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A computable general equilibrium analysis of a statewide fiscal reform: the case of Michigan's 1993-3 property tax reform

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A COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS OF A STATEWIDE FISCAL REFORM: THE CASE OF MICHIGAN'S 1993-4 PROPERTY TAX REFORM

by

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DISSERTATION

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DEDICATION

Dedicated to Perusi Namakula, my late grandmother,

who in 1969 dragged me to my first classroom.

May her soul rest in eternal peace.

Also dedicated to my mother, Aida Nakimbugwe,

and my father, the late Ndugga Musaazi.

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None of the above, however, is responsible for any mistakes that may be found herein.

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CHAPTER 1

INTRODUCTION

The issue of property tax incidence has been contested analytically in the public finance literature since the 1960s. The contest ensued after Mieszkowski (1969, 1972) advanced the "New View" theory of property tax incidence. The "New View" theory of property tax incidence, developed in a general equilibrium framework, stipulates that the burden of property taxes is shared amongst capitalists as profits taxes. Land and labor share the burden as excise taxes effects. The empirical evidence to support these theories is, however, still scant. Analytical frameworks for empirical analysis have been provided by Courant (1977), Kimbell, Shih and Shulman (1979) and Henderson (1985) all of whom have called for empirical work which, they admit, is likely to involve multi-industry complex simulations. The present study has two major goals.

First, the study answers the above calls for empirical work by putting some numerical flesh on the "New View" theory of property tax incidence. The present study fills this void by analyzing the effects of Michigan's 1994 statewide property reform in a general equilibrium framework. Michigan's reform is appropriate for testing the "New View" because it has, inter-industry, intrajurisdictional, and interjurisdictional aspects.

In order to enhance Michigan's economic competitiveness, the state enacted several tax cuts in the early 1990s. The property tax cut was the largest and most controversial. In July of 1993, Michigan's legislature eliminated the local property tax as a source of financing for school districts' operating expenditures. Specifically, the tax cut averaged 35 mills, or two thirds of the average homestead and non-homestead school property tax bill.[1] The state then had the task of finding alternative revenue sources for the lost six to seven billion dollars per year.

Proposal A, voted in March of 1994, approved the alternative revenue sources. Throughout and after 1994, the state: (i) lowered school-operating millage to a statewide average of six mills; (ii) increased the sales tax from four percent to six percent; (iii) increased the unit tax on cigarettes by 50 cents a pack and; (iv) limited annual property assessment increases to five percent or the inflation rate, whichever is lower, adjusting the assessment only when the property is sold. However, some 35 to 40 school districts that used to spend more than $6,500 per student before Proposal A can levy additional mills to maintain that spending. Chapter two discusses more details of Proposal A.

Measures similar to Proposal A have been implemented in other states. California implemented Proposition 13 in 1979 and Oregon implemented Measure 5 in 1990.[2,3] States such as Wisconsin and Ohio were considering similar measures in the 1990s. Public

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[1]A mill is $1 for every $1,000 of the assessed taxable property value. Assessed taxable property value in Michigan is half the market value.

[2]I found Waters, Holland and Weber (1997) article two weeks prior to the final defense of this dissertation. Their study is the closest analog to the present research. Because of time limitations, it has not been given the treatment it would deserve in the present work.

[3]Proposition 13 was passed in 1979 by the state of California to reduce government expenditure and reliance of property tax revenues. Proposition 13 i) restricted property tax rates to one percent; ii) changed the property assessment from market value to acquisition value method; iii) required that any future property tax changes receive a one third approval from the legislature in case of state taxes or the electorate in case of local governments (Oakland, 1979).

debates in a state's media, to some extent in the academia, and naturally in the legislature are not uncommon when such reforms are proposed. However, it is uncertain whether the final legislative outcome is guided to any degree by academic research findings. Most studies, including the present dissertation, are done in retrospect, thus contributing less to the debate. In addition, a majority of such studies focus on the implications of property tax reforms on school financing rather than on the entire economy of the state. [4]

No study to date has attempted to empirically analyze the effects of such reforms on the respective state's economy and welfare in a general equilibrium framework. However, there are several analytical studies along this line. Harrison and Kimbell (1984) provide a theoretical general equilibrium framework for analyzing regional fiscal reforms. Kimbell, Shih, and Shulman (1979) outline a general equilibrium theoretical framework for analyzing the effects of Proposition 13. McLure (1969) also provides a qualitative general equilibrium analysis of the effects of regional fiscal reforms.

Empirical work on such reforms, perhaps for data reasons, is almost nonexistent. Some closely related empirical work is that of Morgan, Mutti, and Partridge (1989) who provide an empirical general equilibrium analysis on non-uniform state-local taxes in a six-region model of the United States. The authors show that a unilateral removal of state and local taxes by one region relocates resources from manufacturing and other labor intensive sectors to the usually high locally taxed real estate and agricultural sectors. The geographical scope of their study is too broad to focus on any particular state. Jones and Whalley (1988, 1989) analyze the regional effects of Canadian federal taxes. They find significant unintended regional effects of Canadian federal taxes.

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[4] Except all the articles discussed in the National Tax Journal, Supplement (1979).

Thus, the second goal of this study is to analyze the implications of Michigan's fiscal reform on its economy by using a computable general equilibrium (CGE) model. The unilateral fiscal reform by Michigan is an incentive for interstate and intrastate resource relocation. In the long run, it is hypothesized that after Proposal A investment may be greater in property-intensive sectors such as housing because the before-tax cost of capital was lowered more in housing services by the fiscal reform. This hypothesis is rooted in Morgan et al. (1989) finding that when a tax is removed from a highly state-taxed industry, more resources flow to that industry so as to avoid the highly federal-taxed manufacturing and other industries. This intrastate relocation increases the marginal product of other factors where capital flows to and reduces it where capital flows out. Also, Mieszkowski (1972) points out that there are "excise-tax" effects across industries if capital is not uniformly taxed across industries. Consequently, the proportion of the respective sectors in Michigan's gross state product (GSP) is expected to adjust accordingly.

Another hypothesis is that Michigan's unilateral reduction of taxes may increase the level of its capital stock vis-à-vis other states. This is due to regional "excise-tax" effects because Michigan is now a low-tax state. The before-tax cost of capital services must decrease in order to keep the state's after-tax rate of return on capital at the national average level. This study shows that such interstate capital inflow depends greatly on the elasticities of substitution between labor and capital, and between capital and land. On the output demand side, it depends on income and price elasticity of demand for housing services.

Regarding welfare, consumer behavior is analyzed on the hypothesis that an increase in sales tax offsets the increase in disposable income from the lower residential property taxes and the higher return to labor. Therefore, there might be no change in aggregate consumption, but there will be a welfare change among various consumer groups because the incidence of property and sales taxes is different for various income groups.

The entire analysis is basically a comparative static model that predicts what happens to input, output and property prices when property tax rates are reduced and sales taxation is increased simultaneously. Conclusions for the above hypotheses are drawn from the relative input and output price changes in a new comparative equilibrium. In particular, the parameters sought in the new equilibrium are: the rates of increase in wages, land rents in the housing industry, land rents in the other goods industries, price of housing, and the price of the composite good. When analyzing capital inflow, quantity rather than price of capital is sought because the price of capital is assumed to be exogenous to Michigan.

Chapter two describes the major provisions and economic fundamentals of Michigan's fiscal reform (Proposal A) along with a concise discussion of its genesis. Courant, Gramlich and Loeb (1995), and Fisher and Wassmer (1995) also discuss the motivations for Proposal A. While integrating Michigan's reform into the public finance literature, Chapter two also performs a microeconomic analysis of Proposal A particularly with respect to tax incidence theory and factor relocation across industries and regions. In addition, Chapter two reviews the current status of applied general equilibrium analysis. With this review, Chapter two provides the background literature for developing Michigan's theoretical general equilibrium model discussed in Chapter three.

In Chapter three, a microeconomic analysis of tax incidence, along with some assumptions, are used to construct the key aspects of an ad hoc general property tax incidence model. A multi-sector model is constructed with a government balanced budget constraint. In addition, regional capital inflows and "excise-tax" effects are modeled in terms of input prices and elasticities of substitution. A welfare loss function is used to measure changes in consumer welfare.

Chapter four is divided into Part A and Part B. Part A specifies the functional forms and the parameters used in the computable general equilibrium model developed in Chapter three. Production and utility are specified as Cobb-Douglas functions. Calibration is performed after specifying the production functions.

Part B discusses another related but independent model. The model is similar to the CGE except that it analyzes each market in isolation thus it can be considered as partial equilibrium model. In other words, it does not rely on a Walrasian sum of excess demands to establish an equilibrium. The partial equilibrium model serves as a benchmark model for the general equilibrium model. The results obtained from both models are consistent with each other and do not differ significantly in magnitude and direction. Thus conclusions are based on the numbers obtained by taking the average of both sets of results.

Chapter five discusses the iterating algorithms used to compute the general equilibrium and partial equilibrium models. The algorithm based on iterating factor prices and quantities in different markets depending on whether there is excess demand or supply. Iterations stop when excess demands or supplies equal or are close to zero. The source codes for both models are provided in Appendix II.

Chapter six discusses the results obtained from the pure effects of Proposal A. The benefits of Proposal A are shared between capital, labor, land and consumers of housing services. Specifically, a 24 percent statewide decrease in commercial property taxes, a 64 percent decrease in residential property taxes and a two percentage point increase in the statewide sales tax, resulted in a 1.09 percent increase in housing services (h), a 0.07 percent increase in the composite good (x), a 2.08 percent increase in housing land rents, a 0.53 percent increase in composite good land rents, a 0.51 percent increase in the housing industry wages, a 0.08 percent increase in the composite industry wages, a 1.03 percent average increase in quantity of capital inflows about 90 percent of which flows into the housing services industry. The price of the composite good x is the numeraire and the price of housing services, whose residential property tax was reduced by the fiscal reform, decreases by -0.52 percent. The decrease in housing services prices leads to an 2.56 percent increase in capitalized value of housing. All these changes are basically the excise tax effects that Mieszkowski (1972) predicts in an interjurisdictional property tax change.

The results are consistent with the "New View" predictions. The "excise-tax" effects dominate the "profit-tax" effect since Michigan cannot lower the national average price for capital. The "excise-tax" effects are responsible for the changes in variables such as wages, land rents, and output prices.

Chapter seven extends and relates the model results to Michigan's state budget. In the model, the government budget is constrained to balance. The results are linked to the state budget by relaxing some of the model assumptions. After relating the model results to the actual state budget, results show that there is a state government internal deficit of about $480m from the School Aid Fund in the final equilibrium. This financing gap is likely to be funded from other state revenues via the General Fund. Otherwise, it is also probable that this deficit might be experienced by local governments that lost their property tax sovereignty and revenues.

The present study recommends that including the Single Business Tax in Proposal A, as had been proposed in the back-up plan had Proposal A failed at the ballot, could have provided additional tax revenue at no extra cost to the economy. This is possible because Michigan has the capability to export such a tax.

Chapter seven further relates the results to federal individual income taxes. There was a $102 million increase in Michigan residents' federal individual income tax liability in 1994 related to Proposal A. The middle income ($30,000-$75,000) group was the most affected by the reform as far as the federal individual income tax is concern.

Regarding welfare, low and high income earners were made better off. The welfare conclusions are also drawn after adjusting for the endogenous increase in agent's income. Thus the hypothesis that low income earners, as it was usually discussed in the media, were made worse off by the reform is not supported.

Recent developments in Michigan's economy are generally consistent with the findings in the model except that labor seems to be spatially mobile, not immobile, across sectors and regions as it is assumed in the model. Some studies Wilson (1985), Henderson (1985) show that mobility of labor is not critical in determining the outcome of a property tax reform. All in all, this dissertation serves as an empirical test of the "New View" in a computable general equilibrium framework.[5]

Finally, limitations of the study are discussed and some conclusions, especially on welfare, should be interpreted cautiously given the aggregation of savings with the composite good. Absence of dynamic equilibrium analysis is another limitation discussed.

[5] Wassmer, 1993a econometrically tests the "New View".

CHAPTER 2

PROPOSAL 'A' AND THE TAX INCIDENCE LITERATURE: A REVIEW

2.1 Introduction

Chapter two describes and integrates the major aspects of Proposal A into the public finance literature. The literature reviewed focuses on regional effects of a state fiscal reform through tax incidence. The major studies on regional tax policy effects are summarized in greater detail with emphasis to the general equilibrium aspects. The current status of computable general equilibrium analytical techniques is reviewed in the present chapter, along with their weaknesses. Moreover, the different estimation techniques, such as calibration and the econometrics approach, are also explored.

The earliest regional general equilibrium work is that of McLure (1969), though applied general equilibrium had already been utilized by Harberger (1962) and others in different contexts. Few empirical regional general equilibrium studies can be found in the literature. Morgan, Mutti, and Partridge (1989), and Jones and Whalley (1988, 1989) are the few empirical studies known to the author. The analysis of Morgan et al. (1989) is a general equilibrium simulation of unilateral and multilateral regional fiscal changes. Jones and Whalley (1988, 1989) analyzed the impact of Canadian regional taxes. Harrison and Kimbell (1984) provided a theoretical analysis of a regional fiscal reform in a general equilibrium framework. They used hypothetical data to simulate their model for California's Proposition 13 with respect to the rest of the US. Nonetheless, Harrison and Kimbell

(1984) study is the closest analog to the present study.

Henderson (1985) also analyzes property tax incidence in a regional framework. The aspects of his work most relevant to the present study are the way he modeled inter-regional factor flows, the role of public goods in property tax incidence, and most importantly, the treatment of the "New View" in light of the fact that the price of capital is exogenous to the taxing jurisdiction.

Finally, the present literature review briefly discusses the welfare implications of Proposal A and reviews the studies that have already been done on Michigan's property taxes. Most studies on Michigan's property taxes analyze the trend of the property tax burden in Michigan. The culmination of this trend led to the 1994 property tax reform (Proposal A). The following section describes the economic basics of Proposal A.

2.2 Description of Michigan's 1994 Tax Reform (Proposal A)

Among other goals, the key objective of Michigan's reform was to boost economic growth by reducing the level of property taxes. Other objectives were linked to education equity aspects of school financing. As noted by Fischel (1989) and Wassmer (1996), there are problems inherent in property taxes, especially with regard to school financing, which such reforms can solve. A common problem, throughout the United States, has been unequal public school spending due to variations in property tax bases in different school districts.

In addition to the education equity problem, Michigan had other concerns with the level of its property taxes. Prior to Proposal A, property assessment was based on current market value of the taxable property. A taxpayer's property tax liability, therefore, could increase just because of an increase in the property value even if the taxpayer's ability to pay has not changed.[1] Several attempts had been made in the 1970s and 1980s to pass propositions similar to Proposal A, but they all failed to pass in the legislature.

Before 1994, Michigan's property tax rates were 30 percent above the national average. In Summer of 1993 the state legislature responded to the tax situation by introducing a bill to reduce local property taxes for public schools starting with the 1994-1995 fiscal year. The bill passed in the state legislature and statewide property taxes fell to about 10 percent below the national average after the reform. Subsequent to the property tax reduction, the legislature had to look for alternative sources for the lost six billion dollars per year to finance the K-12 schools. The legislature called for a state referendum to approve (Proposal A) as a possible revenue source. Note that Proposal A was basically a vote on the financing alternatives but not necessarily an endorsement of the legislature prior move to reduce property taxes.

Proposal A considered to increase the state's sales tax from four percent to six percent. Prior to the reform, Michigan's sales tax was one of the lowest in the country. There were other minor changes in Michigan's tax system. The state income tax rate was decreased from 4.6 percent to 4.4 percent, the tax on interstate telephone calls was increased from 4 percent to six percent, the unit tax on cigarettes from 25¢ to 75¢ per pack, and the renters' homestead property tax credit increased from 17 percent to 20 percent of rent paid. Real estate transfer tax equal to 0.75 percent of the selling price was also introduced effective January 1995. All the additional state revenues are statutory earmarked for the school aid fund (Michigan House Taxation Committee Staff, 1994).

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[1]The ability-to-pay correlate for property taxes is the property value; that is, the value of the property reflects the ability to pay. This presumptive element in property taxes is discomforting to some taxpayers, see *Lund v. Hennepin County*.

Prior to the reform, local school districts used to set their millage rates. The tax reform centralized school financing from school districts to the state government. The state average school operating millage was 35 mills before Proposal A. The tax reform decreased statewide property taxes by introducing a statewide school operating 6 mills on homestead property. The school districts can, with three-quarter voter approval, increase it in their jurisdictions by 18 mills for commercial businesses, factories, vacation homes and cottages, leased farmland, and hunting property. This provision for school districts does not, however, apply to homesteads (Public Acts of 1993). Apparently all school districts adopted this provision (Fisher et. al 1995). This implies that most farms adjacent to farmers' homes may qualify as "homestead" for property taxes purposes and, therefore, be nontaxable for the additional 18 mills.

For a given school district, rates were uniform for homestead and non-homestead property before Proposal A. Now homesteads pay 6 mills, while non-homesteads have a potential of paying 24 mills. This does not, however, apply in some 34 to 36 school districts (out of 557) which had more than $6,500 expenditure per pupil before the tax reform. Such districts can hold themselves harmless by levying supplemental millage with a three-quarter vote approval.[2] The first 18 supplemental mills are applied first to homestead property, and then uniformly to all property. In other words, in high-spending districts there is the state 6 mills on all property, 18 mills with three-quarter vote approval that does not, as in low-spending local districts, apply to homesteads. On top of this, there are supplemental mills where the first 18 mills apply to homesteads. Therefore, homesteads in high-expenditure-per-pupil districts could possibly assess over 24 mills (6+18). Thus,

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[2]Adopting Proposal A provisions would harm high spending schools by cutting down their property tax revenues.

there is no potential for differential property taxation between homesteads and non-homesteads in high-spending school districts.

In addition to the above differential taxation between homesteads and non-homesteads, there is differential tax treatment of agricultural industry versus other industries. This creates an incentive for resource relocation across housing, agriculture and other industries. All leased agricultural land is considered commercial property for tax purposes. Since only 30 percent of the 10 million acres of farmland in Michigan is leased, the other 70 percent can qualify as "homestead" property inasmuch as they are near farmers' homes. Therefore, they are subject to only the statutory 6 mill rate.[3] Evidently the agricultural industry, like the housing industry, is taxed differently.

This differential taxation of capital in different industries, with residential housing and agriculture taxed less, can change the composition of gross state product (GSP) due to resource relocation. This is the essence of Mieszkowski (1972) excise effects across industries. If there is an out-of-state capital inflow due to this fiscal reform, one can expect substitution and expansion effects in GSP. Morgan et. al. have evidence for this outcome.

Studying every change introduced in Proposal A is rather cumbersome; therefore, the present analysis is limited to changes that are likely to have a significant impact on Michigan's economy. The tax changes in Michigan examined in this study sum close to one billion dollars per year in tax cuts or increases. Thus the current study concentrates on the effects of the property tax cut, and the increase in the sales tax.

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[3] In fact, the Farm Bureau lobbied to exclude even leased farmland from school district millage increases (Detroit News, January 16, 1994).

2.3 Theories of Property Tax Incidence

In order to assess the impact of any tax, it is vital to understand who actually pays the tax. The tax burden is usually reflected in the price of a product or input taxed directly or indirectly. The issue of property tax incidence is not clearly settled in the public finance literature. Several theories, namely: the “New View” theory, the “Traditional View,” and the “Benefit View” of property tax incidence dominate the tax incidence debates. Among others, proponents of the "New View" theory are Mieszkowski (1972) and Aaron (1975). The “New View” has almost become orthodoxy; it is the basic theory for economic incidence in most property tax studies. The “New View” postulates that property taxes are taxes on capital. If the supply of capital is fixed and the average ad valorem property tax is reduced, the after-tax return to capital increases. When the amount of capital is fixed, implying a general equilibrium model, there is nowhere the tax can be shifted except to the capitalists.

In the context of Proposal A, the average property tax rate in Michigan was reduced. This implies movement of capital to industries where property taxes were a large portion of total costs.[4] Industries such as real estate, services, and retailing have high proportions of property taxes in their costs. For California's Proposition 13, White (1986) found the services and retailing industries to be more responsive to property taxes. Wages rose in these industries in the short run (four years), probably because capital moved in these industries. This was not true in the manufacturing industry, probably because manufacturing is not footloose and the proportion of property taxes in the total costs is not

[4] Normally the literature uses the "New View" in spatial rather than sectoral capital reallocation context.

high.[5]

A rival theory to the "New View" is the "Traditional View." The 'traditional view' separates property taxes into taxes on structures and taxes on land. The "Traditional View" assumes structures are perfectly mobile, and hence a property tax on structures is passed entirely onto demanders of the structures.

The third theory is the "Benefit View," which contends that there is no economic incidence from property taxes. Its proponents, such as Hamilton (1975, 1976) and Fischel (1987,1992), say property taxes are basically a payment for using local services. The "Benefit View" is expected to hold if there is perfect zoning and capitalization—an unlikely situation in Michigan.

Mieszkowski and Zodrow (1989) provide a comprehensive comparison of the three views and conclude that they need not be mutually exclusive. Wildasin (1986) points out that a property tax can be both a capital tax and a user charge. Hobson (1986) develops a general analytical framework in which the "New view" and "traditional view" are special cases of their framework.

2.4 Property Tax Incidence in a Regional Framework

Instead of intersectoral relocation, inputs can move from high-tax regions to low-tax regions. However, one should not rule out the fact that inputs can simultaneously make both a spatial and a sectoral movement.[6] Regional input relocation is possible in addition to inter-industry relocation as discussed above.

Michigan's fiscal reforms have two levels of regional incidence effects. At the na-

[5]Footloose in the sense that relocating is not a short term matter.
[6]See Harrison and Kimbell (1984).

tional level, Michigan ended up with a lower average property tax and therefore a higher after-tax return. The implication is that capital may move from the rest of the United States to Michigan. The possible increase in supply against a relatively fixed demand may result in a lower rate of return in the long run. Capital stops moving to Michigan when the Michigan after-tax return equals the rest of US return. In the intermediate period, therefore, the capital return rises.

The second incidence effect of Proposal A is intrastate. Homesteads in high-spending school districts have a potential for higher property taxes than do districts spending less than $6,500 per pupil. That is, homesteads pay 6 to 18 mills in low spending districts while in high spending districts pay 24 mills. Thus (residential) capital may move from high-tax districts to low tax districts if there are no changes in public expenditures. This happens through capitalization: properties in high-tax school districts depreciate relative to properties in low tax districts. The "New View" theory predicts this as excise effects: since property is taxed differently, any deviations from the Michigan average property tax rate have excise effects.

