions in the level of PILOTs. For example, Gramlich (1987) suggests that while local

government spending is highly responsive to *increases* in grants-in-aid, it is relatively insensitive to the *loss* of these grants. The conventional argument has been that during periods of retrenchment in grants-in-aid local governments respond by increasing own-source revenue. In this case, reductions in PILOTs would simply be replaced with increases in local taxes.

One could also argue that if PILOTs give rise to fiscal illusion stemming from both income and price effects, a reduction in the level of PILOTs reduces the median voter's perceived income and increases his perceived price of the public good. As a result, if the demand for the public good is price elastic a reduction in PILOTs could lead to a reduction in both local public spending and local own-source revenue collection. In his 1994 study of reduction of federal aid to Pennsylvania counties, Stine found support for this and dubbed it "double asymmetry." In a more recent study using aggregate time-series data on state and local expenditures, Gamkhar and Oates (1996) find that local responses to declining grants-in-aid are symmetrical, thus indicating fiscal retrenchment.

Assuming symmetrical responses and holding all other variables constant, simulations of changes in the level of local government expenditures in response to changes in the level of PILOTs are conducted. The simulations are conducted for a range of possible scenarios regarding changes in the level of PILOTs due to restructuring activity. Additionally, the simulations utilize the elasticities from model 2 of the structural model and the log-linear model. The results are displayed in Table 5.3.

Using the simulation results from both models provides a range of the potential impacts of changing PILOTs on the level of local expenditures. The structural model

Table 5.3

Simulation Results
Stone-Geary Model 2 and Log-Linear Specification
Percentage Decrease in Municipal Spending

	Percentage Decrease in PILOTs				
	10%	**15%**	**25%**	**33%**	**50%**
Stone-Geary Model 2					
General Fund	-2.9	-4.4	-7.3	-9.6	-14.5
Streets and Public Works	-3.4	-5.1	-8.5	-11.2	-17.0
Public Safety	-4.9	-7.4	-12.3	-16.2	-24.5
General Government	-0.8	-1.2	-2.0	-2.6	-4.0
Social Welfare and Recreation	-4.0	-6.0	-10.0	-13.2	-20.0
Log-Linear Model					
General Fund	-3.2	-4.8	-8.0	-10.6	-16.0
Streets and Public Works	-3.6	-5.4	-9.0	-11.9	-18.0
Public Safety	-3.6	-5.4	-9.0	-11.9	-18.0
General Government	-3.9	-5.9	-9.8	-12.9	-19.5
Social Welfare and Recreation	-4.6	-6.9	-11.5	-15.2	-23.0

generally provides the lower end estimate while the reduced form model provides the higher end estimate. The range of changes in PILOTs utilized in the simulations is 10 percent to 50 percent. The resulting range of changes in general fund expenditure is 2.9 percent to 16.0 percent. These simulations imply that if PILOTs fall by 10 percent as a result of electric utility restructuring, local general fund expenditures will respond with a proportionately smaller decline ranging from 2.9 percent to 3.2 percent. In comparison, the model suggests that a 10 percent decrease in household median income

would lead to a 2.5 percent contraction in local public expenditures.[28] The results are even more dramatic for social welfare and recreation where the simulation results indicate that a 50 percent decline in PILOTs could potentially give rise to a 23.0 percent decrease in spending. The current study indicates that spending on social welfare and recreation would sustain the largest decrease in response to declining PILOTs, followed by general government, public safety, and streets and public works, respectively. Notable is the large range of potential impacts for general government. The structural model suggests relatively minimal impacts on general government, whereas the log-linear model indicates moderate effects.

If, however, PILOTs *increase* as a result of restructuring, there would be a corresponding expansion in the level of local government spending and/or reduction in local tax collections. Again, the areas experiencing the most significant increase would be social welfare and recreation. For example, a 20 percent increase in PILOTs would lead to a potential 9.2 percent increase in spending on social welfare and recreation. In comparison, a 20 percent increase in personal income would lead to an expansion in local general fund expenditures of only 3.2 percent.[29]

Contractions in the level of electric utility contributions to local governments can have substantial impacts on the ability of local governments to sustain the current level of services. Although evidence implies that local public expenditures are relatively inelastic

[28] Given that income was statistically insignificant in the reduced form model, the elasticity of income is calculated using parameter estimates from model 2 of the structural model.