2.4.1 Henderson (1985)

Henderson (1985) provides an analytical background for property tax incidence when one regional jurisdiction cannot change the national average price of capital. In this case the fixed capital does not have anywhere to escape; therefore, it has to bear the property tax burden. The return to capital decreases (increases) by the full increase (decrease) in property tax. The "Traditional View" postulates that part of the tax that falls on capital is borne by consumers because it is passed over to users, while that which falls on land is borne by landlords. The distinction is not necessary when it comes to owner-occupied housing, because homeowners are the producers as well as the consumers. Since the "Traditional" and "New View" theories reach different conclusions, Henderson's mission is partly to sort out the issues involved.

$$\hat{R}_i - \eta_i \hat{p}_i = \rho_{k_i} \hat{K}_i, \tag{2.1}$$

where η is the elasticity of demand, and ρ_k is the capital's share in housing, and the circumflex (^) indicates rate of change. Land(N) and income (y) are fixed.

The gross price of housing is $p^* = p(1+t)$ where t is a property tax on housing. In the log differentiated form it equals $\hat{p}^* = \hat{p}(1+\tau)$ where $\tau = d\log(1+t) = \frac{dt}{1+t}$. Assuming perfectly competitive conditions and inputs are paid according to their marginal products, zero profit conditions produce $\hat{p} = \rho_{ki}\hat{P}_k + \rho_{Ni}\hat{P}_{Ni}$, where P_K and P_{Ni} are the per unit price of capital and land, respectively. Notice that P_K is not indexed by i to imply that 'P_K' is exogenous, whereas 'P_{Ni}' is indexed, meaning that the after tax prices of land varies across both communities.

The effects of inputs price changes are analyzed through substitution effects. In differentiated log form the elasticity of substitution (ω) between land and capital is as follows:

$$\hat{K}_i = \varpi(\hat{P}_{Ni} - \hat{P}_k) \tag{2.2}$$

From the equilibrium Equation (2.1), and Equation (2.2) Henderson solves for equilibrium prices as follows:

$$\hat{p}_i^* = \frac{\hat{R}_i - \rho_{ki}\hat{K}_i}{\eta_i} \quad \text{housing price} \tag{2.3}$$

$$\hat{P}_{Ni} = \frac{\hat{p}_i - \rho_{ki}\hat{P}_k}{\rho_l} \quad \text{land rents} \tag{2.4}$$

$$\hat{P}_K = \frac{\hat{R}_i}{\eta_i} - \tau_i - \hat{K}_i\left(\frac{\rho_{m}}{\varpi} + \frac{\rho_{ki}}{\eta_i}\right) \quad \text{capital price} \tag{2.5}$$

The national and local effect of a set of property tax changes is analyzed by combining (2.3) to (2.5) with conditions in the national markets. Mobility of residents is a key assumption in the "New View" theory. Henderson explores what happens to 'P_K' when both communities change property taxes and when residents are mobile; that is, $\hat{R}_1 = \hat{R}_2 = 0$. Also the stock of capital is such that $K_1 + K_2 = \overline{K}$.

If communities start from identical positions of land and housing prices, then the following expression is obtained after appropriate substitutions in 2.5:

$$\hat{P}_k = -\left(\frac{K_1}{K}\tau_1 + \frac{K_2}{K}\tau_2\right) = -\tau_1 - \frac{K_2}{K}(\tau_2 - \tau_1) \tag{2.6}$$

Equation (2.6) means that the return to capital falls by the weighted sum of the community tax rates. That is, if $\tau_2 > \tau_1$ the return to capital falls by more than τ_1 but less than τ_2. This is not consistent with the "New View" notion that the price of capital falls by the full amount of the tax—this is the profit tax effect.

If community 1 has a lower tax rate, then substituting (2.6) into (2.5) and solving for $\hat{K}_1$ leads to the following:

$$\hat{K}_1 = \left(\frac{\tau_2 - \tau_1}{\frac{\rho_l}{\varpi} + \frac{\rho_k}{\eta}}\right)\frac{K_2}{K}, \quad \hat{K}_2 = -\frac{K_1}{K_2}\hat{K}_1 \tag{2.7}$$

The conclusion is that if $\tau_2 > \tau_1$ then $\hat{K}_1 > 0$ and $\hat{K}_2 < 0$; that is, capital moves from a high-tax community 2 to a low-tax rate community 1. In the case Proposal A, even if one assumes a states multilateral tax change, the national return to capital falls not by the full increase in the property tax, but by the new average tax rates.

If the increase in property taxes is not fully paid by capital as shown above, then who pays the rest? This burden is shared by other inputs, such as land in Henderson's model, and by consumers of housing services. From Equation (2.3), the price of housing is as follows:

$$\hat{p}_i^* = -\frac{\rho_k}{\eta}\hat{K}_i \tag{2.8}$$

Hence $\hat{p}_1^* < 0$ and $\hat{p}_2^* > 0$ since there is a positive capital inflow ($\hat{K}_1 > 0$). Therefore, housing prices increase in the high-tax community and decrease in the low-tax community. This indicates that part of the tax burden is passed over to consumers—this is the excise tax effect.

As for land prices, substituting (2.6) into (2.5) and solving for K_i, which in turn is used in (2.3) to get $\hat{p}_1^*$, which in turn is substituted in (2.4), the following are obtained:

$$\hat{P}_{N1} = -\tau_1 + \frac{K_1\rho_k}{K\rho_l}\left(1 - (\frac{\eta\rho_1}{\varpi} + \rho_k)^{-1}\right)(\tau_2 - \tau_1) \tag{2.9}$$

$$\hat{P}_{N2} = -\tau_2 + \frac{K_2\rho_k}{K\rho_l}\left(1 - (\frac{\eta\rho_1}{\varpi} + \rho_k)^{-1}\right)(\tau_2 - \tau_1) \tag{2.10}$$

The interpretation is that land prices fall by the full rate of the respective tax increases plus an adjustment for tax rate differentials. Notice that so long as $(\eta\rho_L/\omega + \rho_K) > 1$, then the percentage decline in land prices is less (greater) than the tax rate increase in the low (high) tax community. This outcome indicates that land owners pay part of the property tax. Tracing the effect on labor in a single-product model is difficult, but surely there are wage effects in a multi-good model.

The most relevant scenario of Henderson's (1985) work to the current study, however, is when only one community raises its tax rate and residents are immobile. This is basically what happened in Michigan; the state unilaterally changed its property tax while other state kept theirs' fixed. Solving for K_1 in Equation 2.5 with $\hat{P}_k = 0$ and then substituting K_1 in Equation 2.3 the price of housing is as follows:

$$\hat{p}^* = \frac{1}{1+\frac{\rho_l \eta}{\rho_k \omega}} \tau < \tau \tag{2.11}$$

and the price of land is as follows:

$$\hat{p}_n^* = \frac{1}{\rho_l + \frac{\rho_l \varpi}{\eta}} \tau < 0 \tag{2.12}$$

The rising housing prices partly pay for the increased tax rate though the former increase at a slower rate than the tax increase. Land pays for the remainder of the tax in the form of lower land rents. In the context of Michigan's reform, this finding means that low property taxes should be reflected in higher property values.

Although Henderson discusses the effect of taxes on input and output prices, he does not explicitly deal with personal income and output changes. These changes are necessary for a rounded analysis of a policy reform. McLure (1969) addresses this issue.

2.4.2 McLure (1969)

McLure (1969) pioneered the theoretical general equilibrium analysis of inter-regional taxes incidence. The interesting aspect of his work for the present study is his treatment of income and the establishment of conditions for tax export possibilities. His analysis encompasses labor, capital, production, and consumption taxes. He uses a two-region (X,Y) Harberger model where region X is the taxing state and Y is non-taxing. Michigan is the taxing state (X), while the rest of the US is (Y). Two goods (x,y) are produced with two inputs (K,L), where region X produces x and Y produces y. Labor (L) is completely immobile across regions, and their respective government budgets remain balanced. From these assumptions he obtains:

$$\text{Production: } \frac{dx}{x} = \gamma_l \frac{dL_x}{L_x} + \gamma_k \frac{dK_x}{K_x} = \gamma_k \frac{dK_x}{K_x} \tag{2.13}$$

$$\text{Demand: } \frac{dx}{x} = -E(dP_x - dP_y) = -EdP_x \tag{2.14}$$

where γ_i is input (i) share in region X, while g_i (below) is the input share in region Y, E is the income compensated elasticity of demand, S is the elasticity of substitution and P_i is the product price.

Relation of input and product prices:

$$dP_x = \gamma_l(dP_{lx} + dT_{lx}) + \gamma_k(dP_k + dT_{kx}) + dT_x \tag{2.15}$$

$$dP_y = g_l dP_{ly} + g_k dP_k = 0 \tag{2.16}$$

where dT_x is the tax change in X.

Input substitution is as follows:

$$\frac{dK_x}{K_x} - \frac{dL_x}{L_x} = \frac{dK_x}{K_x} = -S_x(dP_k + dT_{kx} - dP_{lx} - dT_{lx}) \tag{2.17}$$

$$\frac{dK_y}{K_y} - \frac{dL_y}{L_y} = -\frac{K_x dK_x}{K_y K_x} = -S_y(dP_k + dP_{ly}) \tag{2.18}$$

The effect on agents' income dR_{ij} (in region j on input i) is due to a change in sources (inputs) of income plus the change in uses (price) of income. The tax-induced change in income is from input markets and savings (or more expenditures) from the product market. In Michigan's context, lower property taxes are a source of income in so far as they affect inputs' prices, while the higher sales tax is a use of income. The change in labor income (dR_{Lx}) depends on the change in price of labor (dP_{Lx}) and the offsetting income from the uses associated with the increase in output prices dP_x and dP_y. This is summarized below as:

$$dR_{lx} = L_x dP_{lx} - (X_{lx} dP_x + Y_{lx} dP_y) \qquad (2.19)$$

The change in capital income is due to the change in price of capital (dP_k) multiplied by the proportion of national capital owned by the taxing state. The increase in output prices also offsets the increase in capital income as

$$dR_{kx} = K(1-N)dP_k - (X_{kx} dP_x + Y_{kx} dP_y).$$

N is the fraction of total capital (K) owned by residents of state Y, and X_{ij} is the amount of x consumed. For Michigan's case, 1-N is very small, $dP_K = 0$, and $dP_y = 0$; therefore,

$$dR_{kx} = -X_{kx} dP_x .$$

With the above equations McLure analyzes tax incidence in terms of its impact on output prices (P_x, P_y) and regional incomes ($dR_{Lx} + dR_{Kx}$ and $dR_{Ly} + dR_{Ky}$). He looks at the impact of labor taxes (dT_{Lx}), production tax (income tax), and consumption tax. For purposes of the current study, the closest analogy is that of a production tax (dT_x). Production taxes are taxes on capital and labor. Property taxes are normally considered capital taxes. The respective input and output after-tax prices are:

$$dP_{lx} = \left(\frac{-E\left(S_x g_l \dfrac{K_x}{K_y} + S_y \right)}{ES_x g_l \dfrac{K_x}{K_y} + ES_y \gamma_l + S_x S_y \gamma_k} \right) dT_x \tag{2.20}$$

$$dP_{kx} = \left(\frac{-ES_x g_l \dfrac{K_x}{K_y}}{ES_x g_l \dfrac{K_x}{K_y} + ES_y \gamma_l + S_x S_y \gamma_k} \right) dT_x \tag{2.21}$$

$$dP_{ly} = \left(\frac{-ES_x g_k \dfrac{K_x}{K_y}}{ES_x g_l \dfrac{K_x}{K_y} + ES_y \gamma_l + S_x S_y \gamma_k} \right) dT_x \tag{2.22}$$

$$dP_x = \left(\frac{S_x S_y \gamma_k}{ES_x g_l \dfrac{K_x}{K_y} + ES_y \gamma_l + S_x S_y \gamma_k} \right) dT_x \tag{2.23}$$

Equations 2.21 and 2.22 show that wages and return to capital will increase in Michigan, the taxing state (X), where $dT_x<0$, while wages (Equations 2.22) increase in the non-taxing state (Y), assuming none of the substitution elasticities (S_i) is zero. The flow of capital from X to Y raises labor productivity in Michigan (X), but reduces the return on capital in the rest of the US (Y) and raises it in X until the two rates are equal.

The extent of tax incidence strongly depends on input substitutions (S) and product demand elasticities (E) in the respective states. For instance, if E=0, that is, demand for x is completely inelastic, then there will be no change in X and Y wages and the return to capital. Instead, the entire tax will be completely absorbed in P_x according to Equation 2.23. If production in either state requires fixed proportions, that is $S_i = 0$, then capital, though mobile, will not move in response to a tax on production. Production does not change and the price of x does not change. This implies that the incidence will fall on labor.

Also, if the taxing state is very small relative to the rest of the nation, K_x/K_y is very small; therefore, $dP_K = dP_{Ly} = 0$, implying an infinitely elastic supply of capital. As already indicated, this is the case for Michigan. Michigan is small relative to the rest of the country. Wages dP_{Lx} in the taxing state decrease, and if the demand for x is elastic, that is, E = 0 in Equation 2.23, then its price increases.

In addition, McLure examines the tax export possibilities for the taxing state. Taxes can be exported from both the uses side and the sources side. On the uses side, people in the non-taxing state must be spending a portion of their income on the taxed commodity, and the demand for it is inelastic. On the sources side, the taxing state should be a net debtor, that is, using more capital than it owns. Also there should be a positive change in the price of capital due to the tax in change. This is possible only if the state can change the national price of capital.

The above qualitative results largely depend on labor mobility. McLure (1969) does not explicitly discuss labor mobility in depth. The work of Jones and Whalley (1989,1988) discuss labor mobility explicitly.

2.4.3 Courant (1977)

Courant(1977) uses the "New View" context to show that capital owners can have a positive or negative willingness to pay for a heterogeneous system of taxes relative to a uniform tax in multiple jurisdictions. He concludes that generally the general (profit tax) effect and specific (excise tax) effects of a property tax are not independent of the tax system. Courant (1977) mentions that his model needs to be upgraded to a multisector model in order to make any policy inferences. He cautions that such a model is likely to be complex and involve some numerical simulations. The present study answers his calls by using the a multisector good.

2.4.4 Morgan, Mutti, and Partridge (1989)

Morgan, Mutti, and Partridge (1989) provide some empirical evidence of inter-regional fiscal effects. The authors use a six-region general equilibrium model of the United States to analyze the long-run impacts of differential state and local taxes. The regions used are: Great Lakes, New England-Mideast, Plains-Rocky Mountains, Southeast, Southwest, and the Far West. The authors show that non-uniform regional taxes affect region output differently after interacting with federal taxes.

The key assumption in their model is that labor is intersectorally mobile, but for interregional mobility they consider three scenarios: partial mobility, perfect mobility, and complete immobility. Land is interregionally immobile, but (excluding mining) intersectorally mobile. Residents own non-corporate land while corporate land and capital are owned by both residents and non-residents. For fiscal effects, the authors identify taxes and transfers and incorporate the budget constraints for each region into the model. They recognize the effects of varying deductibility of state taxes from federal taxes. Regional income is considered as the value of regional output less net payments to non-residents.

The authors perform state and local simulations where all regions eliminate current taxes or where just one region unilaterally substitute one tax with another. The latter scenario conforms to Michigan's Proposal A. The authors hypothesize that tax differences create incentives to relocate because the relative differences in public goods provision among regions are very small.

Morgan et al. estimate regional earnings (value-added) by sector and then allocate these earnings to factor ownership. They did not use state gross products (GSP) in their data because of some conceptual differences. Instead, they obtained regional data from regional relationships and other unreported sources (available from the authors) for labor value added. Capital returns were allocated between land and capital improvements based on central values from other (unmentioned) studies, and adjusted the obtained value for property and severance taxes paid. For the present study, GSP data is used with little conceptual reservations.

The authors' results show that removing taxes, by all states, creates an incentive for mobile factors to locate in the previously high-taxing region. New England and Mideast have high regional business taxes and high household taxes, second only to the Far West. In addition, sectoral factor intensities and substitution elasticities are key factors in determining the pattern of growth. Labor is readily absorbed in the labor-intensive sectors such as manufacturing and services as wages before taxes decrease in the New England and Mideast region. This bids up the return to capital and land because of their increased productivity.

When a single region unilaterally removes one of its taxes, as is the case with school district property taxation in Proposal A, the region performs better in terms of regional growth and net inflows relative to the situation where all regions change their taxes multilaterally. Unilateral tax reductions, however, lead to significant terms of trade losses if interregional demand elasticities are assumed to be relatively small. The author assume that expenditures, including school spending, remain the same throughout the regions.

Labor mobility is crucial in attracting capital. The authors' sensitivity analysis shows that when labor is immobile, capital increases only by 60 percent relative to a perfect labor mobility case, and regional output grows by less than 25 percent of the perfect labor mobility figure. The Far West is disproportionately affected because its large household tax cuts lose the effectiveness of capital and labor in spurring economic growth.

There is no growth in US gross output in the case of a unilateral regional tax change, but the output of the remaining regions decreases. The implication is that the non-taxing region grows at the expense of the others. Effective federal taxes increase in the tax-reducing region, because of the lost deductibility of previous high local taxes.

Removal of both federal and multilateral taxes creates an increase of one percent in national output. New England and Midwest and the Great Lakes receive the most growth because they are the key manufacturing regions: effective federal rates on manufacturing are relatively high. The largest declines in output are in the Southeast and Southwest, which already have relatively low business and household taxes.

Note that when only regional taxes are removed, the overall growth is zero, while when federal taxes are removed in addition, there is growth in overall national output. Removal of regional taxes relocates resources to high local-tax sectors; that is, real estate and agriculture from low local-tax sectors such as manufacturing. Removal of federal taxes will relocate resources from real estate to manufacturing because sectors such as agriculture and real estate are low federal-taxed (subsidized), while manufacturing is highly federal-taxed. The social product of resources is higher in manufacturing than in real estate and agriculture, where the private return is higher. Federal effective taxes are highest in labor-intensive sectors that have high elasticities of substitution between capital and labor. In contrast, regional taxes are highest in land and capital-intensive sectors with lower factor elasticities.

2.5 Genesis of Computable General Equilibrium (CGE) Analysis

General equilibrium theory began with Walras (1874), whose work was published in the form of simultaneous equations of an economy. Arrow and Debreu (1954), and Debreu (1959) formalized this system when they theoretically proved the existence of a general equilibrium price vector. Leontief (1947, 1951, 1953, 1986) put it into a tableau form using input-output analysis. Leontief's table made it possible to analyze policy, but constant coefficients were a handicap. Economic agents are expected to react to policy changes. This is not possible when there are no behavioral parameters in the model. Therefore, it was necessary to incorporate economic behavior into the model if it was to be used for policy analysis. Johansen (1960) tried to make final demand flexible by using a demand function. Computation of equilibrium remained a big challenge before the development of computer algorithms in the mid-1960s. Since then, CGEs have essentially been extensions of the Leontief input/output model with more behavioral elements.

The last three decades have witnessed an increased use of computable general equilibrium models, both by academics and policy-makers.[7] Major areas of applications have been in taxation, international trade, and to some extent in finance, macroeconomics, environmental, and energy economics. Although data limitations and the requirement to conform to general equilibrium theory have led to questionable estimation techniques, the major attraction of a CGE is its theoretical ability to trace the effects of a policy change through all the sectors of an economy. Calibration (explained below) leaves room for subjectivity, and sometimes the findings, reported in such a broad manner due to sensitivity

[7]See *inter alia* Aaron, Galper, and Pechman, J.A. (1988); Ballard, Fullerton, Shoven, and Whalley (1985); Capros, Karadeloglou, and Mentzas (1990); Dervis, De Melo, and Robinson (1982); Piggot and Whalley (1985); Powell and Snape (1993); Shoven and Whalley (1984); and Mercenier and Srivivasan (1994).

analysis, have little practical value.

Calibration has become orthodoxy in the CGE literature with very little, if any, modifications. Econometric techniques, though rarely used in CGEs, are flawed with general equilibrium theoretical nonconformities. These flaws have made some policy-makers skeptical about conclusions drawn from CGE models.

2.5.1 How Do Computable General Equilibrium Models Work?

Unlike partial equilibrium analysis, general equilibrium theory works on the notion that what happens in one market affects other markets. Total demand and total supply for each good and each factor in each sector, by both producers and consumers, are estimated. In a chosen benchmark or base period, total demand equals total supply in each sector at an equilibrium price and quantity vector. Elasticities are used to quantitatively assess the impact of a disturbance in one market on other markets.

Figure 5.1 in Chapter five is a profile of a typical CGE. Producers determine their demand for factors by optimizing their cost functions. Also, the cost price of sectoral output as a function of input prices is determined from this optimization. Households take this price along with income from their factors to determine their commodity demand. In a competitive equilibrium, the demand for factors by producers equals the factor supply by households. Also, the demand for commodities by households equals the supply by producers.

CGEs are best applied when the sector affected is relatively large in the economy. Small markets usually have little, if any, feedback into other markets. Therefore, partial equilibrium may suffice in small markets.

2.5.2 Weaknesses in Computational General Equilibrium Analysis

General equilibrium theory assumes perfectly competitive markets that always clear, implying that prices equal marginal costs and marginal benefits. However, real-world observations show the existence of imperfect markets. Therefore, assuming that all prices equal marginal costs and benefits means overestimation or underestimation of efficiency gains or losses. Baldwin and Krugman (1988), Cox and Harris (1985), Dixit (1984), and Smith and Venables (1988, 1989) have all attempted to model imperfect markets. In imperfect markets there are price-marginal cost margins that may reflect the degree of concentration, product differentiation, and whether the nature of competition is by price, quantity or collusion.

Another weakness of CGE analysis is that adjustment time to equilibrium is not considered unless it is a dynamic analysis. Markets are treated as if they adjust instantly. This is typical of comparative static problems that ignores the adjustment path importance. Since the popularization of computable general equilibrium analysis in the 1960s and 1970s by Harberger (1962), Johansen (1960), and Scarf (1967), focus has shifted from computational challenges to methodological and institutional issues. Two schools have emerged: neoclassicals, and structuralists. Structuralism proponents, such as Taylor (1990), emphasize the underlying structural characteristics of the economy, especially income distribution, as the determining factor in any policy consequences. Structuralists allow for the fact that there may be a market disequilibrium, especially in the labor market. In addition, structuralists question whether consumers and producers optimize at all. They also treat a non-clearing market with caution. This gives them the Keynesian umbrella since wages may be sticky.

Neoclassical proponents, such as Shoven and Whalley (1984), emphasize the optimizing behavior of consumers. By assumption, consumers maximize utility given their budget constraints, and producers minimize costs for a given level of output. Another methodological division, even among structuralists and neoclassicals, is whether calibration is better than econometrics estimation. Most models use the calibration technique. Work in the econometrics approach is still very limited. This is probably due to the large amount of data required in addition to the theoretical reservations on this approach.

There has been a casual tendency in the literature to apply structuralists' models to developing economies and neoclassical models to industrial economies. The enormous market rigidities in less developed economies probably justify this dichotomy.

2.5.3 Estimation Techniques

2.5.3.1 Calibration

To begin to calibrate a CGE model an appropriate benchmark period is chosen. The period may be one year or an average of several years. The benchmark period is assumed to be in equilibrium for a given set of existing policies. Thus, the benchmark data is equilibrium data; that is, demand for all factors and outputs is equal to their supply at the existing benchmark relative prices. After specifying the utility and production functional forms, the benchmark parameters of these functions are established by a calibration process such that the obtained parameters can reproduce the benchmark data. Simply put, calibration is using benchmark data to solve for benchmark parameters. However, some functions, such as the CES, need some other external (exogenous) parameters, mainly elasticities.[8] Typically these are obtained from the relevant literature.

To analyze policy effects, the fitted benchmark equilibrium model is simulated with an exogenous (policy) shock. The new counter-factual equilibrium is compared with the original equilibrium to assess the effects of a policy on various variables. Examples include the effect on output, welfare of different income groups, factor demand, and others.

Calibration has the advantage of requiring a small data set; it uses only one data point, the benchmark period. Calibration, however, suffers from using elasticities from the econometrics literature. Some elasticities are contradictory and others are scarce. Functions such as the Cobb-Douglas, constant elasticities of substitution (CES), linear expenditure systems (LES), and others are typically used, but they constrain elasticities to be constant. In addition, some critics question the robustness of calibrated functions because they are not statistically testable. Lau (1984) eloquently outlines more calibration weaknesses.

Sensitivity analysis normally establishes the robustness of the results. Simulations with varying levels of the key parameters are performed to see how the results change under different scenarios. Such sensitivity analyses create problems when it comes to reporting results; the dimensionality of the results may be too large to have any practical value. Probabilistic sensitivity analyses have been suggested by Harrison and Vinod (1990); Harrison, Jones, Kimbell and Wigle (1993); and Pagan and Shannon (1985).

Harrison and Kimbell (1984, 1986), provide a computation method when the dimension of the model is too large. This is likely to happen in interregional general equilibrium analysis where input specificity increases the model's dimension. Harrison and Kimbell (1984), hereafter HK84, use the Harberger (1962), Mieszkowski (1966, 1967, 1972),

[8] There are more unknowns than the number of equations.

McLure (1969,1970,1971) approaches to tax incidence, along with the Scarf (1967, 1973) and Shoven and Whalley (1972) tradition of computable general equilibrium comparative statics, and the inter-industry input-output transactions models of Leontief (1966) to develop a numerical algorithm that can solve an equilibrium factor price vector with no concern for the magnitude of the model's dimension. The advantage with this type of algorithm is that one can split up inputs of production in the model, for instance, with respect to regional and sectoral specificity. Splitting inputs greatly increases the model's dimension. This was a problem in early studies because large dimension models were difficult to solve. Differentiation of inputs is critical in regional tax analysis because mobility across regions and sectors makes a big difference in tax and expenditure incidence.

HK84's numerical algorithm computes output price from inputs prices and proportions under the usual assumption of zero profit conditions. With an arbitrary set of input prices, output prices are obtained and then consumer demand is determined. Producers change their output levels accordingly. From this output level, derived demand for inputs is obtained. However, there is nothing to guarantee that this demand is equal to factor endowments, thus there can be a disequilibrium. The computation algorithm adjusts factor prices depending on the excess demand or supply until the disequilibrium is eliminated.

With factor specificity and mobility, the key result is that taxes on regionally mobile factors tend to fall on regionally immobile inputs such as land. Also, taxes on region-specific factors tend to fall on those inputs. In this case, there are "excise tax" effects because commodity prices of locally produced goods are affected. If other regions import this good then taxes are "exported" in the sense that consumers in other regions bear some of the burden. In order to explore regional specificity, HK84 calibrate their model with an interregional input-output accounting framework that allows them to deal with a regionally differentiated economy.

2.5.3.2 Econometrics Approach.

Proponents of the econometrics technique, namely Barnett, Geweke, and Wolfe (1991a); Hudson and Jorgenson (1974, 1976); Jorgenson (1984), and Lau (1978, 1984), question the restrictions that the traditional calibration technique imposes on producer and consumer behavior. By using a single observation to calibrate, it is assumed that the utility functions are homothetic. Cobb-Douglas, CES, LES and other functions fix elasticities a priori. There is evidence showing that consumer behavior is not homothetic (Jorgenson, 1984). In addition, inter-industry coefficients are constant by assumption. This assumption is not always plausible since there is evidence that firms substitute inputs when there are significant factor price changes (Jorgenson, 1984). Furthermore, it is wrong to assume fixed inter-industry coefficients for a long-term analysis. The econometrics proponents call for less restrictive functions, such as the translog function, to be used and tested.

The econometrics approach to estimating demand and supply conditions minimize the inherent restrictions in calibration by modeling agents' behavioral functions with flexible parameters. One technique, essentially Hudson and Jorgenson models (1974, 1976), involves estimating the price possibilities frontier for each sector to obtain an output price vector. Then the price vector is used in the consumption function to estimate final demand. Instead of being fixed, the input-output coefficients are estimated in a time-series framework as a function of input prices. Factor demand is determined from changes in input-output coefficients. Policy is analyzed by factoring into the consumption and coefficients equations the effects of the policy on these equations' parameters.

Mansur and Whalley (1984) mention the usual criticisms to the econometrics approach. They point out that demand and supply are simultaneously determined. Estimating such a system of equations is likely to create biased and inconsistent parameter estimates because factor endowments have to equal factor demand. In addition, if the sample size is small, there is an over-identification problem. Using consumption and production subsystems is another way out but prices are not likely to be exogenous. Instrumental variables can be used in such a case. Also, subsystems are estimated as independent systems. This is inconsistent with general equilibrium where all the systems are jointly determined.

In addition to a large data requirement, the use of many parameters in estimation leads to a considerable loss of degrees of freedom. Most functions, including the flexible translog, have limitations that sometimes do not meet the regularity conditions globally.[9] Allingham (1973) tried to use the Keynesian consumption function and a linear production side. This was a serious deviation from classical general equilibrium theory where the consumer is assumed to optimize by maximizing utility. For this matter Barnett, Geweke, and Wolfe (1991a, 1991b) suggested the semi-nonparametric Bayesian estimation of the supply and demand systems. The greatest advantage of this approach is that it uses functions that are globally regular.

2.6 Prior Research on Michigan Property Taxes

Work on Michigan's property taxes has mainly addressed the tax burden to residential owners in a partial equilibrium framework. Brazer and Laren (1982) provide a review of Michigan's fiscal structure. Courant (1982) uses a partial equilibrium analysis to analyze the residential, commercial, industrial, agricultural and utility property tax burdens

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[9] Jorgenson (1984) does not test his results to see whether his specifications are compatible with the data, and does not test for the range over which the translog function

on consumers, tenants, homeowners, and other property owners in Michigan. He finds that the average burden, except for residential, declined from 1974 to 1980. However, he acknowledges that his study ignored the possible indirect effects of property taxes on wages. This could be done by using a general equilibrium approach. His argument for using partial equilibrium is that Michigan jurisdictions are too small compared to the overall US economy to cause general equilibrium effects. General equilibrium is used in this research because the study assumes there are regional tax effects. In addition, Brown points out that the small size of the taxed sector is not a sufficient reason for ignoring general equilibrium adjustments (Mieszkowski 1972 footnote 6).

Wolkoff (1982) looks at the incentive effects of various taxes on industry locations. He finds that property taxes have no significant effects on location of industry in Michigan. However, Papke and Papke (1986) and Papke (1991) find that tax differentials influence business location. The current study does not emphasize location of firms but emphasizes relocation of resources.

As already discussed, Morgan, Mutti, and Partridge (1989) analyze the regional implications of unilateral and multilateral changes in state and regional taxes in a general equilibrium framework. The authors empirically find that if labor is partially mobile, a unilateral removal of all regional taxes by states in the Greater Lakes region increases value added, capital, and labor by 2.6, 6.9, and 1.6 percent, respectively.[10]

The fact that Proposal A introduced differential taxation of capital (homesteads and farms taxed less), and assuming that capital is fixed, at least in the short run, one should expect capital to move from other sectors to housing and agriculture. However,

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satisfies the regularity conditions.

[10]For other scenarios of tax changes and other regions see the article.

this is not likely to happen in the agricultural sector for demand reasons: agricultural output is already sufficient.[11] For housing one needs to get elasticities for factor substitution and housing demand plus relative intensity of capital and labor in the respective sectors. The real estate sector (12 percent of Michigan's GSP in 1990) is expected to expand more than any other since it is capital-intensive, and property taxes are a major cost in this sector. Furthermore, the before-tax return on capital in these two sectors is expected to decrease in the long run as the supply of capital from more capital intensive sectors increases until it equalizes with the return in other sectors.

Productivity, and therefore wages and rent, in housing and agriculture is expected to increase as more capital moves to these sectors. However, it may imply unemployment of other factors in sectors where capital moves from, particularly if those sectors are labor-intensive.[12] If elasticities of substitution in these two industries are significant, some substitution of capital for land and/or labor should be expected. This means unemployment of these inputs in the housing and agricultural industries.[13] However, the actual outcome can only be assessed empirically.

2.7 The Sales Tax

Suppliers and demanders share a sales tax burden according to their respective supply and demand price elasticities. If demand is relatively more inelastic than supply, consumers pay a larger proportion of the sales tax. Where demand is very elastic, the incidence is on the suppliers, and hence on factors of production. However, empirical inci-

[11]The fact that some farmers are given incentives not to produce more implies there is a potential for excess supply in agriculture.

[12]Possibly a good reason why labor unions lobbied strongly against Proposal A. See Detroit News, March 6, 1994.

dence of sales tax is not clear.

Proposal A concurrently increased the ad valorem sales tax rate from four percent to six percent. As mentioned above, the incidence of state sales tax is not clearly settled in the literature. Generally the sales tax is treated as if it were fully paid by the consumers. As Poterba (1996) points out, sales tax incidence can only be ascertained empirically. Empirical studies have mixed results; therefore, an incidence assumption is necessary. Accordingly, the present study assumes that the consumers pay the sales tax.

2.8 Summary

This chapter integrated Proposal A into the public finance literature by discussing its origins, major provisions and their implications. The major implications of Proposal A are the spatial and sectoral differential property taxation. Sectorally, the real estate and agricultural industries are taxed far less than the other industries after Proposal A. Spatially, the 36 to 38 (out of 577 statewide) high-spending school districts remained with high property taxes though lower than before, while the majority enjoyed the property tax reductions imposed by Proposal A. But spending remained high is previously high spending districts than spending in previously low spending districts. In addition, the state of Michigan ended up with a lower tax rate vis-à-vis the rest of the nation. This national property tax differential is expected to attract capital inflow to Michigan.

The chapter also discussed property tax incidence in light of the mainstream theories of property tax incidence, namely the "New View," "Traditional View," and the "Benefit View." In the context of Mieszkowski's (1972) work, Proposal A differential taxes would create sectoral and spatial excise tax effects. Michigan's unilateral property

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[13]In general equilibrium analysis, all inputs are presumed to be employed.

tax reform cannot change the national return on capital, but it can create "excise tax" effects.[14] The present study uses Henderson's (1985) work to model a situation where the effect on the national average price of capital is insignificant. Henderson's model shows that the property tax burden is shared among output and inputs. This is like supporting the "Traditional View," but in a general equilibrium framework.

This chapter used McLure (1969) work to discuss the possible effects on personal income, output, and tax exportability created by these fiscal initiatives. McLure (1969) does not directly deal with property taxes, but he categorized his taxes into production and consumption taxes. this chapter categorized property taxes as production taxes in the context of the McLure (1969) model. The effect on output and input is qualitatively shown to depend on price elasticity of demand and on input substitution elasticities. In addition, tax exportability was discussed to see whether it is possible to export some of the burden or benefits due to Proposal A. McLure (1969) established the conditions necessary for any tax burden or benefit to be exported.

This chapter discussed the implications of labor mobility on property tax incidence. Labor mobility determines whether labor can avoid the tax burden by relocating spatially or sectorally. The work of Jones and Whalley (1989, 1988) is used to show that labor mobility does not have to be assumed, but can be modeled. Jones and Whalley (1988, 1989) modeled labor mobility by using a labor utility function augmented with location preferences. The authors argue that any presumptions on labor mobility may fail to capture the location-specific characteristics of labor, and the migration-inducing characteristics of some tax policy initiatives.

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[14]There is possibility that the reform may slightly increase the national return on capital.

Although there are no empirical regional studies close to the present study, Chapter 2 discussed the empirical work of Morgan et al. (1989), considered to be closest to the present study. They showed that regional tax differentials create spatial resource relocation across regions. This gives credence to one of the hypotheses in the present study, that Proposal A may attract out-of-state capital. They also showed that the interaction of state and federal taxes creates sectoral resource relocation. Traditionally, real estate and agricultural sectors have high state-taxes but low federal-taxes (sometimes federally subsidized). Thus removal of state taxes, keeping federal taxes constant, attracts resources from other industries, usually with high federal taxes, to real estate and agricultural industries.

The chapter discussed the origins of general equilibrium analysis by Walras (1874) and reviewed how Leontief (1947, 1951, 1953, 1986) turned this work into a policy tool in the form of an input-output analysis table. Leontief's work was evolved into computable general equilibrium analysis mainly by the work of Johansen (1960), who incorporated behavioral demand functions into the input-output table.

By the late 1960s and early 1970s fixed-point algorithms developed by Scarf (1967) were in use, and calibration techniques were used to solve general equilibrium models. Dissatisfied with the calibration technique—which does not use stochastic data—some economists such as Jorgenson (1984), Barnett et al. (1991a), Lau (1984), and Hudson et al. (1976), called on an econometrics approach to computing general equilibrium models.

Prior literature on Michigan property taxes generally shows that the residential property tax burden had been increasing steadily over the period relative to the property tax burden in other industries. The passing of Proposal A indicates the residential property tax burden had risen to a level high enough to initiate a reform. Ironically, Michigan's median voter had rejected earlier property tax reduction proposals. In the 1993-1994 school finance reform, the legislature never allowed the median voter to decide on property tax reductions. Instead, the legislature itself reduced the property taxes and asked the median voter, through a referendum, to decide on the alternative replacement revenue sources that included Proposal A.

Finally, the chapter has discussed the incidence of the local sales tax. The presumption on the sales tax incidence is inevitable. There is no consensus in the literature on who generally pays the local sales tax (Poterba, 1996). Accordingly, it has been assumed that in the case of Proposal A consumers pay for the increase in the sales tax from four percent to six percent.

CHAPTER 3

THE THEORETICAL ANALYSIS

3.1 Background

The present model is a modified version of Henderson's (1985) one industry analysis of property tax incidence in a national economy. The present study modifies Henderson's model into a multi-industry and multi-consumer general equilibrium analysis and treats it in a framework close to that suggested by Kimbell, Shih and Shulman (1984). The intention is to see whether Michigan's Proposal A could have affected the local inputs markets and whether it had any income effects.

3.2 Assumptions

Consider an economy with a set (S) of jurisdictions and a fixed inputs endowment. There are two taxes in the economy: sales and property taxes. Each jurisdiction ($s_i \in S$) sets its sales tax (t_s) on consumer items and property taxes on residential (t_{hr}) and commercial structures (t_n) and other production assets (t_k). In each s there is a bundle of consumer goods represented by vector **x** in R^n_+. There is some level of interjurisdictional trade, therefore some elements of **x** are traded goods and others are non-traded. In addition, some of the goods in **x** are public goods (g). There is also a vector of inputs **z** in R^n_+ used to produce **x**. By assumption there is no single jurisdiction large enough to influence the national price of the traded goods and inputs.

When any jurisdiction changes its fiscal policy; that is, change the level of its property and sales taxes, the local markets' equilibrium is distorted. Input and output prices change in the markets where the jurisdiction's policies can influence them. In other markets where the jurisdiction tax policies cannot influence the national prices, quantity used or consumed adjusts in the policy-changing jurisdiction. The external markets that a jurisdiction policy cannot influence are markets for traded outputs and mobile inputs. Consumers choices in the tax-reforming jurisdiction change in order to re-optimize their utility.

Local producers too have to adjust their output (**x**) and input (**z**) choices in order to optimize production in light of the tax policy change. Changes in producers' choices can result in spatial and industry relocation of inputs. The focus in the present study is on spatial relocation. When producers change their demand for an input, its price or quantity used in case of traded inputs, adjusts accordingly to establish a new equilibrium. In case of traded inputs, an increase in their demand results in an inflow (outflow) of that input from other jurisdictions to the jurisdiction changing its fiscal policy. For non-traded inputs, it is their local after-tax prices that changes. Thus the new equilibrium will have a new set of prices for nontraded and traded input/outputs. The following section establishes the equilibrium parameters that determine how a new comparative equilibrium is reestablished after a tax reform.

3.3 Consumption and Production

For each jurisdiction, there is a set $\{M\}$of consumer income classes. Thus in our economy, there is an agents set $\{C_{sm} | m \in S \times M\}$. That is, in this economy, each consumer is a member of given jurisdiction and income class. For a given jurisdiction the s subscript on C is dropped. There are d consumers in each jurisdiction (i.e. $|C|=d$) paying a local gross price p_x for each commodity x, with a sales tax t_{sx}. Each consumer maximizes a homothetic utility function U(**x**) over a budget constraint **p.x** ≤ y. Agents get their income (y) from selling their endowments (**z**) at after-tax prices ($\mathbf{p_z}$). The government budget constraint is dc = $d(\sum_{x=1}^{x} t_x p_x + \sum_{z} t_z p_z)$ where is c is the per person level of public goods, $t_x p_x$ is the sales tax revenue and $t_z p_z$ is the property tax revenue.

From the objective function and the budget constraint the following Lagrangian is obtained:

$$\zeta(\mathbf{x},\lambda) = U(\mathbf{x}) - \lambda(\mathbf{p.x} \leq y) \quad (3.1)$$

Solving the Lagrangian for optimal conditions leads to the respective output consumer demand vector D(**x***(**f**)) where **f** is the vector for all factors affecting the demand for **x**. Such factors include, among others, income (**y**), consumer gross price ($\mathbf{p_x}$), prices of related goods ($\mathbf{p_x}$) and public goods (g). The price of x_a influences the demand for x_b depending on whether x_a and x_b are substitutes or complements. The subscripts a and b represent different goods in **x**.

On the supply side, production is such that firms minimize total costs TC = $\mathbf{p_z(1+t_z).z}$ for a given level of output $Q_x(\mathbf{z})$ where Q is **x**'s production function. The supply of non-traded goods depends on the availability of **z** inputs. Vector **z** contains traded ($\mathbf{z_j}$) and non traded ($\mathbf{z_i}$) inputs.[1] The traded goods (x_j) are composed of the jurisdiction's production and out-of-jurisdiction net imports (Q_{Ex}). Out-of-jurisdiction net imports are considered to be a function of the jurisdiction's local production, income and relative output after tax prices. When a jurisdiction's after tax output price is relatively high, that jurisdiction imports more from other jurisdictions. If a given jurisdiction produces most of its

[1]Subscripts I and j respectively represent nontraded and traded goods. Subscripts

output, there is less incentive to trade. Also, a jurisdiction's income level attracts other jurisdiction's output.

3.4 The General Equilibrium Output and Input

In equilibrium, total demand **D(x*(f))** for **x** must equal its supply **Q_x(z)** in each jurisdiction. Thus,

$$D_x(y, p_{xa}, p_{xb}, g) = Q_x(z_x) + Q_{Ex}(y) \quad (3.2)$$

where z_x is the amount of input z demanded by producers in a given jurisdiction's equilibrium to produce item x, Q_{Ex} is the out-of-jurisdiction import of **x** assumed to depend only on the jurisdiction's income.

Logarithmic differentiation of 3.2 leads to the following rates of change in equilibrium:

$$\frac{\partial D}{\partial y}\frac{dy}{D}\frac{y}{y} + \frac{\partial D}{\partial p_{xa}}\frac{dp_{xa}}{D}\frac{p_{xa}}{p_{xa}} + \frac{\partial D}{\partial g}\frac{dg}{D}\frac{g}{g} + \frac{\partial D}{\partial p_{xb}}\frac{dp_{xb}}{D}\frac{p_{xb}}{p_{xb}}$$

$$= \sum_z \frac{\partial Q_x}{\partial z_x}\frac{dz}{Q_x}\frac{z}{z} + \frac{\partial Q_{Ex}}{\partial y}\frac{dy}{Q}\frac{y}{y} \quad (3.3)$$

In a reduced form, this equals the following:

$$\eta_{yxa}\hat{y} + \eta_{pxa}\hat{p}_{xa} + \eta_{gxa}\hat{g} + \eta_{xb}\hat{p}_{xb} = \sum_z \alpha_{zx}\hat{z}_x + \eta_{yEx}\hat{y} \quad (3.4)$$

The elasticity of demand for x with respect to variable is denoted as η and circumflex ^ represents rates of change. For goods whose demand is not influenced by public goods $\eta_{gx} = 0$. Factors are paid according to their marginal productivity; hence,

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are not applied where such a distinction is unnecessary.

$$\frac{\frac{\partial Q_x}{\partial z} z}{Q_x} = \frac{p_z z}{p_x x} = \alpha_{zx}$$

is the proportion of z used in the production of Q_x.

Based on Equation 3.4, the local output equilibrium price vector is as follows:

$$\hat{p}_x = (\sum \alpha_{zx} \hat{z}_x + (\eta_{Ex} - \eta_{yx})\hat{y} - \eta_{gx}\hat{g} - \eta_{x_i x_j} \hat{p}_{x_j}) / \eta_{px} \quad (3.5)$$

for $\eta_{px} \neq 0$.

Equation 3.5 indicates that the output price vector $\mathbf{p_x}$ changes with the elasticity of demand with respect to public goods (η_{gx}), the price cross elasticity of demand between x_a and x_b, the income elasticity of demand for local (η_{yx}) and out-of-jurisdiction imports (η_{Ex}), and the developments from the supply side such as changes in input demands.[2]

Output prices are determined after considering the sales tax. The gross price of x is as follows:

$$p_x = p_{xp}(1 + t_{sx}) \quad (3.6a)$$

After taking logarithmic differentials of 3.6, the rate of change in gross price is,

$$\hat{p}_x = \hat{p}_{xp} + \tau_{sx} \quad (3.6b)$$

where $\tau_{sx} = \frac{dt_{sx}}{1 + t_{sx}}$ and p_{xp} is the producer price for x.