[29] The calculation is based on the elasticity of income derived from model 2 of the structural model specification for social welfare and recreation expenditures (0.16).

to changes in the level of PILOTs, the consequences for local government can be significant since contraction in the level of revenue contributions from electric utilities will result in either fiscal replacement or fiscal retrenchment.

5.4 Policy Insights

Competitive forces emerging nationally across the electric utility sector, as a result of actual and anticipated restructuring activity, are requiring the industry and governmental units to consider a number of important issues. One major concern is the potential revenue loss to state and local governments. State and local electric utility taxes account for about 2.5 percent of total state and local taxes collected nationally, with notably higher percentages in many of the larger states (National Conference of State Legislators, 1996). Thus, any substantial loss of tax revenue could have important fiscal consequences for state and local governments.

As a regulated monopoly, all applicable federal, state and local taxes and fees are viewed as part of allowable operating costs and as such are included in the electric rates charged to consumers. Since utility bills generally do not explicitly reflect these tax obligations, the general public is likely to have imperfect knowledge regarding the tax burden. Howe and Reeb (1999) report that the majority of electric utility taxes flow directly into the general funds of state and local governments. Thus, if revenue from electric utilities declines as a result of restructuring, many local government officials may find themselves in the pernicious position of choosing between raising local taxes or reducing services.

The role of the municipal electric utility has conventionally been thought of as the

provider of reliable, affordable and universal electric power to a local jurisdiction. The current study reveals that it may also serve as a vehicle for internal subsidization which gives rise to price and income distortions on behalf of the voter. These distortions result in electric utility contributions having a more stimulative effect on local government services relative to increases in the private incomes of constituents. In an era of restructuring, the role of the municipal electric utility is likely to change dramatically which has many policymakers concerned with the potential revenue consequences for local governments. Before addressing the issue of whether legislation should protect revenue contributions from electric utilities to local governments, policymakers first need to understand the behavioral consequences arising from these contributions. Understanding the fiscal illusion arising from revenue contributions of electric utilities is an important key to understanding the impact of these contributions on the provision of local services.

The current trend in states that have implemented competition either at the wholesale or retail level is to enact legislation aimed at protecting local governments from revenue erosion. For example, many of the first states to implement retail competition, such as California, Pennsylvania, and Rhode Island, passed laws allowing municipal electric utilities to opt out of competition at least for a transition period, thus allowing municipalities to retain their exclusive franchise. Other legislation enacted to shelter local governments from revenue loss focus on stranded cost. It is often the case that large electric generating facilities locate in rural communities and comprise a large portion of the community's assessed property value. If these facilities become economically

nonviable as a result of restructuring, the costs of these facilities become stranded costs. If electric utility companies are allowed to remove nonviable facilities from their books, significant portions of a community's property tax base can be eliminated resulting in monumental revenue loss for the local government. Protecting a single local jurisdiction from bearing the full burden of the negative impacts from stranded costs arising from a facility that benefited other localities is justifiable.

However, the fact that electric utility contributions to the general fund of local governments have been shown in this study to give rise to price and income distortions raises new questions regarding the legitimacy of safeguarding local governments against all revenue loss stemming from electric utility restructuring. In other words, the constituents in a jurisdiction should decide if losses in local government revenue should be mitigated via a "hold harmless" policy (and thus, continue collecting the same level of taxes on restructured electric utilities), increases in local own-source revenue or contractions in local services. However, the voters must first be aware of revenue contributions flowing from municipal utilities to the general fund of their owning government. California, for example, has taken the approach of allowing municipal electric utilities an initial transition period of three years during which they can either opt out of competition or open their market to competition. If the municipals open their markets, they can without state oversight charge transmission and severance fees to customers and competitors. The law also requires that no less than once a year a city-owned electric utility must report on each customer's bill the amount expected to be transferred to the general fund of the city from revenues generated by the municipal

electric utility (Flentje and Lawing, 1999). Such a provision allows voters to be aware of internal subsidization, thus potentially eliminating fiscal illusion due to resulting price and income distortions.

Another observation is that revenue from electric utilities may be used to redistribute resources in a fashion deemed socially optimal. For example, under regulated prices, industrial or commercial consumers are likely to pay a higher portion of the electric tax payment but residential customers may receive more of the benefits of expanded local public services. After restructuring, many argue that competition for large industrials and commercial customers will result in lower rates for those customers at the expense of residential consumers. Electric utilities will no longer be able to simply pass the cost of taxation on to industrial customers. Instead, it is plausible that a larger portion of the tax burden will be shifted to residential customers. Therefore, the distributional aspects of electric utility taxes may also be altered. To the extent that costs are shifted away from industrials and commercial customers to residential customers, protecting the revenue contributions to local governments becomes less tenable still.