For each unit of output, zero profit conditions require that $p_{xp} = \sum (1 + t_z) p_z z$ which is equivalent to the following:

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[2]We have to make a strong assumption that D_x/D due to price does not equal D_x/D due to income. Otherwise, the income effect will be eliminated because $\frac{\eta_{yx}}{\eta_{px}} = \frac{\hat{p}_x}{\hat{y}}$.

$$\hat{p}_{xp} = \sum \alpha_{zx}(\hat{p}_z + \tau_z + \hat{z}) \tag{3.7}$$

Then the consumer gross price from Equation 3.6b is as follows:

$$\hat{p}_x = \sum \alpha_{zx}(\hat{p}_z + \tau_z + \hat{z}) + \tau_{sx} \tag{3.8}$$

The new equilibrium local input price for one input z_x is determined from Equation 3.8 as follows:

$$\hat{p}_z = \frac{p_x - \tau_{sx} - \sum_{z}^{z-1} \alpha_{zx}(\hat{p}_z + \tau_z + \hat{z})}{\alpha_{zx}} - \hat{z}_x - \tau_z \tag{3.9}$$

The price of an input is affected by the commercial property tax (τ_z) cut. A tax cut reduces input prices; the proportion (α_{xz}) of each input in the industry. The smaller the proportion of an input in production, the higher is the sensitivity of the input to changes in tax policy. Finally, input prices are affected by the rate of demand for other (z-1) inputs and their prices.

3.5 Interjurisdictional Input

Some inputs (z_j) are mobile across jurisdictions and others (z_i) are not mobile across jurisdictions. If one jurisdiction unilaterally lowers its property tax, it attracts more mobile inputs from other jurisdictions if all of its existing mobile inputs are fully employed. The inflow of mobile inputs continues until their local price equals the economywide price. This section develops the economic mechanism that determines the extent of mobile inputs inflow. This is accomplished by interacting the local input demand conditions with the national market conditions.

From Equation 3.9 the national price of mobile inputs (z_j) is as follows:

$$\hat{p}_{z_j} = \frac{\hat{p}_x - \tau_{zx} - \left(\sum_{z_i}^{z_i - 1} \alpha_{zx}(\hat{p}_{z_i} + \tau_z + \hat{z}_i)\right)}{\alpha_{zx}} - \tau_{z_j} - \hat{z}_j \quad \text{for } i \neq j \tag{3.10}$$

where $\hat{P}_{z_i}$ is the price of the local inputs and the summation is over (z-1) local inputs only. The local latent effect on this after-tax price of a mobile input e.g. capital, is obtained by interacting the local input substitution effects with the national market price (Henderson 1985, p.176). This is accomplished by eliminating the nontraded inputs ($\hat{z}_i$) from Equation 3.10 by using the factor substitution equation,

$$\hat{z}_i = \hat{z}_j - \psi_{z_i z_j}(\hat{p}_{z_j} + \tau_z - \hat{p}_{z_i}) \tag{3.11}$$

which represents local substitution demand conditions to obtain the following expression where $\psi_{z_i z_j}$ is the elasticity of substitution between inputs z_i and z_j:

$$\hat{p}_{z_j} = \frac{\hat{p}_x - \tau_{zx} - \left(\sum_{z}^{z-1} \alpha_{zx}(\hat{p}_{zj} + \tau_z + [\hat{z}_j - \psi_{z_i z_j}(\hat{p}_{z_j} + \tau_z - \hat{p}_{z_i})])\right)}{\alpha_{z_j x}} - \tau_z - \hat{z}_j \tag{3.12}$$

As already mentioned, no single jurisdiction can influence the national price of mobile inputs; therefore, the long run effect in the mobile inputs market is a quantity effect in the form of input inflow to the tax-reducing jurisdiction rather than a price change. Thus, in order to obtain the input inflow due to factor substitution, Equation 3.12 is set to zero ($\hat{p}_{z_j} = 0$) and solved for the substituted z_j to obtain the following:[3]

$$\hat{z}_j = \frac{\hat{p}_x - \tau_{zx} - \left(\sum_{z}^{z-1} \alpha_{zx}(\tau_z + \psi_{z_i z_j}(\tau_z - \hat{p}_{z_i}))\right)}{1 + \alpha_{z_j x}} - \tau_z \tag{3.13}$$

[3]The same expression could be obtained by substituting Equation 3.9 with subscript i in 3.11, and then substitute zero for $\hat{p}_{z_j}$.

Expression 3.13 shows that the amount of input inflow negatively depends on the rate of change in the immobile input (z_i) prices. If the immobile inputs price is high, the demand for the local endowments in an industry decreases thus reducing the demand for other complementary ($\psi = 0$) inputs inflows from other jurisdictions or industries. However, the increase in the local input prices increases the demand for the nationally mobile inputs if the mobile and immobile inputs are substitutable ($\psi > 0$).

The expression also shows the components of capital inflow.[4] Total capital or any other mobile input, inflow is the sum of capital substituted for each local input. That is, total inflow is composed of that portion from the substitution of z_j for z_i, plus that portion from the substitution of z_j for z_k where $i \neq j \neq k$. The rate of input inflow is also moderated by the proportion (α_{zx}) of the respective input in total cost. If the proportion of z_i used in the production of x is small, there is very little z_i to substitute for z_j. If the proportion of immobile inputs used in the production of x is considerable and it is easy to substitute them with mobile inputs, then the inflow in this industry is larger.

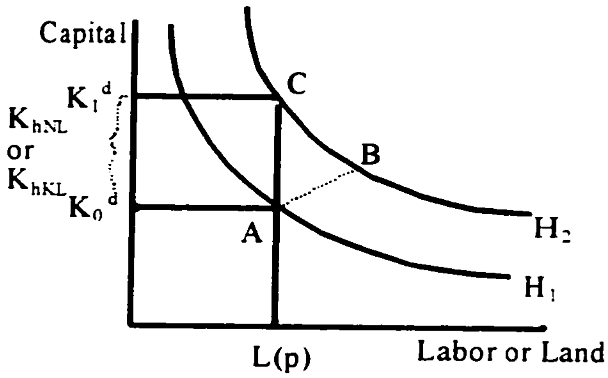
The level of z_j inflow also depends on the elasticity of demand for the product via output price p_x —derived input demand. Price elasticity of demand η_{PX} is the source of the output effect that determines the demand for capital; if x demand is inelastic, the output effect is small; hence there is less capital inflow to that industry. The sensitivity of public goods (η_g) to x demand also increases the inflow of mobile resources into the x industry through the output effect. An increase in valued public goods increases the demand for local output. Last, of course the tax change (τ_z) also determines the extent to which capital is attracted: a tax cut (τ_z<0) increases $\dot{z}_j$. The above situation is illustrated in Fig-

[4]Assuming capital is one of the mobile inputs.

ure 3.1 assuming that z contains capital (K), land (N) and labor (L).

Figure 3.1

Labor and Capital Market



Isoquant H_1 represents output before any tax change in a jurisdiction. The corresponding capital-to-labor and capital-to-land ratios, assuming capital is the mobile input and land and labor are the immobile inputs, are represented by point A. The output effect (A to B) shifts the isoquant outside to a new isoquant H_2. At the new isoquant more inputs are demanded depending on input shares. The tax reform also creates changes in relative input prices which in turn leads to inputs substitution. This substitution effect creates a new set of input ratios from B to C. Input inflows are K_{hKN} and K_{hKL}; that is, $z_j = K_{hKN} + K_{hKL}$ where K_{hKN} and K_{hKL}

3.6 Effects of Capital Inflow—Excise Tax

After modeling capital inflow, it is important to see how it affects local input and output prices. Capital inflow generates some exercise tax effects by adjusting some output price ($\hat{p}_x$) and input prices ($\hat{p}_z$). Therefore, equations 3.5 and 3.9 must change if one still assumes fixed initial endowments, fixed public goods ($\hat{g} = 0$), and only capital from outside constitutes the new capital increase. The last assumption implies that prior to any tax change all the inputs (z) in the jurisdiction are fully employed. That is, the any increase in input demand is met by resource inflow as modeled in Equation 3.12. After substituting Equation 3.13 for z_j in Equation 3.5, input inflow affects output prices as follows:

$$\hat{p}_x = \frac{\left(1 + a_{z_i x}\right)}{\left(1 + a_{z_i x}\right)\left(1 - \alpha_{zx}\right)\eta_{px} - \alpha_{zx}}$$

$$\cdot \left(\sum \alpha_{zx} [\frac{\tau_{sx} - \left(\sum_{z}^{z-1} \alpha_{zx} (\tau_z - \psi_{z_i z_j} (\tau_z - \hat{p}_{z_i})) \right)}{1 + \alpha_{z_i x}} - \tau_z] + (\eta_{EX} - \eta_{yx}) \hat{y} - \eta_{gx} \hat{g} - \eta_{x_i x_j} \hat{p}_{x_j} \right)$$

(3.14)

Equation 3.14 now shows how output price depends on the change in property taxes (τ_z) and sales tax (τ_{sx}). The expression also shows that the property tax effect is moderated by other factors such as demand for related output x, valued public goods (g) the income and other elasticities of demand (η_{lx}) for x.

For the excise tax effects in input markets, the input inflow Equation 3.13 is included the input price Equation 3.9. Input inflows change z through substitutions and addition. Therefore z in Equation 3.9 is merged with inflows so that it becomes z_i+z_j. Then input price functions are affected as follows:

$$\hat{p}_z = \frac{p_x - \tau_{sx} - \sum_{z}^{z-1} \alpha_{zx}(\tau_z + \hat{z}_i + \frac{\hat{p}_x - \tau_{sx} - \left(\sum_{z}^{z-1} \alpha_{zx}(\tau_z + \psi_{z_i z_j}(\tau_z - \hat{p}_{z_i})) \right)}{1 + \alpha_{z_j x}} - \tau_z)}{(1 + \alpha_{zx})\alpha_{zx}} - \hat{z}_x - \tau_z \tag{3.15}$$

Expression 3.15 shows that the excise property tax effect an industry depends on the input share in x industry (α_{zx}). The product of input share (α_{zx}) and elasticity of input substitution (ψ) is the elasticity of input demand η_{zp}. Therefore the elasticity of input demand with respect to its price determines its after-tax price level. If the input share is insignificant, then the property taxes effect is small. The reason is that input price movements in one industry do not affect the other industries if the share of that input in other industries is small. Brueckner (1982), Wilson (1982) and Henderson (1977) also investigated the permeation of residential property taxes into other industries.

3.7 The Government Budget Constraint

Another sector in the model is the government sector. The government collects tax revenues and provides public goods; therefore, its activities can affect the input and output markets. In the present analysis one does not have to include government production and demand functions since they do not change in a differential tax analysis. The only constraint the government has to take care of is the government budget constraint, and this is what is controlling in this model for the government sector. Absence of public goods modeling helps the analysis to focus on the pure effects of the reform. The government in the model is represented by its budget constraint (Shoven and Whalley, 1992). This section outlines the government role in the model.

Even if there is no expenditure incidence analysis in the present study, one must accept the fact that the tax effect is guided by the government budget constraint. Local governments legally required to have balanced budgets will either cut services and /or raise taxes. Assume total government revenue (T) is composed of residential and commercial property taxes, and sales tax revenues. Let property tax revenue be $t_p\, p_z.z$, and sales tax revenue be $xp_{px}t_{sx}$. The budget constraint is then:

$$T = \sum_z zp_z t_i + \sum_x xp_x t_i + tr \tag{3.16}$$

where tr are transfer payments.

Total differentiation of the government budget constraint yields the rate of change in state tax revenues as follows:

$$\hat{T} = \sum_x \phi_x (x + \hat{p}_x + \hat{t}_x) + \sum_z \phi_z (z + \hat{P}_z + \hat{t}_z) + \phi_{tr} \hat{tr} \tag{3.17}$$

where ϕ_i is the proportion of tax base i in state tax revenues.

If it is a differential revenue reform, there is no change in total tax revenues; therefore $\hat{T} = 0$. When property taxes are disintegrated into residential and commercial property taxes, the following is obtained:

$$\phi_{xt}(x + \hat{p}_x + \hat{t}_x) = \phi_{xr}(x_r + \hat{p}_{xr} + \hat{t}_{tr}) + \sum_z \phi_z (z + \hat{p}_z + \hat{t}_z) \tag{3.18}$$

Some observations can be made on Equation 3.18. First, in order to have a balanced budget, the rate of decrease in residential and commercial property tax revenues (right hand side where x_{rh} = housing services) must equal the rate of increase in sales tax revenue. Except for the tax rates all the other variables are endogenously determined. That is, the state government can change only the statutory tax rates but the tax bases change endogenously. In order to balance the budget there has to be an increase in factor prices, quantity of capital, labor, land, and/or the quantities of x. An endogenous increase in any of these variables can only be determined empirically.

3.8 Walrasian Equilibrium

In the general equilibrium, factor and output supply has to equal factor and output demand in each jurisdiction. In the present study there are three major sectors to consider, namely, output market, factor market and the government sector. The output and input markets are subdivided into the traded and untraded subsectors.

In the factor market, the initial endowment of the fiscal-reforming jurisdiction is fixed; therefore, the only source of traded inputs for that jurisdiction is out-of-state inflow or outflow. In equilibrium, the rate of inflow or outflow has to equal the rate of change in the jurisdiction's traded input demand. That is, $z_{out} = \sum_x z_{ikx}^{dd}$. This is equivalent to $\hat{z}_{out} = \sum_x \lambda_{ik} \hat{z}_x$ where $\lambda_{zx} = z_x \Big/ \sum_x z_x$ is the proportion of capital devoted to x in the jurisdiction.

There are no input supply functions in the model; therefore, the rate of change in input demand is equal to their initial endowments. Since the initial endowments are fixed, any change in their supply is moderated by their respective prices not quantity; that is, $\bar{z}(\hat{P}_z) = \sum_x \lambda_{zx} \hat{z}_x$ where the bar implies fixed quantity. In order to achieve Walrasian equilibrium, factor prices adjust at a rate that equates the rate of change in factor demands to the rate of change in factor supply.

Therefore, prices P_z adjust to keep $\hat{z} = 0$ as follows:

$$\bar{z}(\hat{P}_z) - \sum \hat{z}_i^{dd} = \varepsilon_z \quad . \quad (3.19)$$

For the government sector, the rate of increase in sales tax revenues should equal the rate of decrease in property tax revenues, and the government budget constraint is as follows:

$$\phi_x(\hat{x} + \hat{p}_x + \hat{t}_x) - \phi_h(\hat{x}_h + \hat{p}_{xh} + \hat{t}_{xr}) + \sum_z \phi_{zj}(\hat{z} + \hat{p}_z + \hat{t}_z) = \varepsilon_g \qquad (3.20)$$

Walras' law requires that the sum of all the value of excess demands to equal zero. The equilibrium in the output market is obtained automatically when the government and inputs sector are in equilibrium.

CHAPTER 4

FUNCTION SPECIFICATION, DATA AND COMPUTATION OF EQUILIBRIUM

Part A

4.1 Introduction

When Michigan changed its property and sales taxes in 1994-1995, the change altered the equilibrium conditions in the housing and the other remaining industries, hereafter, referred to as the composite good (x). Firms view the property tax as a tax on commercial structures, capital assets and land but not labor. In addition to distorting input demand, the property tax also changed personal income in the sense that it altered factor prices. As such, output demand also changed. The underlying input markets also had to adjust in order to accommodate the changes in the output markets.

Equilibrium in all input and output markets is restored when the sum of excess demands from all the affected markets equals zero; that is, when Walras law is satisfied. The new equilibrium prices and quantities in all the markets are the basis on which the tax effects are assessed. This chapter discusses the input and output markets in the tax reforming community and the mechanism by which a new equilibrium is restored. The chapter focuses on the developments in the input market most because zero profit conditions ensure that output market is in equilibrium whenever the input markets are in equilibrium.

The following section outlines the model used and the key assumptions. Property and sales tax policy change parameters are specified. Cobb-Douglas functions specify output demand, inputs demand and capital inflows. The benchmark data used to estimate inputs and output demand is specified in Section III. The data used is Michigan's 1990 gross state product and Michigan's personal incomes. Supply of endowments is assumed to be fixed except capital which is modeled to respond to interstate property tax differentials. From the benchmark data, demand functions' parameters are obtained by calibration. The chapter also outlines the Walrasian conditions necessary for the general equilibrium computation.

4.2 Assumptions

Assume two regions, Michigan (M) and the rest of the US (R),. There are two goods: the non-traded housing services (h) and the traded composite good (x). Three primary inputs of production: capital (K), land (N) and labor (L) are used. All prices are determined under perfectly competitive conditions. The government is another sector, treated only by its budget constraint.

In order to analyze the welfare implications of Proposal A, two consumer groups are used: low income and high income consumers. The rationale for this is that the incidence of property and sales taxes to both groups is different: property taxes are generally progressive while sales taxes are regressive. Therefore it is necessary to trace any inequity implications that may be in the tax reform.

4.3 Inputs Specificity

Assume that residents are immobile because the magnitude of the tax changes was too small to cause any labor migration, at least in the short run and intermediate future. In the context of Jones and Whalley (1989), who modeled partial labor mobility in terms of income and location preferences, assume in the present study that the income effect of Proposal A on wages did not outweigh the location preference effect. Therefore labor is regionally immobile and that labor is not sectorally mobile. Considering these assumptions, one ends up with two prices of labor: P_{lx} for labor in the composite good industry, and P_{lh} for labor in the housing services. The corresponding out-of state wages are P_{lx}^{R} and P_{lh}^{R}.

The assumption made on labor mobility is very important in determining the overall outcome of the analysis. Henderson (1985) shows that if labor is mobile, the incidence of property tax in a taxing state falls on land unless the raised revenue is used to provide "valued" public goods. Otherwise economic agents relocate until regional utilities are equal. In case of labor immobility, Henderson (1985) shows that the incidence is on housing services prices and land. Morgan, Mutti and Partridge (1989) simulated their model with mobile, immobile, and partially mobile labor. The authors found that output and the return to capital increase more when labor is mobile than when it is not. Jones and Whalley (1988,1989) modeled labor mobility to be triggered after a certain utility threshold created by regional tax differences.

Capital (K) is mobile sectorally and regionally; therefore, there is only one price of capital (P_k). Land is not mobile either regionally or sectorally. Land sectoral immobility is justified on the basis of zoning laws that may not allow land for housing services (h) to be used for the composite good (x) production. Therefore, there are four factors related to land: housing services land in Michigan N_h^M and housing in the rest of the U.S.A N_h^R, land for the composite good in Michigan N_x^M and land for the composite good in the rest of the US N_x^R. The corresponding respective prices are: P_{nh}^M, P_{nh}^R, P_{nx}^M, and P_{nx}^R.

Although there are nine specified prices in the model, essentially only five input prices, namely, P_k, P_{hl}, P_{xl}, P_{nh}^M and P_{nx}^M are active. The other prices are inactive because Michigan's tax changes cannot significantly influence other states prices. Michigan's actions cannot create any visible general equilibrium effects in the entire United States, but these effects can be visible in the tax-reforming state as regional resource inflow: there is an infinitely elastic supply of capital to the tax-reforming state. Therefore, it is important to focus on Michigan's prices.

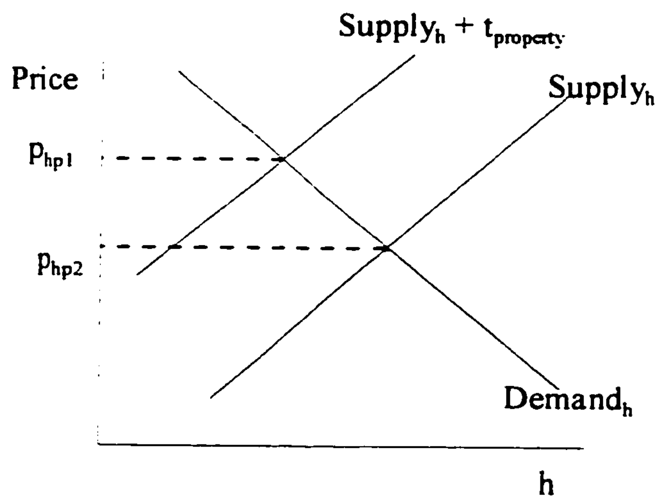
4.4 Output Demand

In order to arrive at the new comparative equilibrium after the fiscal reform, it is necessary to establish the demand and supply sides first. The following product demands are based on a Cobb-Douglas utility function $U = h^{\alpha}x^{\beta}g^{\gamma}$ where g is the per person level of public goods, h is the quantity of housing services and x is a homogenous composite good.

For housing services, consumers pay a gross p_{hp} which is also the producer price. The residential property tax t_h is considered as a tax on capital (K) and land (N). The key assumption in the New View theory of property tax incidence is that property taxes are taxes on capital. Some authors (Henderson, 1985 and Brueckner, 1981) have treated the property tax as an *ad valorem* tax on housing services. Figure 4.1 below illustrates the housing services market and the tax effect. Before any reduction in property taxes, consumers of housing services pay p_{hp1}. A reduction in property taxes reduces the cost of primary inputs in housing services and the supply curve shifts rightwards. The gross price of housing declines from p_{hp1} to p_{hp2}.

Figure 4.1

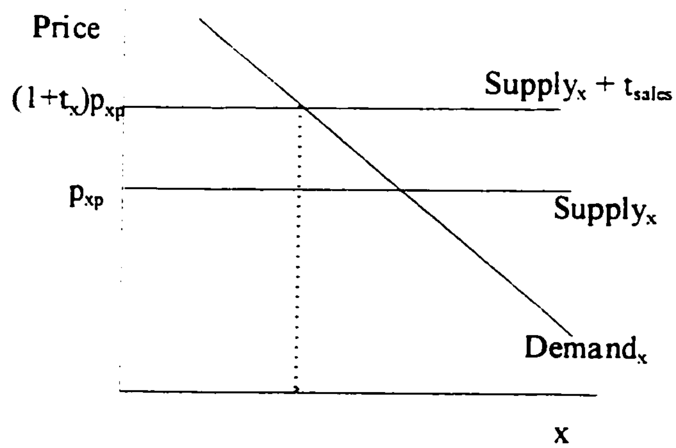
Tax Effect on Consumer and Producer Price in Housing



Consumers pay a gross price $(1+t_x)p_{xp}$ for x where t_x is an ad valorem tax on x and p_{xp} is the producer price of x. Unlike housing services that are produced and consumed locally, the supply of the composite good (x) is perceived by Michigan producers to be infinitely elastic because it is tradable in the national and international markets. Therefore, for local producers of x to stay competitive they must keep p_{xp} constant —they cannot increase p_{xp} by shifting the property tax to consumers of x. Since producers keep their before-sales tax price (p_{xp}) competitive, they can shift the sales tax to consumers because even the out-of-state producers face the same sales tax. This means that consumers of x fully bear the sales tax as indicated in Figure 4.2 below. The issue of sales tax incidence is not yet empirically settled (Poterba, 1996). Analytically, the incidence of sales tax depends on the relative elasticities of demand and supply; the more inelastic side of the market pays most of the sales tax.

Figure 4.2

Tax Effect on Consumer and Producer Price in Composite x Industry



Consumers get their income from selling labor (L), capital (K) and land (N) to producers at after-tax prices P_{li}, P_k and P_{ni}, respectively, thus $y = P_lL + P_nN + P_kK$. The net price of x is the numeraire.[1] Consumers maximize utility subject to their income constraints $y = (1+t_x)p_{xp}x + p_{hp}h$. Residents who own residential capital (K_h) and land (L_h) pay residential property taxes $t_hP_kK_h$ and $t_hP_{nh}N_h$. Those who own non-residential capital (K_x)

[1]x is carried on throughout the algebra but set to one in the computation algorithm.

and land (N_x) pay commercial property taxes $t_kP_kK_x$ and $t_kP_{nx}N_x$ on their assets. The government is constrained to provide the same level of the public good after the fiscal reform. Therefore, its budget constraint is $dcg = nt_xp_{xp}x + nt_hP_kK + nt_hP_nN$ where d is the number of residents, c is the unit cost of public services.[2]

By assumption tax revenues are distributed back to residents in form of public services. The objective function and the constraint are combined to obtain the following Langrangian:

$$\text{Max. } \zeta(h, x, \lambda) = h^{\alpha}x^{\beta} - \lambda[y - p_{hp}h - p_{xp}x] \tag{4.1}$$

The first order conditions are:

$$\xi_h = \alpha h^{*\alpha-1}x^{*\beta} + \lambda p_{hp} = 0 \tag{4.2}$$

$$\xi_x = \beta h^{*\alpha}x^{*\beta-1} + \lambda p_{xp} = 0 \tag{4.3}$$

$$\xi_\lambda = y - p_{hp}h^* - p_{xp}x^* = 0 \tag{4.5}$$

Dividing 4.2 by 4.3 one gets the optimal $x^* = \dfrac{\beta p_{hp}h^*}{\alpha p_{xp}}$ and optimal $h^* = \dfrac{\alpha p_{xp}x^*}{\beta p_{hp}}$. The obtained optimal x and y are respectively substituted in 4.5 to obtain the following demands for x and h:

$$h^* = \frac{\alpha y}{(\alpha+\beta+\gamma)p_{hp}} \tag{4.6}$$

[2]At the margin of consumption, the level of a public good is the sum of the individuals' marginal benefits from consuming the public good.

$$x^{*} = \frac{\beta y}{(\alpha+\beta+\gamma)p_{xp}} \tag{4.7}$$

In comparative statics terms, the above demands are equivalent to the following:

$$\hat{x}^{*d} = \hat{y} - \hat{p}_{xp} \text{ and } \hat{h}^{*d} = \hat{y} - \hat{p}_{hp} \tag{4.8}$$

By assumption there is no change in commodity shares in consumption; that is, $d\beta = d\alpha = d\gamma = 0$. Also, assume there is no change in the per person cost of public goods and their level; that is, $\hat{c} = \hat{g} = 0$.

4.5 Input Demand

The following input demands are derived from the Cobb-Douglas function. $Q_i = \phi_i K_i^{\alpha_{ki}} L_i^{\alpha_{li}} N_i^{\alpha_{ni}}$, with constant returns to scale such that $\alpha_{li}+\alpha_{ni}+\alpha_{ki}=1$. Producers are expected to minimize total costs for each level of output (Q_i). Thus, they minimize the Lagrangian in the following form:

$$\xi(P_k, P_l, P_n, \lambda) = P_k(1+t_i)K_i + P_{li}L_i + P_m(1+t_i)N_i + \lambda(Q_i - \phi K_i^{\alpha_{ki}} L_i^{\alpha_{li}} N_i^{\alpha_{ni}}) \tag{4.9}$$

where P_j is the after-tax price of input j = capital (K), labor (L), land (N); and t_h is the property tax on commercial structures, capital assets and land. The first order conditions are obtained as follows:

$$\xi_k = P_k(1+t_i) - \lambda^{*}\phi_i\alpha_{ki}K_i^{*\alpha_{ki}-1}L_i^{*\alpha_{li}}N_i^{*\alpha_{ni}} = 0 \Rightarrow \lambda^{*} = \frac{P_k(1+t_i)}{\phi_i\alpha_{ki}K_i^{*\alpha_{ki}-1}L_i^{*\alpha_{li}}N_i^{*\alpha_{ni}}} \tag{4.10}$$

$$\xi_{L_i} = P_{li} - \lambda^{*}\phi_i\alpha_{li}K_i^{*\alpha_{ki}}L_i^{*\alpha_{li}-1}N_i^{*\alpha_{ni}} = 0 \Rightarrow \lambda^{*} = \frac{P_{li}}{\phi_i\alpha_{li}K_i^{*\alpha_{ki}}L_i^{*\alpha_{li}-1}N_i^{*\alpha_{ni}}} \tag{4.11}$$

$$\xi_{N_i} = P_{ni}(1+t_i) - \lambda^{*}\phi_i\alpha_{ni}K_i^{*\alpha_{ki}}L_i^{*\alpha_{li}}N_i^{*\alpha_{ni}-1} = 0 \Rightarrow \lambda^{*} = \frac{P_{ni}(1+t_i)}{\phi_i\alpha_{ni}K_i^{*\alpha_{ki}}L_i^{*\alpha_{li}}N_i^{*\alpha_{ni}-1}} \tag{4.12}$$

$$\xi_{\lambda_i} = Q_i - \phi_i K_i^{*\alpha_{ki}} L_i^{*\alpha_{li}} N_i^{*\alpha_{ni}} = 0 \tag{4.13}$$

From dividing Equation 4.10 by 4.11 one obtains $K_i^* = \dfrac{\alpha_{ki} P_{li} L_i^*}{\alpha_{li} P_k (1+t_i)}$ and from dividing Equation 4.11 by 4.12 one obtains the optimal $N_i^* = \dfrac{\alpha_{ni} P_{li} L_i^*}{\alpha_{li} P_m (1+t_i)}$. N_i* and K_i* are substituted in Equation 4.13 to obtain the following demand for labor:

$$L_i^{*d} = \frac{Q_i}{\phi_i}\left(\frac{P_m(1+t_i)}{\alpha_m}\right)^{\alpha_m}\left(\frac{P_k(1+t_i)}{\alpha_{ki}}\right)^{\alpha_{ki}}\left(\frac{\alpha_{li}}{P_{li}}\right)^{\alpha_m - \alpha_{ki}} \tag{4.14}$$

A similar operation is repeated to obtain the following demands for capital and land:

$$K_i^{*d} = \frac{Q_i}{\phi_i}\left(\frac{P_m(1+t_i)}{\alpha_{ni}}\right)^{\alpha_m}\left(\frac{P_l}{\alpha_{li}}\right)^{\alpha_{li}}\left(\frac{\alpha_{ki}}{P_k(1+t_i)}\right)^{\alpha_m - \alpha_{li}} \tag{4.15}$$

$$N_i^{*d} = \frac{Q_i}{\phi_i}\left(\frac{P_{li}}{\alpha_{li}}\right)^{\alpha_{li}}\left(\frac{P_k(1+t_i)}{\alpha_{ki}}\right)^{\alpha_{ki}}\left(\frac{\alpha_{ni}}{P_m(1+t_i)}\right)^{\alpha_{li} - \alpha_{ki}} \tag{4.16}$$

In comparative static terms these are equivalent to the following, assuming there are no changes in input shares and shift parameters; that is, ($d\phi_i = d\alpha_{ij} = 0$) for j = K, L and N:

$$\hat{K}_i^{dd} = \hat{Q}_i - (\alpha_m + \alpha_{li})(\hat{P}_k + \tau_i) + \alpha_{li}\hat{P}_{li} + \alpha_m(\hat{P}_m + \tau_i) \tag{4.17}$$

$$L_i^{dd} = \hat{Q}_i - (\alpha_{ni} + \alpha_{ki})\hat{P}_{li} + \alpha_{ki}(\hat{P}_k + \tau_i) + \alpha_{ni}(\hat{P}_m + \tau_i) \tag{4.18}$$

$$N_i^{dd} = \hat{Q}_i - (\alpha_{ki} + \alpha_{li})(\hat{P}_m + \tau_i) + \alpha_{li}\hat{P}_{li} + \alpha_{ki}(\hat{P}_k + \tau_i) \tag{4.19}$$

for i = h, x.

The input demand functions reflect the output effect (Q) and the substitution effect due to input prices change. The net demand effect is ambiguous—the output effect is positive while the substitution effect is negative. Output (Q_i) in equations 4.17 to 4.19 is determined in the output market: it adjusts to any new output demand as determined above in Equation 4.8. At each iteration the supply of h and x changes according to the following Cobb-Douglas output function:

$$Q_i = \alpha_k \hat{K}^{dd} + \alpha_l \hat{L}^{dd} + \alpha_n \hat{N}^{dd} \tag{4.20}$$

The substitution effects are represented by α, the proportion of each input in total cost. Allen (1950) shows that $\alpha_{ij} = \varepsilon_{ij} / \varphi_{ij}$ where ε_{ij} is the price elasticity of demand for factor j in industry i and φ_{ij} is the partial elasticity of substitution between capital and labor. Figure 4.3 illustrates the input markets equilibria.

4.6 Inputs Substitution and Property Tax Incidence

Land and labor endowments are fixed but there is a tax-induced out-of-state capital inflow. Therefore there is a need to model capital inflows. The model here is based on Mieszkowski (1972) theory that if total capital is fixed among tax jurisdictions (all states), there will be excise tax effects in a jurisdiction (Michigan) whose tax rate deviates from the average property tax rate. In this section capital inflow and excise tax effects are modeled as a response to Michigan's property tax decrease.

Whereas capital inflows respond to higher after-tax return, the overall inflow also depends on the recipient jurisdiction's ability to absorb it in the long-run. The ability to absorb incoming capital largely depends on the production conditions and the availability other complementary endowments in the jurisdiction. Therefore, it is necessary to examine the local production conditions.

Assuming firms are efficient, optimal production requires that: a) marginal cost equal marginal revenue and, b) the factor price ratios equal to the rate of technical substitution (RTS). For cost minimization, the ratio of input prices always equal the ratio of

Figure 4.3a

Capital Demand and Supply

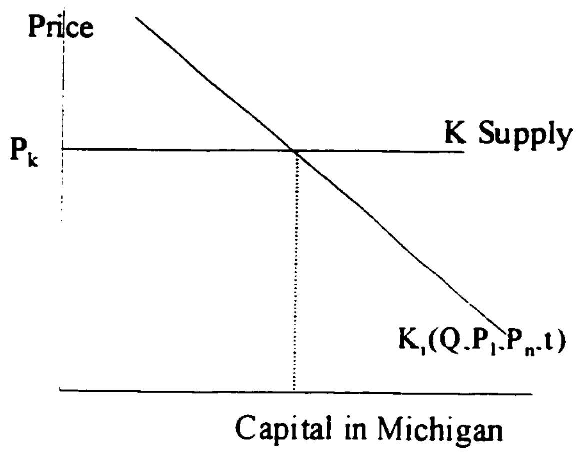
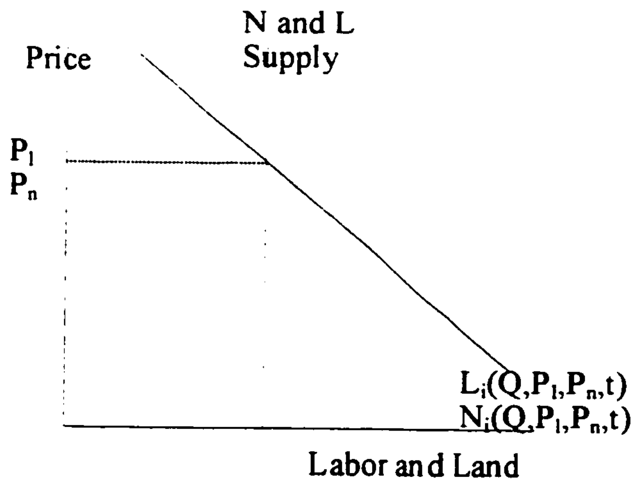


Figure 4.3b

Land, Labor Demand and Supply



their respective marginal products—also known as the rate of technical substitution (RTS). When a tax is imposed on an input, the factor price ratio increases because the tax has increased the input gross price (assuming the taxed input is in the numerator). This means that in order to stay cost minimizing, the firm must increase its RTS to match the new input price ratios. That is, the firm must increase the marginal product (numerator) of the taxed input. According to the law of diminishing returns, marginal product of the taxed input increases only if less of it is used. Therefore, the demand for the taxed input must decrease.

The gross price increase of the taxed input, however, depends on whether that input can shift the tax to other inputs or to the product produced. Therefore, tax incidence is vital in determining what happens to the demand of a taxed input. Generally, three major factors determine incidence of a tax on an input: a) If the input is mobile, it can avoid the tax implying that for the firm to keep using this input at the pre-tax cost, the firm must shift the tax to something else. b) If the firm can easily substitute the taxed input with other (non taxed) inputs then some of the taxed input can be relinquished from production. c) Finally, if the firm can shift the tax to the product produced then the taxed input demand will not be affected, even if it is mobile, because the marginal cost-marginal revenue ratio is maintained. This latter option, however, depends on the elasticity of demand for the product. If the product produced is inelastic, then one can easily pass over the tax. Otherwise, it is not possible to pass over the tax and stay competitive. If the firm is facing a perfectly elastic demand curve because it is in a competitive industry, then the firm's ability to pass over the tax is very limited. To sum it up, whenever taxes distort relative prices, a firm will re-optimize in light of the above options feasible under its circumstances.

The above tax shifting options and the subsequent effects are analyzed by assuming that for a given level of output, the producer price exhausts all the inputs marginal products. Zero profit conditions imply that the producer price exhausts all the after tax revenues to inputs; that is, $Q_i\, p_{ip} = P_k(1+t_i)\, K + P_{li}L + P_{ni}(1+t_i)\, N_i$. This relation is appropriate to analyze optimal input choice because it links the input prices (P_j) to producer price (p_{ip}) that appears in the market. Therefore, the ability of a firm to shift input taxes to the market or to other inputs can easily be traced. In comparative statics terms, the producer price relation is equivalent to the following:

$$\hat{p}_{hp} = \alpha_{kh}(\hat{P}_k + \hat{K}_h^{dd}) + \alpha_{lh}(\hat{P}_{hl} + \hat{L}_h^{dd}) + \alpha_{nh}(\hat{P}_{hn} + \hat{N}_{nh}^{dd}) + (\alpha_{kh} + \alpha_{nh})\tau_h - \hat{Q}_h \qquad (4.21)$$

$$\hat{p}_{xp} = \alpha_{kx}(\hat{P}_k + \hat{K}_x^{dd}) + \alpha_{lx}(\hat{P}_{xl} + \hat{L}_x^{dd}) + \alpha_{nx}(\hat{P}_{xn} + \hat{N}_{nh}^{dd}) + (\alpha_{kx} + \alpha_{nx})\tau_x - \hat{Q}_x \qquad (4.22)$$

Equations 4.21 to 4.22, where α_{ij} the respective cost shares of capital, labor, land and commercial property taxes in total cost, indicates how the property tax is linked to the producer market prices.

Tax incidence is analyzed in terms of price changes. In order to trace the direct and indirect effects of taxes to the prices of labor and land, the output market conditions are introduced in producer price equations 4.21 and 4.22. If the producer can shift the tax to the market, then $\hat{p}_{xp} \neq 0$, otherwise $\hat{p}_{xp} = 0$. However, it is necessary to first substitute for input demands in 4.21 and 4.22. The Cobb-Douglas capital, labor and land demand functions derived in equations 4.17 to 4.19 above are used to substitute for $\hat{K}^{dd}, \hat{L}^{dd}$ and $\hat{N}^{dd}$ in 4.21 and 4.22. The following expressions are obtained assuming that $\alpha_{ki} + \alpha_{li} + \alpha_{ni} = 1$:

$$\hat{p}_{hp} = \alpha_{kh}\hat{P}_K + \alpha_{lh}\hat{P}_{lh} + \alpha_{nh}\hat{P}_{nh} + (\alpha_{kh} + \alpha_{nh})\tau_h \tag{4.23}$$

$$\hat{p}_{xp} = \alpha_{kx}\hat{P}_K + \alpha_{lx}\hat{P}_{lx} + \alpha_{nx}\hat{P}_{nx} + (\alpha_{kx} + \alpha_{nx})\tau_x \tag{4.24}$$

The following sections discuss the property tax incidence in capital, labor and land markets basing on the above zero profit conditions.

4.6.1 Incidence on Labor and Land in the Composite Good(x) Industry

The composite good x is considered a traded good; that is, it is exportable and importable and therefore produced in a competitive industry. Its producer price is assumed to be fixed; the supply of x is infinitely elastic (see Fig. 4.2) if one considers the out-of-state supply. Michigan producers have to compete with out-of-state suppliers of x on the before-sales tax price. Hence, the option of shifting some of the commercial property tax to the consumers is not feasible.

Accordingly, any increase in the commercial property tax (t_h) must be absorbed by an overall decrease in the combination of all the variables on the right hand side of Equation 4.22 except the price for capital. That is, generally, the firm can resort to less capital ($\hat{K}$), less land ($\hat{N}$) and less labor ($\hat{L}$), lower wages ($\hat{P}_l$) and/or less land rent ($\hat{P}_n$) and vice versa in order to keep p_{xp} constant. As already indicated, the price of capital ($\hat{P}_k$) is also determined in the national and international markets. Likewise, a decrease in property taxes, as in the case of Michigan, is accompanied by one or any combination of: an increase in the demand for K, L, and N, and/or an increase in P_l, and P_n.

For producers, the property tax is a tax on commercial structures, capital assets and land; therefore, it affects firms' demand for these inputs. When the property tax changes the relative gross input prices, input optimal combinations are distorted. From Equation 4.24 this effect is traced by equating p_{xp} to zero because it is exogenously determined. Thus, the following expression for land rents in x is obtained for a given level of wages; that is, $\hat{p}_{lx} = 0$:

$$\hat{P}_{nx} = \frac{\hat{p}_{xp} - \alpha_{kx}\hat{P}_k - \alpha_{lx}\hat{P}_{lx} - (\alpha_{kx} + \alpha_{nx})\tau_x}{\alpha_{nx}} = -\frac{(\alpha_{kx} + \alpha_{nx})\tau_x}{\alpha_{nx}} \tag{4.25}$$

The relative intensities (α_{xj}) of land and taxes (τ_x) in total costs play a role in how land rents are affected by commercial property taxes in a Cobb-Douglas world. If the industry is land intensive (high α_{nx}), then the effect of property taxes on land rents will be moderate. Land in a less land intensive industry is more likely to be affected by taxes than land in more land intensive industry. This is because in the former scenario shifting the tax to other inputs whose proportion is already high will increase the total cost more than in the scenario that raises land rents. Therefore, it is appropriate to shift the tax to land whose relative cost is low. Notice that if the proportion of capital is very small ($\alpha_{kx} \cong 0$), then the entire tax is fully capitalized in land rents.

Likewise, local wages in the composite good industry are determined by the following expression, for a given level of land rents—$\hat{p}_{nx} = 0$:

$$\hat{P}_{lx} = \frac{\hat{p}_{xp} - \alpha_{kx}\hat{P}_k - \alpha_{nx}\hat{P}_{nx} - (\alpha_{kx} + \alpha_{nx})\tau_x}{\alpha_{lx}} = -\frac{(\alpha_{kx} + \alpha_{nx})\tau_x}{\alpha_{lx}} \tag{4.26}$$

The interpretation is similar to that of land rents above. Notice that if land rents are fixed, and labor is 50 percent of the total costs, then the entire tax is capitalized in wages.[3]

[3]If $\alpha_K + \alpha_N + \alpha_L + 1$, then $(\alpha_K + \alpha_N)/\alpha_L = 1$ only if $\alpha_L = 0.5$.

4.6.2 Incidence on Land and Labor in the Housing Industry

Housing services is considered to be an untraded good. Housing services are not exportable or importable. Then producer price p_{hp} can be changed by Michigan producers as the housing supply is not infinitely elastic. Therefore, a change in commercial property taxes is spread not only to other input prices but also to consumers of housing services.

For the housing services industry, the local wage obtained from 4.23 is as follows, for a given level of land rents—$\hat{p}_{nh} = 0$:

$$\hat{P}_{lh} = \frac{\hat{p}_{hp} - \alpha_{kh}\hat{P}_k - \alpha_{nh}\hat{P}_{nh} - (\alpha_{kh} + \alpha_{nh})\tau_h}{\alpha_{lh}} = \frac{\hat{p}_{hp} - (\alpha_{kh} + \alpha_{nh})\tau_h}{\alpha_{lh}} \qquad (4.27)$$

Equation 4.27 shows how wages in housing are affected by the property tax. An increase in property taxes reduces the rate of change in housing industry wages. Also the wage is directly related to land parameters. An increase in land rents reduces the wage rate. If the industry is land intensive (high α_{nh}), then wages decrease as land rents increase for any given level of labor intensity (α_{lh}). This implies that land and labor are complements.

Likewise, the land rent in housing industry is as follows, for a given level of wages:

$$\hat{P}_{nh} = \frac{\hat{p}_{hp} - \alpha_{kh}\hat{P}_k - \alpha_{lh}\hat{P}_{lh} - (\alpha_{kh} + \alpha_{nh})\tau_h}{\alpha_{nh}} = \frac{\hat{p}_{hp} - (\alpha_{kh} + \alpha_{nh})\tau_h}{\alpha_{nh}} \qquad (4.28)$$

As in P_{lh}, the proportion of capital (α_{kh}) in total cost relative to the proportion of labor (α_{lh}) determines the extent to which the property tax is capitalized in wages and land rents. For instance, if the proportion of land (labor) and capital are roughly equal $((\alpha_{kh}/\alpha_{nh})=1)$ then the entire tax is capitalized in the land rents (wages), *ceteris paribus*. On the other hand, if the proportion of land rents in total costs (α_{nh}) relative to that of capital (α_{kh}) is large, then only a small fraction of the property tax change is shifted to land rents. The logic is that as land rents are already a large part in total costs, it does not make sense to shift the property tax to land. Therefore, the firm should shift the rest of the tax to something else or it should exit the industry. Exiting the industry means that the tax is eventually capitalized in land as land rents decrease due to lack of complementing inputs.