Based on the conventional argument that the flypaper effect and fiscal illusion is likely due to government officials maintaining monopoly power and manipulating public opinion (Fisher, 1996), one might conclude that protecting revenue loss is not desirable and should not be a goal of restructuring legislation. However, based on the existence of positive externalities stemming from local public services, a valid argument can be made in favor of protecting local governments from potential revenue shortfalls. A fundamental result of microeconomics is that a decrease in price will have a greater effect on

consumption than an increase in income. Therefore, a decrease in the price (real or perceived) of services that are deemed socially desirable, such as sanitation and education, will lead to a larger expansion in the voter's demand for these services relative to an increase in the voter's income. Evidence presented in the current study supports the existence of price distortions arising from internal subsidization of local governments by electric utilities. Therefore, protecting these subsidies to local governments as opposed to returning them to the voter via lower electric rates will enhance the local government's ability to provide the socially optimal level of services.

5.5 Conclusions

Public electric utilities can contribute to municipal budgets via several vehicles including property and gross receipts taxes, PILOTs, free or discounted services, and profits of municipally owned utilities. By using public utilities as tax collectors, local governments can use revenue received from these entities to supplement their general fund. Because electric utilities have historically been regulated monopolies, the cost of these tax payments to local governments has been recovered by the industry through higher rates to consumers. If consumers fail to recognize that their electric bill contains implicit taxes, they under-calculate the tax price for local services, leading to an increase in the demand for local services. The misperceptions about revenue contributions from electric utilities and the manner in which they are funded can give rise to fiscal illusion.

The current study develops a model to examine the way in which internal subsidization by electric utilities impacts the level of local public services. Both a structural model and a reduced form model are empirically estimated and the results are

used to examine price and income distortions arising from electric utility revenue. Its innovation lies in the formulation of a model that provides a measure of fiscal illusion arising from price distortions associated with internal subsidization of local government by electric utilities. The models developed in the study incorporate parameters that allow for the estimation of elasticities of electric utility revenue contributions. Additionally, the study examines the impact of electric utility contributions on both the total level of local general fund expenditures and expenditures across four of the major service functions. The empirical findings of both the structural model and the reduced form model find evidence of a positive and significant relationship between electric utility contributions and the provision of local public services.

The current study credits the existence of a flypaper effect to the stimulative nature of electric utility contributions on local government expenditures. Moreover, empirical evidence suggests that the source of the flypaper effect is fiscal illusion stemming from price and income distortions. As discussed in section 2.2 there are other potential explanations for the flypaper effect. Tax substitution is one possible explanation. For example, if the voter's share of the electric utility subsidy is greater than his tax payment for the subsidy, the demand for local public expenditures could increase as a result of the resulting positive income effect. While feasible, this effect is not likely to be significant in the current study due to the fact that PILOTs going to a local community are financed by the residents in that community through higher utility rates. In other words, the subsidy is from an internally owned entity. Another potential explanation of the flypaper effect that receives much attention is that it really does not

occur and is caused by statistical error. This argument is used extensively in the grant literature and normally focuses on the difficulties in correctly measuring exogenous aid. Chernick (1979) and Fisher (1982) argue that many types of grants are administered in a manner that makes the level of the grant endogenous to the recipient government. As a result, conclusions drawn from empirical work in which these grants are treated as exogenous lump-sum grants can be misleading. Concerns that the flypaper effect in the current study arises due to this type of statistical error are limited owing to the fact that the subsidies are mandated by state legislation and thus, exogenous to local policymakers. Limiting the significance of other potential explanations of the flypaper effect reinforces the conclusion that the effect found in the current study stems from fiscal illusion.

The main purpose of this study has been to examine the effects of internal subsidization by electric utilities on the provision of local public goods in an effort to better understand the implications of restructuring in the electric utility industry for local governments. The study provides evidence that electric utility contributions to local governments create a fiscal illusion that induces the voter's perceived price for local public services to be lower than the actual price, thus giving rise to expansions in the provision of local public services. As a result of these distortions, potential contractions in the level of electric utility contributions due to restructuring in the electric utility industry can have substantial impacts on the ability of local governments to sustain the current level of services. Empirical evidence presented in the current study indicates that local public expenditures are relatively inelastic to small changes in the level of PILOTs. However, the consequences for local government can still be significant since contraction

in the level of revenue contributions from electric utilities must result in either fiscal replacement or fiscal contraction, both of which increase opposition from residents.