4.6.3 Effect on Capital Demand and Capital Inflow

There is always a tendency for capital to flow to a property tax reducing jurisdiction. This section models the mechanism by which capital flows to low tax jurisdictions. As already discussed, if tax incidence affects input prices, firms tend to substitute inputs whose gross prices have increased with those whose relative gross prices have decreased. Specifically, property taxes distort the choice of inputs by raising the gross price of capital and land but not labor. If the price of capital relative to that of labor increases, then labor is substituted for capital. The same applies to land. The substitutions follow the following formulations:

$$\hat{K}_{ikl} = \psi_{kl}(\hat{P}_{li} - \hat{P}_k - \tau_k) + \hat{L}_i \tag{4.29}$$

$$\hat{K}_{ikn} = \psi_{kn}(\hat{P}_{ni} - \hat{P}_k) + \hat{N}_i \tag{4.30}$$

$$\hat{N}_{inl} = \psi_{nl}(\hat{P}_{li} - \hat{P}_k - \tau_k) + \hat{L}_i \tag{4.31}$$

where ψ_{ikl} and ψ_{ikn} are the respective elasticities of substitution between capital and labor, and capital and land in the respective industries. After substitution, the change in capital demand $\hat{K}^{dd}$ is the sum of capital substituted for labor $\hat{K}_{kl}$ and that substituted for land $\hat{K}_{kn}$; that is,

$$\hat{K}^{dd} = v_{kl}\hat{K}_{kl} + v_{kn}\hat{K}_{kn} \tag{4.32}$$

for a given level of output or isoquant.[4] Notice that a similar expression was obtained in Chapter 3. Figures 4.4a and 4.4b, reproduced from Chapter 3, illustrate the substitution process.

The pre-reform output is Q_1 and point A represents the capital-to-labor and capital-to-land ratios. If there is a change in output demand, as indicated in Equation 4.8, a new isoquant Q_2 is needed. The movement from B to C represents the substitution effect. This movement results in a change in capital demand from K_0 to K_1 in Figure 3.1 or $K_{hKN}+K_{hKL}$.

The price of capital is obtained by substituting equations 4.29 and 4.30 in 4.32 to get the following:

$$\hat{P}_k = \frac{v_{kl}\psi_{kl}\hat{P}_{lt} + v_{kn}\psi_{kn}\hat{P}_{nt} - v_{kl}\psi_{kl}\tau_k + v_{kl}\hat{L}_t + v_{kn}\hat{N}_t - \hat{K}_t}{v_{kl}\psi_{kl} + v_{kn}\psi_{kn}} \tag{4.33}$$

This expression means that from a firm's perspective, the rate of change in the price of capital depends on the firm's proportionate change in capital demand $\hat{K}^{dd}$, its ability to substitute some of the capital with land and labor (ψ) and; therefore, how the prices of labor and land are also changing.

4.6.4 Capital Inflow in the Composite Good (x) Industry

As already discussed, producers cannot pass over the property tax on capital to consumers because they (producers) are facing an infinite supply of x nor can they push

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[4] v_{kj} is the proportion of capital substituted for j where j= L, N in total capital substituted. For instance, if total change in capital substitution is 40%, but only 10% came from substituting capital with land, then v_{kn} is 0.25.

the tax back to capital owners because it is mobile across jurisdictions—capital owners can always take their capital to lower tax jurisdictions. Therefore, the after-tax price of capital has to remain constant. In order to keep the after-tax price of capital $\hat{P}_k$ in Equation 4.33 constant, any increase in property taxes (τ) must be offset by a decrease in land rents ($\hat{P}_{nt}$) and/or a decrease in the quantity of capital ($\hat{K}$) or any other variable in the numerator of Equation 4.31. The effect on land rents have already been discussed above. As already discussed in Equation 3.13, the change in capital demand is obtained by equating 4.33 to zero and solving for $\hat{K}^{dd}$ and then substituting out $\hat{P}_{lx}$ using 4.26 (or $\hat{P}_{nx}$ from 4.25 but not both) to get the following:[5]

$$\hat{K}_x^{dd} = v_{kl}\hat{L}_x^{dd} + v_{kn}\hat{N}_x^{dd} + \left[\frac{v_{kn}\psi_{kn} - v_{kl}\psi_{kl}}{\alpha_{lx}}\hat{P}_{nx}\right] - \left[\frac{\tau_k}{\alpha_{lx}}\right]v_{kl}\psi_{kl} \tag{4.34}$$

Expression 4.34 can be broken into two parts: the right part in brackets represents the pure tax effect (τ) on the demand for capital while the left part represents the effect of complementing or substituting inputs on capital demand (ψ). The conditions on the left represent the capital absorption situation in the recipient jurisdiction. In other words, capital adjustment to the equilibrium depends on local labor and land demand in addition to the tax change.

After substituting the following calibrated parameters for Michigan composite good (x) industry in Equation 4.34: $\psi = 1$ (Cobb-Douglas standard), $\alpha_{kx} = 0.1409$, $\alpha_{lx} = 0.7799$, $\alpha_{nx} = 0.0792$, $v_{kn} = v_{kl} = 0.5$ (assumed)[6], $\tau_k = -0.005$, the following capital ad-

[5]There are three unknowns (P_l, P_n and K) and two equations (4.33 and 4.26 or 4.27) for each industry. Therefore, one variable P_l or P_n has to be assumed in the capital flow equation.

[6]That is, land and labor are substituted for capital in equal proportions in the com-

justment equation is obtained:

$$\hat{K}_x^{dd} = 0.0032 + 0.5\hat{L}_x^{dd} + 0.5\hat{N}_x^{dd} \tag{4.35}$$

Equation 4.35 means that in the short run a 24 percent statewide reduction in commercial property taxes triggers a 0.32 percent increase in capital demand to the composite (x) industry, *ceteris paribus.* That is, in a partial equilibrium framework, the tax change induces a 0.32 percent increase in capital demand. Since the gross price of capital is low due to the tax cut, more capital is demanded and capital flows in to meet the increased demand. In the short run this is what happens as the change in taxes is almost instantaneous. In terms of figures 4.4a and 4.4b, the 0.32 percent represents the AB movement. In the long run, however, availability of labor and land determines the final outcome.[7] This is one of the justifications for a general equilibrium approach.

After considering the long-run equilibrium conditions in land and labor markets, the overall capital demand may be less or more than 0.32 percent depending on whether $0.5\hat{L}^{dd} + 0.5\hat{K}^{dd}$ is less (more) than zero. Thus, there may be local excess supply or demand of capital in the long-run because the initial capital inflow is not matched by the long-run demand. If there is less demand for other inputs, then some of the capital inflow will be in excess supply. If there is more demand for land and labor, then capital demand can increase at a rate higher than the initial trigger rate—0.32 percent. The availability of other inputs depends on the level of endowments and how the other industries share the endowments, the output effects—shifts in isoquants. Thus, there is a strong need for a general equilibrium approach.

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posite industry.

[7]Notice that in Equation 4.34 if $\nu_{kn}\psi_{kn} = \nu_{kl}\psi_{kl}$, then land rents do not affect

The quantity of capital adjustment depends on the ease at which capital is substitutable with other factors (elasticity of substitution, ψ) and its proportion in overall production (capital intensity, α_k). If the proportion of capital in total production (α_k) is small, then the effect of an increase in property tax on the price of capital will be small. This is due to the fact that the amount of capital needed is small; therefore, the proportion of income spent on capital is visibly small. Capital prices are not likely to respond to changes in capital quantities as the change in total cost is not likely to be visible. Also, the tax effect increases with the substitutability of capital with other inputs. If capital is easily substitutable with other inputs, then there is a large impact of a tax on the quantity of capital.

If a firm cannot change N, L, P_l and P_n—local absorption conditions, then an increase in property tax ($\tau_x > 0$) results in less capital demand as per Equation 4.34. This reduced demand for capital however depends on the proportion of other inputs (α_{ij}) in total costs and the overall substitutability of capital with other inputs (ψ). The proportion of other inputs in total costs varies across industries within the composite good.[8] For instance, generally the retail industry has a relatively high proportion of property taxes yet its ability to influence wages (P_l), land rents (P_n), quantity of labor (L) or land (N) is limited. Hence, such an industry is more likely to exit (enter) the industry or jurisdiction increasing (reducing) property taxes because it cannot shift the tax to other inputs. The effect on land, labor, wages and rents however comes later when capital have fled. Otherwise, any firm can offset the increase in property taxes by shifting it to wages (P_l), land rents (P_n), quantity of labor (L) and land (N) used. The share going to each item depends

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capital demand in the long-run.

[8]See discussion of weaknesses of composite good theorem (p. 162).

on its share in total cost. For instance, if the proportion of land in total cost is low relative to that of labor, then rents may not be high enough to offset the tax.

For land, the problem of less capital is compounded by the immobility of land. Therefore the tax burden is born mainly by land owners and to some extent by workers depending on the spatial mobility of their labor skills. Similar qualitative conclusions have also been reached by Mieszkowski (1972), Courant (1977), Wilson (1985) and Hobson (1986).

4.6.5 Capital Inflow in the Housing Services (h) Industry

For the housing services industry, it was assumed that producers can shift some of the tax to consumers of housing services since this industry is non-traded. Therefore, the above algebraic operation is repeated but the housing producer price (p_{hp}) is not equated to zero. The following expression for capital demand is obtained after assuming the equilibrium labor and land conditions as above and substituting out $\hat{P}_{lh}$ (the way it was done in Equation 4.34) in 4.31 by using 4.27 to get the following:

$$\hat{K}_h^{dd} = v_{kl}\hat{L}_h^{dd} + v_{kn}\hat{N}_h^{dd} + v_{kn}\psi_{kl}\hat{P}_{nh} - \left(\frac{v_{kl}\psi_{kl}(\alpha_{kh} + \alpha_{nh})}{\alpha_{lh}} + \psi_{kl}v\right)\tau_h + v_{kl}\psi_{kl}\hat{p}_{hp} \quad (4.36)$$

Some implications can be discerned from Equation 4.34. There are particularly three factors in play. First, because housing is considered a non traded good—therefore its price is not exogenous—then market considerations are important in the firms' assessment of the tax effect on its capital demand. Market conditions are represented by $v\psi\hat{p}_{hp}$. They reflect the housing services price. Second, the commercial property tax (τ_h) effect is in brackets. Its implications are similar to those discussed above in the capital demand for the composite good (x) industry. Third, the long-run effects due to other inputs are represented by the first three sub-expressions on the left. Also, their implications are similar to those explained in the demand for capital in x.

Concisely, the short run effect of the fiscal reform would be for capital demand to respond to the tax and market changes. Capital supply flows to meet this demand. In the long-run, however, other input markets play a role in determining capital demand. Therefore, given the initial capital inflow and the long-run adjustment of capital demand, the local economy may end up with excess capital demand if the capital supply response is not sufficient or excess capital supply if the eventual capital demand is less than the initial capital inflow.[9]

Using $\psi = 1$ and the following calibrated Michigan Cobb-Douglas input parameters, the $\alpha_{kh} = 0.5715$, $\alpha_{lh} = 0.0630$, $\alpha_{nh} = 0.3654$, $\tau_h = -0.0142$, and $v_{kl} = 0.2$, $v_{kn} = 0.8$ the following is obtained:

$$\hat{K}_h^{dd} = 0.0451 + 0.0200\hat{p}_{hp} + 0.0800\hat{P}_{nh} + 0.2000\hat{L}_h^{dd} + 0.8000\hat{N}_h^{dd} \qquad (4.37)$$

A 24 percent statutory decrease in commercial property taxes and a 64 percent decrease in residential property taxes have a short-term instantaneous effect of increasing capital inflows and demand in the housing industry by about 4.51 percent. In the long-run equilibrium, capital inflow into the housing services industry depends on housing producer prices (p_{hp}), land rents (P_{lh}) and the quantity of land (N) and labor (L) demanded. For instance, for every percentage point increase in the housing producer price, capital demand increases by 20 percentage points. In addition, any increase in land rents in the housing

[9]Considering the fact that the housing industry is less labor intensive relative to land intensity, it is plausible to assume that roughly 80% percent of total capital substitu-

industry also increases capital demand. A one percent decrease in land rents increases the demand for capital by about 0.36 percentage points. The effect of land rents depends on whether $v_{kn}\alpha_{lh}\psi_{kl} > v_{kl}\alpha_{nh}\psi_{kn}$. If $\alpha_{nh} > \alpha_{lh}$, that is, more land intensive relative to labor intensity, the coefficient on P_{nh} will be negative. This indicates that an increase in land rents reduces the demand for capital. Roughly, an equal percentage increase in housing services prices and wages will offset each other in the capital demand function.

The housing industry has a higher (4.51 percent) short run tax-induced capital inflow compared to the composite good (x) industry tax-induced capital inflow (0.32 percent). The major cause of this is that the reduction in residential property taxes (τ_h=-0.0149) was greater than the decrease in residential commercial property tax (τ_x=-0.0005). Therefore, any change in the gross price of capital caused a higher proportionate change in capital demand in housing than in the x industry.

The relative wage changes and most other variables in the model are endogenously and simultaneously determined by market forces. This is another justification for a computable general equilibrium model. For instance, the overall labor endowment has to be used in both industries. Therefore, wages adjust until the wage in each industry clears the labor market.

Another observation should be made on the structure of equations 4.34 and 4.34. As mentioned in Wilson (1985), Equation 4.34 shows that the property tax distortion in the traded good (composite x) industry is confined in the factor markets while Equation 4.34 shows that the distortion in the non-traded (housing) is spread beyond the factor markets to include the product market conditions. For optimal property taxation—that is,

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tion will be between capital and land only, and about 20% between capital and labor.

the tax rates vector (τ_h, τ_k) that maximizes the jurisdiction's utility—Wilson (1985) shows that commercial property taxes rates should be lower than residential property tax rates{ that is, $\tau_h^* < \tau_{hr}^*$, assuming production parameters are similar in both industries. The logic is that since the distortion in the traded good industry is confined only to factor markets, the welfare effect is greater in the non-traded industry where the distortion effects are spread on a broader base that encompasses the produced good. "For the normal case where production characteristics differ, the difference between optimal tax rates has been analyzed in terms of "production considerations" and "demand considerations."

As shown above, Michigan's residential and commercial property statewide average tax rates were uniform (45 mills) prior to the reform. This means that the statewide tax rates for residential and commercial property were not optimal based on Wilson's (1985) analytical conclusion, assuming production parameters were similar in both industries. Michigan's 1994 fiscal reform changed the statewide average property tax rates to 16 mills for residential and 34 mills for commercial. If Wilson (1985) conditions hold, then Michigan's 1994 fiscal reform shifted Michigan's property tax rates away from an optimal tax structure than it was prior to the reform. However, such a conclusion should be judged in terms of the "identical production characteristics in both industries" assumption. Prior to the reform, it was difficult to have non uniform statewide average tax rate because the state government never set mill rates for local jurisdictions as it did after the reform. Prior to the reform, there was a statutory 16 mills rate on all property in school districts. This created a substantial uniformity in tax rates across the state and industries.

For the empirical analysis of the excise tax effects, the capital inflow equations are not substituted in the local price functions as it was performed under the theoretical analysis in Chapter 3. Instead, local price functions are numerically updated during the iteration process in the computation algorithm.

4.7 The Government Budget Constraint

Proposal A did not create a net change in the level of public goods since it was a balanced budget reform. Changes in the level of public goods have implications on the welfare aspects of Proposal A. Any potential change in public goods would have been in the area of education because Proposal A targeted the elimination of property taxes from financing school operating expenses. The state government took measures to ensure that the school expenditure levels remained constant; that is, $\hat{g} = 0$. The government budget constraint is as follows:

$$\phi_h(\hat{h} + \hat{p}_h + \hat{t}_h) + \phi_x(\hat{p}_x + \hat{t}_x + \hat{x}) + \phi_h(\hat{t}_h + \hat{P}_k + \hat{K}) + \phi_h(\hat{t}_h + \hat{P}_n + \hat{N}) = \varepsilon_g \quad (4.38)$$

ϕ_i is the contribution of i in state tax revenues where i = x is sales tax revenues, and i = h is property tax revenues. Total tax revenues in the 1990-1991 fiscal year were $19,730,854,000 of which sales, income and property taxes contributed 88 percent (Department of Commerce, Bureau of Census [1990-1991]).[10] For purposes of computing ϕ, only revenues from sales, property and income are considered. The following values were obtained: $\phi_{sales} = 0.260$, $\phi_{property} = 0.450$, and $\phi_{income} = 0.290$. In the computation, however, the excluded taxes, such as income tax, are represented by the sales tax. Therefore $\phi_{sales} = 0.55$, and the property tax proportion is split into three equal proportions of 0.15 for residential, capital and land property taxes. These tax parameters are adjusted in

[10]Total state revenues were $39,536,774,000. The remaining tax revenues were from motor fuel, motor vehicle license, and other taxes.

the algorithm until the government budget constraint is zero.

4.8 Walrasian Equilibrium

In the general equilibrium, factor and output supply must equal demand in a given jurisdiction. In the present study there are three major sectors to consider, namely, output, factor and the government sector. The output and input markets are subdivided into traded and untraded subsectors.

In the factor market, the initial capital endowment of the fiscal-reforming jurisdiction is fixed; therefore, the only source of this traded input is out-of-state inflow or outflow. In equilibrium, the rate of capital inflow or outflow should equal the rate of change in the jurisdiction's capital demand. That is $K_{out} = \sum_i K_i^{dd}$ which is equivalent to $\hat{K}_{out} = \sum_i \lambda_{ik} \hat{K}_i$ where $\lambda_{ki} = K_i / \sum_i K_i$ is the proportion of capital devoted to output i in the jurisdiction.

There are no other input supply functions in the model. As the initial endowments are fixed, any change in their demand is reflected in the respective price changes. In order to achieve Walrasian equilibrium, factor prices adjust at a rate that equates the rate of change in factor demands to the rate of change in factor supply. Therefore, prices P_z adjust to keep $\hat{z} = 0$ as follows:

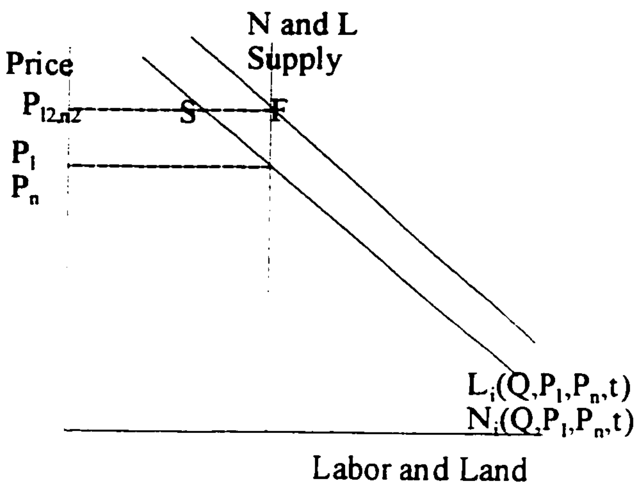
$$\bar{z}(\hat{P}_z) - \sum \lambda_i \hat{z}_i^{dd} = \varepsilon_z \tag{4.39}$$

where the bar implies fixed quantity and z = L, N and ε_z is excess demand or supply.

In terms of Fig. 4.3b, reproduced below as Fig. 4.4a, the labor and land excess demand or

Figure 4.4a

The Excess Demand or Supply in the Land and Labor Markets



supply is represented by SF.

For capital, it is the quantity that adjusts to restore the equilibrium since its price is exogenous, thus

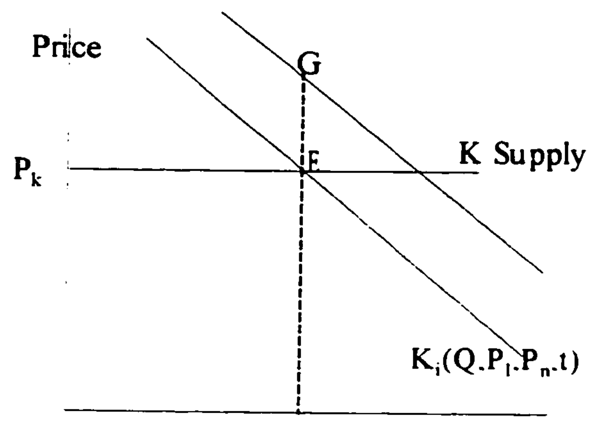
$$\hat{K}(\bar{P}_k) - \sum_i \lambda_{zi} \hat{K}_i^{dd} = \varepsilon_{kt} \qquad (4.40)$$

In terms of Fig. 4.3a reproduced as Fig.4.4b the excess capital demand or supply is represented by EG.

For the government sector, the rate of increase in sales tax revenues should equal the rate of decrease in property tax revenues, and the government budget constraint is as in 4.38.

Figure 4.4b

The Excess Demand or Supply in the Capital Market



Walras' law requires the sum of all the value of excess demands to equal zero, $\sum \varepsilon_z = 0$. The equilibrium in the output market is obtained automatically when the government and input sector are in equilibrium. The output-input relation exploits the zero profit conditions where output prices can be expressed as a function of input prices.

4.9 Tax Parameters

Property taxes decreased by 64 percent from an average of 45 (35 for school districts, 4 for townships and 6 for counties) mills to 16 (6 mills on all property for school districts, 4 for townships and 6 for counties) in residential sector and by 24 percent to 34 (24 mills in the non-residential property [statutory 6 mills + 18 vote approved], 4 for townships and 6 for counties). That is, for commercial property taxes decreased from t_{th1}

= (45/2000) 0.0225 cents per dollar to t_{h1} = (34/2000)= 0.0170 cents per dollar of property value. Then $\tau_{hp} = \frac{dt_h}{1+t_h}$ is equivalent to (-0.0050/1.0198) = -0.005 where $t_h = (t_{h0} + t_{h1})/2$ and $\hat{t}_h$=24 percent. Residential property taxes decreased from t_{h0r} = (45/2000) = 0.0225 cents per dollar to t_{h1r} = (16/2000)= 0.0080 cents per dollar of property value. Then $\tau_{hr} = \frac{dt_h}{1+t_h}$ is equivalent to (-0.0145/1.0153) = -0.0142 where $t_h = (t_{h0} + t_{h1})/2$ = 0.0153 and $\hat{t}_{hr}$=64 percent. The change in sales tax was from t_{s0} = 0.04 cents per dollar to t_{s1} = 0.06 cents per dollar of sale. Then τ_x = 0.02/1.05 = 0.0190.

4.10 Benchmark Data

Benchmark prices are assigned a unit value; that is, in the benchmark equilibrium $\hat{P}_z$=0. However, these amounts are changed in an iterating process depending on whether there is excess demand or supply. Factor shares (α) for each industry are obtained by calibration of the Cobb-Douglas production function with respect to 1990 Michigan's gross state product (GSP) in Table 4.1A in Appendix I.

The year 1990 is assumed to have been in equilibrium given the then existing fiscal policies. Capital and labor data are reported only in values, yet the analysis requires their prices and quantities. The convention in applied general equilibrium is to define their net prices in the benchmark period as unit.[11] Therefore a published value becomes quantity. The 1990 capital charges and the compensation value added are taken to be capital and labor quantities, respectively, for Michigan (Table 4.1A Appendix I). The implication is

[11]This assumption is based on the principle that it is relative, not absolute prices,

that people with high labor incomes have high numbers of labor units. These labor units are a composite of quality and quantity. Capital value added is split into capital and labor using the ratios used by Morgan, Mutti, and Partridge (1989).[12]

4.11 Data Consistency Adjustments

Inputs are supposed to be the jurisdiction's endowment. However, GSP data contains out-of-state capital. It is important to isolate resident from nonresident capital for tax exporting purposes. In order to accomplish this, firms' expenditure of primary inputs has to equal factors' incomes. Theoretically, expenditures on factors should equal factor incomes. Therefore, value added by capital, land and labor should equal capital, land and labor income, respectively.

Available data does not conform to this theory because it is collected from different sources and by different methods. For instance, there are no state data for capital payments (interest, rents, dividends, etc.) by industry. In addition, capital value added by each industry at the state level is computed differently for each sector. It is therefore necessary to make adjustments for data to be consistent.

The Bureau of Economic Analysis (BEA) estimates capital charges (capital value added) for agriculture, mining, construction, and manufacturing industries by subtracting compensation, proprietors' income, and indirect business taxes from GSP. For regulated service and distributive industries, namely, transportation, communication, utilities, and finance, BEA uses indicators of capital stock, i.e., airline boardings, to allocate capital charges to states. For unregulated services and distributive industries, BEA uses data on

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that matter in real analysis.

business receipts or sales data and wages and salaries data to allocate capital charges to states. Research by Trott, Dunbar and Friedenberg (1991) has more details on GSP estimates.

Capital income inconsistency in Michigan is very wide. Total value added by capital in GSP is $41,637,000,000 whereas reported capital income from the Statistics of Income (Internal Revenue Service, various issues) is only $17,972,676,000. By definition capital value added in GSP should be the return to capital services provided in the state. Theoretically the difference between value added and capital income of $23,664,324,000 would represent return to out-of-state capital and data discrepancy.[13] There is no basis on which one can allocate this difference to out-of-state capital and data discrepancy. This discrepancy also indicates the extent to which Michigan is a debtor state. Michigan uses more capital than it owns. This aspect has some tax exporting implications to be discussed below.

Conceptually, general equilibrium analysis needs the capital endowments for the state. Plausibly, one should use Michigan's SOI reported capital income of $17,972,676,000 in the analysis as the 1990 capital endowment. In essence, Gross State "Resident" Product (GSRP) is used in the analysis as opposed to Gross State "Domestic" Product. However, the reported value added is used as whole in the computation of production parameters. The proportion of labor or capital used depends on the technology used not on whether the input is imported or not.

Unlike capital estimates, labor compensation (value added) by industry is available

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[12]Proprietors' income in GSP is insignificant therefore it is completely ignored.
[13]It is possible that Michigan's auto industry attracts considerable out-of-state capital.

at state level. The total labor value added in GSP, $128,530,000,000 which is more than the reported labor income of $100,854,779,000 in the Statistics of Income (SOI).[14] The difference could be attributable to data discrepancy. Since IRS data is more likely to be correct, the value added data is scaled down by 0.785 to adjust it to SOI data. Ballard et al. (1985) also use this method of data adjustment.[15].

Housing services (h) is represented by the real estate output while agriculture, industrial, commercial, and utilities represent the composite good (x). Government output is left out because the government budget is preserved; therefore a change in public output is not expected. Morgan et. al (1989) split capital into capital and land in the ratio of 0.61: 0.39 in real estate (H), and 0.64: 0.36 in composite good. Table 4.1 reports below the obtained values, while Table 4.3 reports the factor proportions. Table 4.2 shows value added adjusted for consistency.

In equilibrium total domestic output GSP plus imported output M equals aggregate demand. Aggregate demand is composed of intermediate demand (A*GSP), where A is the input-output coefficient matrix, C is consumption, G is government, I is investment, and Ex is net export demand. That is, GSP +M= (A x GSP) + C + G + I + Ex which is rearranged to get GSP - (A x GSP) = C + G + I + Ex-M. The latter expression implies that value added (left of the equation) from each industry equals total final demand. Therefore, in the model, 1990 expenditures on factors (value added) must equal final demand since it is assumed that 1990 was in equilibrium. There are no official data on the

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[14]The difference is small because the labor imported out-of-state is insignificant.

[15] Misreporting income for tax purposes is punishable; therefore, there is an incentive for people to report accurate income.

Table 4.1

Value Added in Industry h and x in ('000) Dollars

	Capital	Land	Labor	Total
Housing	7,099,000	4,539,000	783,000	12,421,000
Composite	22,404,000	12,603,000	124,048,000	159,055,000
Total	29,503,000	17,142,000	124,831,000	171,476,000

Table 4.2

Adjusted Value Added (thousands of dollars)

	Capital	Labor	Total
Agriculture	587,046	941,615	1,528,661
Industry	3,523,572	38,947,537	42,471,109
Commercial	4,765,433	41,733,147	46,498,581
Real Estate	6,371,177	779,186	7,150,363
Utilities	2,506,601	5,217,330	7,723,931
State Govt.	218,847	13,235,964	13,454,811
Total	17,972,676	100,854,779	118,827,455

components of final demand at the state level. In the present study G and I are constant and Ex-M is determined on a residual basis. Figure 5.1 in Chapter 5 illustrates the role of G, I and Ex-M.

4.12 Calibration

After establishing the benchmark data, it is necessary to find parameters for agents' behavioral functions such that with these parameters one can reproduce the equilibrium data from the behavioral equations. A Cobb-Douglas function $Q_i = VA = \phi_i K^{\alpha_{ki}} L^{\alpha_{li}} N^{\alpha_{ni}}$ is used, where $\alpha_{li} + \alpha_{ni} + \alpha_{ki} = 1$ and VA is value added, assuming constant returns to scale. The conditional factor demands are as given in equations 4.17, 4.18 and 4.19. The parameters chosen should enable these demand functions to reproduce the benchmark data. That is, demand for inputs should equal the benchmark supply in Table 4.1 above. If zero profit conditions are assumed, then $VA_i = P_k K + P_l L + P_N N$. For Cobb-Douglas functions the parameters are as follows:

$$\alpha_{zi} = \frac{P_z z}{\sum_z P_z z} \tag{4.41}$$

$$\phi_i = \frac{P_k K + P_l L + P_N N}{K^{\alpha_k} L^{\alpha_l} N^{\alpha_n}} \tag{4.42}$$

Inputs data is obtained from Table 4.1 above. Factor gross prices P_K, P_L and P_{Ni} are assigned a unit value. The following calibrated values in Table 4.3 are obtained after running the algorithm.

Table 4.3

Calibrated Parameters of the Model

Parameter	h	x
α_K	0.5715	0.1409
α_L	0.0630	0.7799
α_N	0.3654	0.0792
ϕ	2.3675	1.9559

4.13 Income Determination

The 1992 Statistics of Income (Department of the Treasury, Internal Revenue Service, 1992) for Michigan format of consumer incomes is followed in this study but compressed from seven to two consumer income groups in Table 4.4. The "low" income group earns less than \$30,000 per year, while the high income group earns more than \$30,000 per year.

Table 4.4

Michigan's 1990 Household Incomes ('000 dollars)

	Annual Income(\$)	Pop.	Labor Income	Capital Income	Transfer Payments	Total
1	29,999	2,631,886	23,800,771	6,719,130	535,916	31,055,817
2	> 30,000	1,236,188	77,054,008	11,253,546	482,999	88,790,553
Total		3,868,074	100,854,779	17,972,676	1,018,915	119,846,370

Source: Statistics of Income, 1992 Vol. 11, No. 4., Department of the Treasury, Internal Revenue Service.

Labor income is composed of wages and salaries, while capital income is composed of interest, dividends, net capital gains, rents, pensions and annuities. The income generating function is as follows:

$$\hat{y}_m = \delta_{km}(\hat{K}_m + \hat{P}_k) + \delta_{lm}(\hat{L}_m + \hat{P}_l) + \delta_{nm}(\hat{N}_{lm} + \hat{P}_{nl}) + \delta_{tr}t\hat{r} \qquad (4.43)$$

δ_{mz} is the share of input z in total income for each income group m. Table 4.5 shows the income shares obtained from Table 4.4. There is no separate data reported for land. However, it is not unusual to combine land and capital in data reports. The land component is therefore obtained by splitting up capital into capital and land by a 0.63:0.37 ratio, see Morgan and Mutti (1989).

The initial endowments were assumed to remain fixed, that is, $\hat{N} = \hat{L} = 0$. Also the capital endowment is expected to change but not its price; that is, $\hat{P}_k$=0. Therefore, based on Equations 4.41, this implies agents' incomes change with input prices as follows:

Table 4.5

Proportions (δ_{ijz}) of Capital, Labor and Land in Total Income

Income Group	Labor	Land	Capital	Transfers
1	0.766	0.080	0.136	0.017
2	0.867	0.047	0.080	0.005

$$\hat{y}_m = \delta_{km}(\hat{K}_m) + \delta_{lm}(\hat{P}_l) + \delta_{nm}(\hat{P}_{nt}) + \delta_{tr}\hat{tr} \tag{4.44}$$

Capital inflow is considered to generate income to out-of-state residents therefore capital should not appear in the Michigan residents' income equation. Transfer payments are also excluded since their rate of change is zero. McLure (1969) shows that income, in regional fiscal analysis, is generated from the sources (inputs) and uses sides. In the present study the uses side is marginal; therefore, any changes in commodity prices do not affect real income. The income discussed in the present study is from the income side only.

4.14 Walras Equilibrium

The excess demand equations are obtained from Equations 4.38, 4.37, 4.38. The input demand functions to be used in these equations are obtained from equations 4.17-4.19. The proportions of each input in total input used in each industry (λ) are obtained from Table 4.6 below.

Coefficients such as 0.34 mean that 34 percent of Michigan's capital is devoted to housing. The coefficients are obtained by dividing the columns in Table 4.1 by the column sum.

Table 4.6

Proportion of Total Input Devoted to a Particular Output (λ)

	Capital	Land	Labor
h	0.344	0.373	0.008
x	0.656	0.627	0.992

Note: These proportions do not include inputs used by the government.

4.15 Consumer Demand Parameters

Even if commodity demand is not directly measured in the computation of equilibrium, it is needed in the computation of welfare changes.[16] The goods category in Table 4.14A in Appendix I is from the Consumer Expenditures Survey (1990-1991), Midwestern region. The consumer expenditure shares (ρ) on h and x, used in calculating compensating variation, were obtained by transcribing the goods category in the Consumer Expenditure Survey. All the goods in the Consumer Expenditures Survey (CES) are compressed into the composite (x) except Shelter that is classified as housing in Table 4.7 below.

4.16 Summary

Chapter 4A developed the data, demand functions and tax parameters, discussed property tax incidence, and the capital inflow mechanism. The model is benchmarked to 1990 Michigan's gross state product (GSP) data. The data is adjusted for consistency and

[16]If other markets are in equilibrium, the goods market will also be in equilibrium therefore there is no need to solve for output demand and supply.

Table 4.7

Consumer Expenditure Shares on the Model's Sectors

Industry	Group's ρ	
	1	2
Composite(x)	0.80	0.88
Housing (h)	0.20	0.12

Source: Computed from Consumer Expenditure Survey (1990-1991)

then calibrated. There is data inconsistency between capital valueadded and capital income of $24 billion. The postulation is that the large data discrepancy in capital is generated by out-of-state capital inflow. After this postulation, Michigan was found to be a net debtor state— it uses more capital than its residents own. Labor discrepancy was reasonable; the gap between value added and labor income was only $28 billion.

Land data is not reported directly; therefore, the value of land was obtained by splitting up the reported value added for capital into capital and land. The splitting-up ratios were obtained from the Morgan et al. (1989) study. In addition, the Cobb-Douglas function was used on the supply and demand sides.

Table 4.8 shows the results obtained for Model 4A. Their implications are discussed in chapters 6 and 7 where the implications on welfare, state budget and tax exportability are also included that discussion.

Table 4.8

Results For Model 4A

	Composite (x)	Housing (h)
Wages	0.08%	0.25%
Land Rents	0.47%	1.96%
Capital Inflow	0.49%	1.75%
Output	0.05%	0.93%
Output Price	0.00%	-0.55%

Part B

An Alternative Model

4.17 Introduction

This section discusses a simpler approach to solving the effects of a statewide property tax policy change. This model is hereafter referred to as Model 4B. The model analyzes the housing services and the composite good markets separately. The model basically uses a partial equilibrium approach and utilizes the profit maximization objective function of a representative firm. Under a similar set of assumptions as in Part A, it is shown that a representative firm in industry i, for i = x, h, maximizes a profit function with the property tax parameters included as a tax on capital and land. Then in equilibrium the rate of change in input prices equals the rate of change of the their marginal products. It is also true that this condition guarantees that the underlying input markets are in equilibrium, therefore there is no need to explicitly solve for the respective inputs markets equilibria.

4.18 The Composite Good (x) Industry

A representative firm maximizes the following profit function:

$$\pi = p_{xp}\phi K_x^{\alpha_{kx}} L_x^{\alpha_{lx}} N_x^{\alpha_{nx}} - (1+t_{px})P_k K_k - P_{Lx} L_x - (1+t_{px})P_{Nx} N_x \tag{4.45}$$

Differentiating Equation 4.45 with respect to K_x, L_x and N_x, and setting these derivatives to 0, it is seen that,

$$(1+t_k)P_k = p_{xp}\alpha_{kx}\phi K_x^{\alpha_{kx}-1} L_x^{\alpha_{lx}} N_x^{\alpha_{nx}} \tag{4.46}$$

$$P_{Lx} = p_{xp}\alpha_{lx}\phi K_x^{\alpha_{kx}} L_x^{\alpha_{lx}-1} N_x^{\alpha_{nx}} \tag{4.47}$$

$$(1+t_k)P_{nx} = p_{xp}\alpha_{nx}\phi K_x^{\alpha_{kx}} L_x^{\alpha_{lx}} N_x^{\alpha_{nx}-1} \tag{4.48}$$

The demand for land and labor is constant because a single firm faces a perfectly elastic input demand curve. Since land and labor are fixed their rate of change is zero. Therefore in equilibrium, the rate of change in their demand must also be zero. Therefore, since p_{xp}, P_K, L_x and N_x are fixed, the comparative static versions of 4.46-4.48 are as follows, assuming $d\phi = 0$:

$$\tau_k = (\alpha_{kx} - 1)\hat{K}_x \tag{4.49}$$

$$\hat{P}_{Lx} = \alpha_{kx}\hat{K}_x \tag{4.50}$$

$$\tau_k + \hat{P}_{nx} = \alpha_{kx}\hat{K}_x \tag{4.51}$$

From these three equations, it is seen that

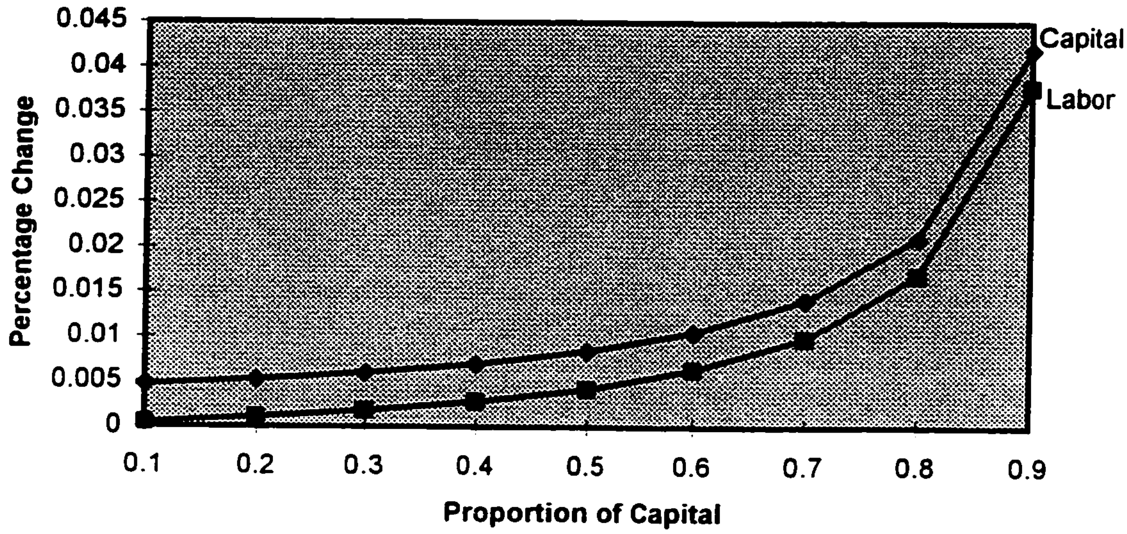
$$\hat{K}_x = \frac{1}{\alpha_{kx} - 1}\tau_{px} \tag{4.52}$$

where $\alpha_{kx} \neq 0$.

The increase in capital demand depends on capital intensity of the industry. The more capital intensive an industry is, the more responsive is the industry to the property tax change. More specifically, capital intensity over 0.70 is very sensitive to price changes as shown in Figure 4.5 obtained from Equation 4.52 and 4.53 assuming τ = -0.0042. Therefore, to obtain the maximum benefit of a tax, it is better to target capital intensive industries. Labor increase lags capital increase.

The effect of taxes on labor is determined by solving 4.50 and 4.51 for P_{lx} and P_{nx} to obtain the following:

Figure 4.5
Capital and Labor Response as the Proportion of Capital Increases



$$\hat{P}_{Lx} = \frac{\alpha_{kx}}{\alpha_{kx} - 1}\tau_{px} \qquad (4.53)$$

$$\hat{P}_{Nx} = \frac{1}{\alpha_{kx} - 1}\tau_{px} \qquad (4.54)$$

Notice that land is affected at the same rate as capital. In addition, the tax effect on land depends on capital, not land intensity.

In a Cobb-Douglas world, output equals $X = \alpha_{kx}\hat{K}_x + \alpha_{lx}\hat{L}_x + \alpha_{nx}\hat{N}_x = \alpha_{kx}\hat{K}_x$. Considering Equation 4.52 it follows that:

$$\hat{X} = \alpha_{kx}\hat{K}_x = \frac{\alpha_{kx}}{\alpha_{kx} - 1}\tau_{px} \qquad (4.55)$$

These equations can further be simplified to show that

$$\hat{K}_x = \hat{P}_{nx} \qquad (4.56)$$

$$\hat{P}_{Lx} = \hat{X} \qquad (4.57)$$

Capital and land rates change at the same rate. The slowest changing input determines the rate of which output changes. In this case labor sets the rate at which output changes.

4.19 The Housing Industry (h)

In a similar fashion, a representative firm in housing maximizes the following profit function:

$$\pi = p_{hp}\phi K_h^{\alpha_{kh}} L_h^{\alpha_{lh}} N_h^{\alpha_{nh}} - (1+t_{ph})P_k K_h - P_{Lh}L_h - (1+t_{ph})P_{Nh}N_h \tag{4.58}$$

Differentiating with respect to K_h, L_h and N_h, and setting these derivative to 0, it is seen that

$$(1+t_{ph})P_k = p_{hp}\alpha_{kh}\phi K_h^{\alpha_{kh}-1} L_h^{\alpha_{lh}} N_h^{\alpha_{ln}} \tag{4.59}$$

$$P_{Lh} = p_{hp}\alpha_{lh}\phi K_h^{\alpha_{kh}} L_h^{\alpha_{lh}-1} N_h^{\alpha_{nh}} \tag{4.60}$$

$$(1+t_{ph})P_{nh} = p_{hp}\alpha_{nh}\phi K_h^{\alpha_{kh}} L_h^{\alpha_{lh}} N_h^{\alpha_{nh}-1} \tag{4.61}$$

Unlike in the composite good (x) industry, the price of housing is not fixed because housing in not traded in the national market. Then since P_K, L_h and N_h are fixed, the comparative static versions of 4.59 to 4.61 are the following:

$$\tau_{ph} = \hat{p}_{hp} + (\alpha_{kh} - 1)\hat{K}_h \tag{4.62}$$

$$\hat{P}_{Lh} = \hat{p}_{hp} + \alpha_{kh}\hat{K}_h \tag{4.63}$$

$$\tau_{ph} + \hat{P}_{nh} = \hat{p}_{hp} + \alpha_{kh}\hat{K}_h \tag{4.64}$$

From these three equations, it is seen that

$$\hat{K}_h = \frac{1}{\alpha_{kh} - 1}(\tau_{ph} - \hat{p}_{hp}) \tag{4.65}$$

$$\hat{P}_{Lh} = \hat{p}_{hp} + \frac{\alpha_{kh}}{\alpha_{kh} - 1}(\tau_{ph} - \hat{p}_{hp}) \tag{4.66}$$

$$\hat{P}_{nh} = \frac{1}{\alpha_{kh} - 1}(\tau_{ph} - \hat{p}_{hp}) \tag{4.67}$$

Input prices in the housing industries depend on the price of housing. In a Cobb-Douglas world, output equals the following:

$$\hat{h} = \alpha_{kh}\hat{K}_h = \frac{\alpha_{kh}}{\alpha_{kh} - 1}(\tau_{ph} - \hat{p}_{hp}) \tag{4.68}$$

These equations can further be simplified to show that

$$\hat{K}_h = \hat{P}_{nh} \tag{4.69}$$

$$\hat{P}_{Lh} = \hat{h} + \hat{p}_{hp} \tag{4.70}$$

The price of housing is obtained by equating the demand and supply in the housing market. This is accomplished by iterating the housing price in the demand function $\hat{h}^{dd} = \hat{y} - \hat{p}_h$ (Equation 4.8) and comparing it to supply Equation 4.68. The price at which iterations converge is the equilibrium price for housing.

As the government budget is supposed to stay balanced, tax revenues changes are compared to tax cuts at the new prices and output.

4.20 Results Summary

Excess demands converge after 49 iterations. The percentage changes in Table 4.9 were obtained after the iterations converged. The implications of these results on personal welfare and government budget constraint are discussed further in chapters six and seven.