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APPENDICES

APPENDIX A

APPENDIX A

Revenue Contributions to Local Governments from Electric Utilities in Tennessee

A.1 Revenue Contributions from TVA

TVA is a federal corporation and as such is exempt from several federal, state, and local taxes. Nonetheless, TVA makes payments-in-lieu of taxes (PILOTs) to states, counties, and cities in their service region. The funds going to the state, as well as most local jurisdictions, supplement the general fund. The payments, set forth in the Tennessee Valley Authority Act, Section 13, are equal to five percent of TVA's gross receipts. In 1998, tax-equivalent payments made by TVA amounted to nearly $180 million in Tennessee and $264 million in the entire TVA region. The Tennessee State Sharing Act[1] defines the basis for apportionment of the state's TVA PILOTs in the following manner:

> (1) Forty-eight and one-half percent (48.5%) shall be paid to or retained by the State of Tennessee;
>
> (2) Forty-eight and one-half percent (48.5%) shall be paid to the counties and municipalities of Tennessee; and
>
> (3) Three percent (3%) shall be paid to impacted local governing areas which are experiencing TVA construction activities on facilities to produce electricity. Such areas are designated by TVA.

PILOTs designated for counties and municipalities are apportioned based on the following formula:

---

[1] *Tennessee Code Annotated* §67-9-101.

(1) Thirty percent (30%) is paid to counties based on the percentage that the population of each county bears to the total state population;

(2) Thirty percent (30%) is paid to counties based on the percentage that the total acreage in each county bears on the total acreage of the state;

(3) Ten percent (10%) is paid to each county containing land owned by TVA based on the percentage that TVA owned land in that county bears on total TVA owned land in Tennessee; and

(4) Thirty percent (30%) is paid to incorporated municipalities based on the percentage of population of that municipality relative to the population of all incorporated municipalities in Tennessee.

Adjustments to this formula include a monthly deduction of $4,462 from payments made to counties and incorporated municipalities based on population shares, which is appropriated for use by the Tennessee Advisory Commission on Intergovernmental Relations.[2] Furthermore, for purposes of calculation, only the population and acreage contained within the TVA electrical service area is included.

The three percent allocated for impacted areas is distributed based on recommendation by TVA. No individual county or municipality can receive greater than ten percent of the total amount allotted for impacted areas. Payments to impacted areas are made during the period of construction activity and for a period of three full fiscal years after completion of construction. Payments will be phased out over this three year period by decreasing the last payment made during construction by twenty-five percent per year. If, in any year, there are funds remaining after allocation has been made to

[2] Provided by Title 4, Chapter 10, Part 1.

impacted areas, the funds are allocated to the comptroller of the University of Tennessee for use in operating the County Technical Assistance Service. This allocation is not to exceed twenty percent of the total available funds for impacted areas. In the event that it does, the remainder will be allocated to the Tennessee Advisory Commission on Intergovernmental Relations.[3]

A.2 Revenue Contributions from Municipal Electric Utilities

According to *Tennessee Code Annotated* §7-34-116, municipally owned electric utilities are exempt from federal, state, and local taxes. However, TVA requires its distributors to make tax-equivalent payments. In Tennessee, PILOTs are based on the following formula:

> (i) the equalized property tax rate of the respective jurisdiction in which the municipality's electric system is located multiplied by the net plant value of the electric plant and the book value of materials and supplies within the taxing jurisdiction as of the beginning of the fiscal year; and
>
> (ii) four percent of the average of operating revenue from electric operations minus the costs of power purchased from TVA for the preceding three fiscal years.

Payments of PILOTs are made only after all operating expenses, current payments of interest on indebtedness, reasonable reserves for renewals, replacements, and contingencies, and cash working capital adequate to cover operating expenses for a reasonable number of weeks are met. These payments are in lieu of *all* state, county,

[3] *Tennessee Code Annotated* §67-9-102.

city, and local taxes with the exception of sales taxes on the nonresidential sale of electric power. In 1998 the tax equivalent payments totaled more than $76.5 million.[4] Tax-equivalent payments are distributed to the owning municipality, county governments, and any other municipality in which the utility operates or owns facilities. The recommended arrangement specifies that twenty-two and one-half percent (22.5%) of the total PILOTs be allocated to county taxing jurisdictions based on the proportion of the ratios of net plant value and total book value of materials and supplies in qualifying counties. The remaining seventy-seven and one-half percent (77.5%) is distributed to municipalities based on the same criteria. It is important to note that payments going to taxing jurisdictions other than the owning municipality include only an amount equal to the equalized property tax rate multiplied by the net plant value and the book value of supplies and materials. They do not include any portion of the PILOTs derived from operating revenue.[5] Local jurisdictions may choose to share the PILOTs based on some other agreed upon formula.

A.3 Revenue Contributions from Electric Cooperatives

Rural electric cooperatives are customer-owned, non-profit corporations. As such, they are exempt from federal and state income taxes, but are subject to ad valorem property taxes assessed by the state and payable to cities and counties. However, all facilities and plants are exempt for the first four years following construction.[6] In 1998, Tennessee rural cooperatives paid $12.6 million in taxes to the cities and counties in

[4] Tennessee Valley Authority, Annual Report for 1998.

[5] *Tennessee Code Annotated*§ 7-52-307.

[6] *Tennessee Code Annotated*§ 65-25-222.

which they are located.[7] Payment of the taxes is conducted in the same manner as for-profit corporations operating under the Tennessee Business Corporation Act.

The method of assessing electric utility property in Tennessee is the same regardless of the ownership status. The state appraisal ratio for public utility property is fifty-five percent (55%). The utilities are assessed based on net plant value of electric plants and the book value of construction work in progress. Net plant value is defined as the depreciated original cost of the electric plant, both for portions in service and those held for future use. Non-operating property is appraised annually and assessed in the same manner as other locally assessed property. Along with the general schedule and statement of properties owned, electric utilities must also submit the following: (i) the number of miles of poles and wires of its entire system, the nature of its wire system and the number of miles inside and outside the corporate limits of the city or town in which its property is located; (ii) the total number of transformers owned by the company, their location and their value; (iii) the description and location of all of its property, real and personal; and (iv) the gross income of the company from its operation and from all other sources and its operating expenses.[8]

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[7] Comptroller of the Treasury, Office of State Assessed Properties, *1998 City and County Taxes by Company.*

[8] *Tennessee Code Annotated* §67-5-1313

APPENDIX B

APPENDIX B

Table B.1

Stone-Geary Model Specification[a]
Municipalities with Population <10,000

	Total Expenditures	*Streets and Public Works*	*Public Safety*	*General Government*	*Social Welfare and Recreation*
Constant	-3.49	-0.042	-0.302	0.182	0.129
	(-1.04)	(-0.08)	(-0.66)	(0.64)	(0.46)
B4 (population)	2.43**	0.553**	0.780**	0.444**	0.134**
	(7.27)	(5.10)	(13.14)	(3.59)	(3.87)
B2 (PILOT)	0.227*	0.857**	0.636**	1.111**	1.33**
	(1.66)	(9.92)	(2.33)	(15.54)	(5.53)
B3 (Income)	0.090**	0.003	0.002	0.004	0.012**
	(3.18)	(0.28)	(0.52)	(0.34)	(4.78)
θ (PILOT perception)	-1.283**	-7.001*	-2.702**	-8.91*	-3.010**
	(-2.21)	(-1.67)	(-2.34)	(-1.69)	(-2.38)
B5 (Aid)	0.064**	0.010**	0.038**	0.030**	0.007**
	(5.10)	(3.41)	(17.35)	(3.46)	(3.37)
(1-B1) τ_Q	0.765**	1.003**	0.972**	1.004**	1.005**
	(3.87)	(28.83)	(37.95)	(128.93)	(63.16)

Notes: *t-statistics are in parenthesis*
**Indicates significance at the 90% confidence level*
***Indicates significance at the 95% confidence level*
[a] *Model specification assumes* $\sigma = 1$ *and* $\Gamma = 0$.

Table B.2

Stone-Geary Model Specification[a]
Municipalities with Population > 10,000

	Total Expenditures	*Streets and Public Works*	*Public Safety*	*General Government*	*Social Welfare and Recreation*
Constant	-41.706	16.967	-6.178	-3.920	-9.945
	(-0.24)	(0.36)	(-0.06)	(-0.19)	(-0.39)
B4 (population)	2.492**	0.704**	1.903**	0.679**	0.420**
	(4.84)	(5.49)	(5.59)	(9.16)	(4.52)
B2 (PILOT)	0.698**	0.392**	0.597**	0.128**	0.438**
	(21.67)	(16.80)	(21.55)	(5.20)	(25.87)
B3 (Income)	0.044**	0.008**	0.091**	0.008**	0.029**
	(4.57)	(2.65)	(26.21)	(5.86)	(24.63)
θ (PILOT perception)	-3.004**	-1.685**	-2.212**	-1.182**	-1.670**
	(-10.94)	(-28.25)	(-16.12)	(-37.34)	(-36.53)
B5 (Aid)	0.012*	0.0004	0.008**	0.011**	0.002E-2
	(1.85)	(0.35)	(1.98)	(16.04)	(-0.01)
(1-B1) τ_Q	-1.439	1.835**	2.116	0.448*	1.057
	(-0.17)	(2.13)	(0.56)	(1.66)	(0.92)

Notes: *t-statistics are in parenthesis*
**Indicates significance at the 90% confidence level*
***Indicates significance at the 95% confidence level*
[a] *Model specification assumes* $\sigma = 1$ *and* $\Gamma = 0$.

APPENDIX C

APPENDIX C

Derivation of the Partial Derivative of Expenditures With Respect to PILOTs

The derivation of the partial derivative of the expenditure equation with respect to PILOTs proceeds in the following manner. First, the direct derivative of the equation yields:

$$\frac{\partial P_Q Q}{\partial L_E} = \frac{[(\beta_2\theta) + (1-\theta) - (\beta_2\theta\sigma_{LE})Nw_E - (\beta_2\theta\sigma_{LE})Nw_E\Gamma(\Sigma P_{j_E}^s)]P_Q Q^2}{[(P_Q Q^2) - (1-\beta_1)\tau_Q(1-\theta)]}$$

$$-\frac{(1-\beta_1)\tau_Q(1-\theta)P_Q Q}{P_Q Q^2 - (1-\beta_1)\tau_Q(1-\theta)L_E} \qquad \text{(C.1)}$$

Dividing both the numerator and denominator by Q and rearranging yields:

$$\frac{\partial P_Q Q}{\partial L_E} = (1-\theta)\frac{[P_Q Q - (1-\beta_1)\tau_Q P_Q]}{P_Q Q - (1-\beta_1)\tau_Q(1-\theta)\frac{L_E}{Q}}$$

$$+\frac{[\beta_2\theta - (\beta_2\theta\sigma_{LE}Nw_E) - (\beta_2\theta\sigma_{LE}Nw_E\Gamma)(\Sigma P_j^s)]P_Q Q}{[P_Q Q - (1-\beta_1)\tau_Q(1-\theta)\frac{L_E}{Q}]} \qquad \text{(C.2)}$$

Recall that α_E is the proportionate change in the perceived price of public goods due to illusion arising from PILOTs. Hence, $(1-\theta)\frac{L_E}{Q} = \alpha_E P_Q$. Furthermore, the specification used in the empirical analysis assumed $\sigma_{LE} = 1$. Substitution yields the derivative expressed in equation (22).

$$\frac{\partial P_Q Q}{\partial L_E} = (1-\theta)\frac{[P_Q Q - (1-\beta_1)\tau_Q P_Q]}{P_Q Q - (1-\beta_1)\tau_Q \alpha_E P_Q]}$$

$$+\frac{P_Q Q}{[P_Q Q - (1-\beta_1)\tau_Q \alpha_E P_Q]}\beta_2\theta[1-(Nw_E)-(Nw_E\Gamma)(\Sigma P_j^s)] \qquad \text{(C.3)}$$

VITA

Paula Dowell was born in Bristol, Tennessee on August 15, 1967. She attended school in the Bristol, Tennessee school system and graduated from Tennessee High School (Bristol, Tennessee) in May 1984. She entered East Tennessee State University (Johnson City, Tennessee) in August 1984. After leaving school to work for several years, she returned and graduated with honors with a B.B.A. in Economics from East Tennessee State University in December, 1994. She started her graduate studies in Economics at the University of Tennessee, Knoxville in August 1995. While at Tennessee, she held assistantships with the Center for Business and Economic Research and the Department of Economics. In addition, she held an adjunct position at Pellissippi State Technical Community College (Knoxville, Tennessee) and worked for a year as a consultant to the World Bank in Bosnia and Herzegovina. She received her M.A. in Economics in December, 1998 and her Doctor of Philosophy in Economics in December, 2000. Paula has accepted a position at the University of Tennessee, Knoxville as a Research Assistant Professor in the Center for Business and Economic Research.