Table 4.9

The Results Obtained from Model 4B

	Composite (x)	Housing (h)
Wages	0.08%	0.77%
Land Rents	0.58%	2.19%
Capital Inflow	0.58%	2.19%
Output	0.08%	1.25%
Output Price	0.00%	-0.48%

CHAPTER 5

THE COMPUTATION ALGORITHMS

5.1 The Algorithm for Model 4A: Introduction

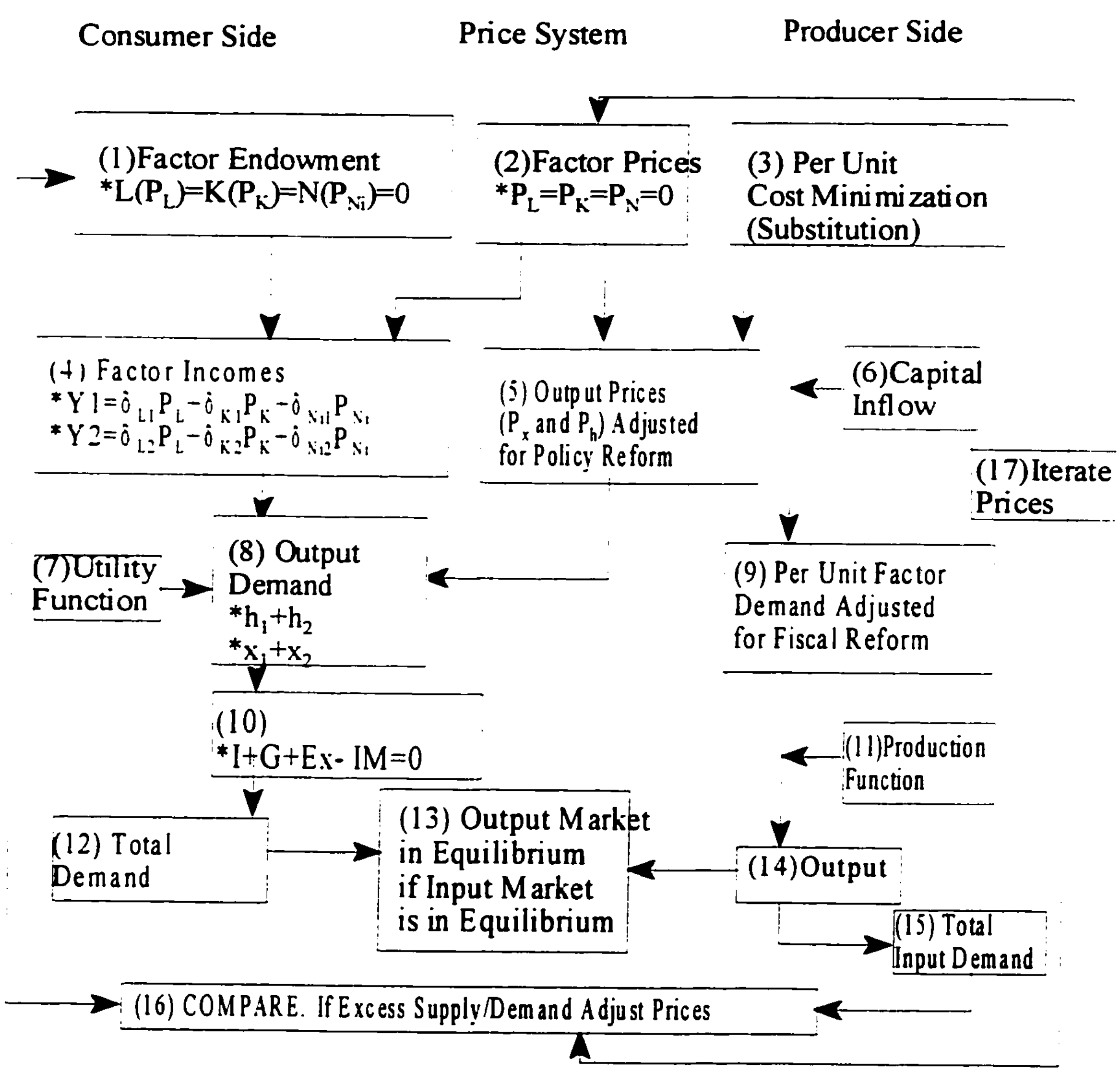
The computation algorithm constructed here is a variation of the class of numerical algorithms used by Harrison and Kimbell (1986) and Dinwiddy and Teal (1988). The common characteristic of such algorithms is that they use a factor price revision rule that raises the price of a factor in excess demand and lowers the price of a factor in excess supply. This process is repeated until the excess demands or supplies are eliminated or minimized. The flowchart in Fig 5.1 provides an overview of the algorithm.[1]

Factor income (4) is generated from the sale of endowments (1) at the going factor prices (2) and factor income shares.[2] Given a utility function (7), factor incomes along with output prices (5), consumers determine their output demand (8). The sales tax impact is analyzed by including it here in the output prices (5). Aggregate state output demand (12) also includes government, investment and the net export demands (10). There was no change in these components of aggregate demand, therefore, their rates of change in the model are zero.

[1]The chart is a modified version of that found in Ballard et al. (1985).
[2]Numbers in braces correspond to numbers in Figure 5.1.

Figure 5.1

The Algorithm Flow Chart



Notes: The symbol * shows that the equation is supposed to have circumflex ^ on each of the variables.

On the supply side, firms minimize production costs through input substitution (3) when the tax reform changes relative input prices. Capital flows (6) in due to the tax-induced increase in capital demand. Given a production function, this level of inputs demand leads to a new rate of change in output supply (14). This rate of change in output supply has to equal the rate of change in demand for housing services (h) and the composite good (x) in equilibrium (13).

If the output produced is not equal to consumer demand, firms adjust their inputs demand (output effect). The net effect of the substitution and output effects gives the input demand (15). The input demand is compared to the state inputs endowment (16). If there is disequilibrium, iterate input prices (17). Then a new equilibrium is recalculated with the new set of input prices. Once the input market is in equilibrium the product market is automatically in equilibrium too. Equilibrium in the factor market is archived by iterating input prices until the inputs sum of excess demands is almost zero—as required by Walras law. The computation source code is programmed in "C" computer language. Appendix II shows the code and is also available from the author on request.

5.2 Benchmark Data in the Algorithm

All benchmark prices are initially set to one—in comparative statics form they are set to zero. Total factor endowments are from Table 4.1. These are defined as value added in each sector plus indirect taxes but not adjusted for consistency. Thus in model units, K_x = 22,404,000,000, K_h = 7,099,000,000, L_x = 124,048,000,000, L_h = 783,000,000, N_x = 12,603,000,000, N_h = 4,539,000,000.

All other parameters such as input shares, tax parameters and income shares are specified at this point. Calibration is used to obtain the production function parameters. Parameter evaluations are based on equations 4.41 and 4.42 for a Cobb-Douglas function. The obtained parameter values are checked to see whether they can reproduce the benchmark data.

Initially there is no change in income. Income adjusts according to Equation 4.44 when factor price iterations start. Factor income shares are computed from the Statistics of Income for Michigan (Internal Revenue Service, Department of the Treasury, 1992).

Inputs supply does not change except for capital which is initially set to flow in according to Equations 4.34 and 4.36. The proportions of capital substituted for labor (land) in total capital substituted (ν_{kli}) in industry i are assumed to be 0.2 for labor in housing, 0.8 for land in housing, 0.5 for labor in composite industry and 0.5 for land in composite industry. There is no change in initial factor demands. The immediate effect of the tax reform is to change input prices according to Equations 4.25 through 4.28 before iterations begin.

5.3 The Iteration Loop

Iterations start with new output demands according to Equation 4.8. Then supply is stepped up to equal average rate of change in demand. From the new supply rates, derived factor demands rates are recalculated basing on Equations 4.17 to 4.19.

5.3.1 Excess Demands and Price Adjustments

The new input demand is compared with the endowments. For capital, increase or decrease capital supply by a factor of 0.001, an adjustment parameter chosen arbitrary. Likewise, compare the rates of change in demand for labor and land. If there are any excesses adjust the respective input price by a factor equal to 0.001. Once a market clears, its prices are restricted not to adjust again due to iterations from other adjusting markets.

For personal incomes, the proportion of labor income (δ_l) in Equation 4.44 from each industry is difficult to obtain. Therefore a weighted average wage for both industries is used to compute income. The weights are a function of the proportion of the industry in GSP and labor intensity. For instance, the proportion of housing services in the GSP is about 12 percent and labor intensity is α_l. Therefore the weight (w) attached to the wage from housing is $w_h = 0.12\alpha_l/(0.12\alpha_{lh} + 0.88\alpha_{lx})$.

After obtaining the average rates of change in wages, land rents and quantity of capital, income changes due to fluctuations in input prices are computed in each iteration. Output demand changes on the next iteration because of the change in income. This changes output production and hence starts off a new set of input demands. Price iterations are performed again to equate the new input demand to the endowment. The process is repeated until the sum of excess demand or supply converge as iterations increase.

5.3.2 The Government Budget Constraint

Also the government budget deficit or surplus Equation 4.38 is introduced in the algorithm. The initial proportion (ϕ_i) of each revenue source in total state tax revenue is specified from the state budget. In the final equilibrium the government budget should balance. Therefore, the proportions (ϕ_I) are manually adjusted until the budget balances. That is, the eventual proportions of the sales tax and the property tax in the state tax revenues are those that maintain the government budget constraint in the model balanced. Fortunately, the adjustments are marginal such that the final proportions are not significantly different from the actual proportions.

5.3.3 Walras Check

This check is based on $\sum_{z} \varepsilon_{z}$, the sum of the value of excess demands. Excess demand in product markets is left out because equilibrium in input markets implies equilibrium in output markets.

5.3.4 Normalize Prices

Updated prices are normalized before the next iteration or loop exit by dividing them with a numeraire—the producer price of x. Producer prices are based on the zero profit conditions Equations 4.23 and 4.24. Iterations stop after getting the sum of excess demands closest to zero and the sum is converging. Table 6.1A in the Appendix I shows how some selected variables move throughout the iterations. Figure 6.1 in Chapter 6 shows how the sum of excess demands converge as iterations proceed.

5.4 The Computation Algorithm for Model 4B

Unlike in Model 4A where both industries are simulated, the simulation in Model 4B is only for the housing industry. Equilibrium in the composite good industry is ensured by the fact that the price of X, therefore the equilibrium parameters are computable analytically. The price of housing in not constant, therefore iterations must be performed until the equilibrium price is obtained. Therefore iterations are limited to the housing industry.

The Cobb-Douglas production function is calibrated on Michigan's 1990 Gross State Product to obtain input shares (α_h). All benchmark price and income changes are initially set to one before any tax policy change.

The property tax policy change is introduced by defining the tax parameters as τ_x = -0.0050 for the commercial property taxes and τ_h = -0.0142 for residential property taxes in housing services. The tax policy impacts the benchmark input prices according to Equations 4.66 and 4.67 and capital according to Equations 4.65 and 4.69.

The tax impact disturbs the equilibrium which is restored through a tetannoment process. Equilibrium is restored when excess demand in the housing industry is eliminated through a series of iterations.

At the new input and output prices, capital demand changes and output demand ($\hat{h}^{dd} = \hat{y} - \hat{p}_h$, Equation 4.8) also changes because of income changes. The average increase in income is a weighted average increase in the wages from both industries and the weighted average increase in land rents from both industries. The weights are $w = \frac{\alpha_{iz}\kappa_i}{\sum \alpha_{iz}\kappa_i}$ where α_{iz} is the factor (z) proportion in industry (i) and κ is the industry share in gross state product.

Housing supply changes due to changes in input demand (Equation 4.68). Housing demand $\hat{h}^{dd}$ is compared to supply, if supply exceeds demand then $\hat{p}_h$ is incremented accordingly by an arbitrarily chosen parameter, in 0.0001 is used in the present case. This process is repeated until excess housing demand is eliminated and there is a convergence in the excess demand or supply.

The government budget is constrained to balance, therefore, tax revenues decrease due to change in the tax rate is compared to tax revenue increase due to changes in output and input prices (Equation 4.38). The proportion of each revenue source in total state tax revenue is obtained but adjusted until the budget balances. Table 6.2A in Appendix I shows how some selected variables move throughout the iterations. Figure 6.2 in Chapter 6 shows how the excess demand or supply in the housing services industry converges to zero as iterations progress.

CHAPTER 6

RESULTS

6.1 Introduction

This project used a computable general equilibrium model to analyze the impact of Proposal A on Michigan's economy. The postulation is that the effect of property tax changes permeate the labor, land and output markets as excise tax effects. The impact was assessed in terms of changes in output quantity and prices, factor prices and welfare. All prices changes are relative to the producer price of the composite good (x)—the numeraire.

As for welfare, it was hypothesized that the benefit of lower property taxes was offset by the increased sales tax. According to this hypothesis, low-income earners experience a welfare loss because the increased sales tax is generally regressive if the sales tax is totally shifted to consumers, while the reduced property tax is generally progressive. Generally low income earners do not own taxable property; therefore, any property tax decrease does not visibly benefit them.

Additional hypotheses were advanced regarding the other effects of the reform. One of the hypotheses stated that the proportion of housing services output in gross state product will increase relative to the other composite commodity (x), and the absolute level of both outputs will increase.

Unrelated economic state policy reforms during the same period were not considered in the present study—the results discussed here are only for the pure effects of Proposal A. The following section discusses the sum of excess demand or supply criterion for determining the results. Sections 6.4 through 6.6 show the changes in output, land, labor prices and quantity of capital inflow. Results in this section are interpreted mainly in terms of the "excise-tax" effects of the "New View" theory of taxation. Section 6.7 outlines the effects of the reform on personal incomes and discusses the source of income change. Section 6.8 discusses the welfare impact in terms of compensating variations for two—low and high—income groups. The government budget deficit is discussed in Section 6.9.

6.2 Sum of Excess Demand (Supply)

6.2.1 Choosing the Sum of Excess Demand or Supply

In the computation algorithm iterations are supposed to stop when the sum of excess demands is zero. However, it is not practical for the sum of excess demands to equal zero. The sum of excess demands is a continuous variable because it is generated by continuous functions. Therefore there are some sums that cannot be observed because iterations are performed in discrete steps. Figure 6.1 shows how the sum of excess demands or supply vary with the number of iterations during the computation.

The 28th iteration has the lowest sum and convergence of the sum of excess demands starts in this region. Therefore all the results discussed here are based on the 28th iteration because any further iterations do not generate any new information. In addition, since two models results were obtained and they are not very different, the conclusions drawn here are based on the means of both sets of results each set reproduced below in

Table 4.8′ and Table 4.9′.

Fig. 6.1
Sum vs Iterations in Model 4A

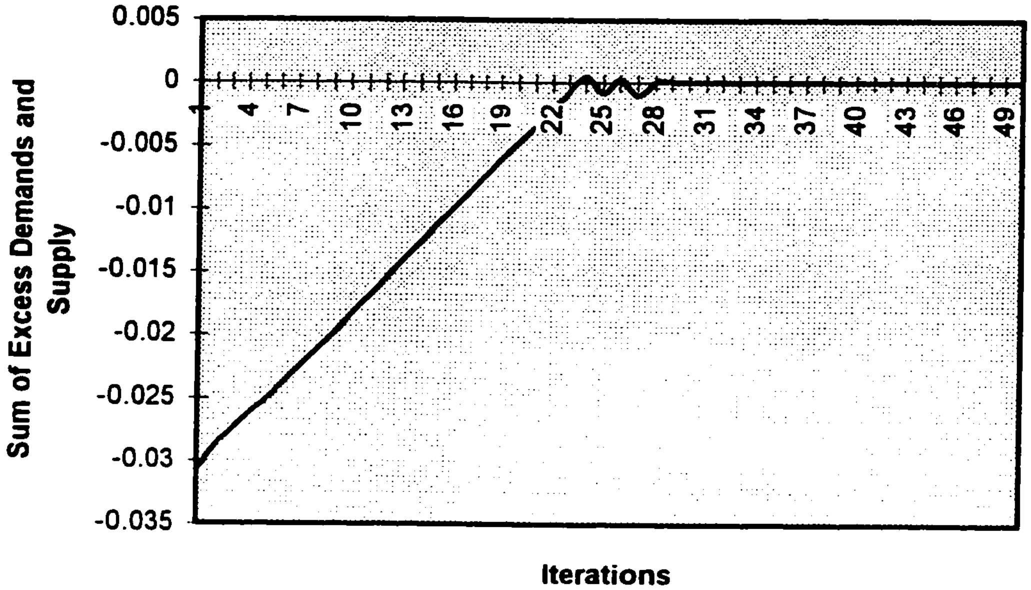


Table 4.8′

Model 4A Results

	Composite (x)	Housing (h)
Wages	0.08%	0.25%
Land Rents	0.47%	1.96%
Capital Inflow	0.49%	1.75%
Output	0.05%	0.93%
Output Price	0.00%	-0.55%

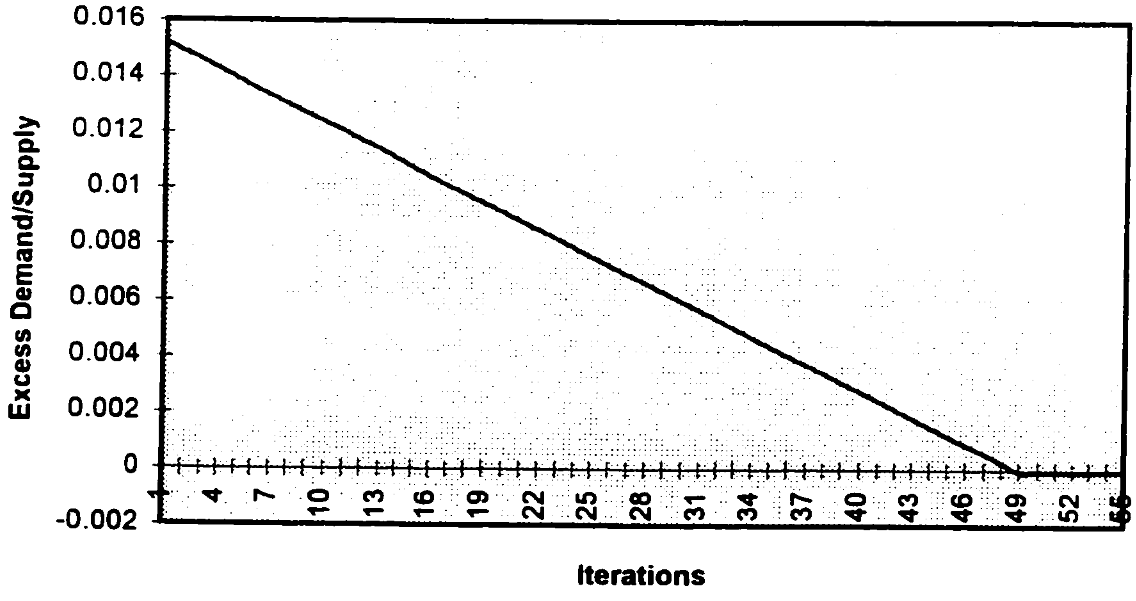
Table 4.9′

Model 4B Results

	Composite (x)	Housing (h)
Wages	0.08%	0.77%
Land Rents	0.58%	2.19%
Capital Inflow	0.58%	2.19%
Output	0.08%	1.25%
Output Price	0.00%	-0.48%

Figure 6.2 shows the iterations from Model 4B. In this model only the housing market equilibrium is obtained through iterations. The equilibrium in the composite good (x) is computed analytically. Results are based on the numbers obtained on the 49th iteration.

Figure 6.2
Housing Excess Demand/Supply vs Iterations in Model 4B



6.3 Capital Inflow to Michigan

At the onset, local capital supply increases only by the capital inflows according to Equations 4.37 and 4.39 while other endowments remain fixed. Thus, just before the first iteration, the tax reform has the potential to trigger off a 2.3 percent capital inflow in the housing industry and a 0.4 percent capital inflow into the composite good x industry due to the decrease in the property tax. This potential inflow is the amount necessary to keep the after-tax price of capital constant.

This trigger effect is subjected to iterations in order to interact it with the other input markets to see how the capital inflow is absorbed in the long run. Local production of h and x competes for resources flowing in along with other local inputs. In the first iteration, capital demand is set to equal capital supply but as iterations proceed, a disequilibrium is generated. The competition should reach an equilibrium when the sum of excess demands in all markets equals zero; that is, when all markets clear.

Equilibrium results indicate capital demand in housing services ($\hat{K}_h^{dd}$) increases by 1.97 percent (1.75 percent in Model A and 2.19 percent in Model B) and for the composite good x ($\hat{K}_x^{dd}$) it eventually increases by 0.54 percent (0.49 percent in Model A and 0.58 percent in Model B). Notice that as mentioned above, the immediate tax effect was to increase capital demand by 2.3 percent in housing and 0.4 percent in x. The conclusion is that the short run and long run capital inflows are not different. That is, the process of capital inflow stabilizes fast. The eventual average capital inflow ($\hat{K}$) in both industries increases by 1.03 percent where $\hat{k}_h$ = 1.97 percent and $\hat{k}_x$ = 0.54 percent and the weights are λ_{kx} = 0.66 and λ_{kh} = 0.34, see Equation 4.40 for $\hat{K} = \sum_i \lambda \hat{K}_i$.

Table 6.1

Summary of Capital Changes

Industry	Initial Capital (model units)	Change (based on capital demand change)
Housing	3,886,418,000	1.97%
Composite x	7,424,956,000	0.54%

6.4 Changes in Inputs Prices

Regarding labor, wages in the composite good increase by 0.08 percent (0.08 percent in Model 4A and 0.08 percent in Model 4B). Wages in the housing industry increase by 0.51 percent (0.25 percent in Model 4A and 0.77 percent in Model 4B). The statewide average increase in wages is virtually zero because 98 percent of all wages come from the composite good industry.[1] Note that there is no labor supply function in the model. Therefore, labor supply is fixed and the only adjusting parameter is the wage rate. This implies that the wage increase is biased upwards because quantity of labor does not change—an increase in the quantity of labor would offset some of the wage increase. Therefore, if quantity of labor is allowed to increase (decrease), the wages in housing relative to wages in composite x would be lower (higher). Employment in housing may however increase. Table 6.2 summarizes these results. Table 6.2 summarizes the input results according to input specificity discussed in Chapter 3.

The link between wages and the output markets is worth analyzing. Considering Equation 3.14 and the fact that initially there is no change in income, the direction of change in wages pivots around the price elasticities of h and x, and the elasticity of substitution between labor and other inputs (ψ). The lower the h and x price elasticities (h)

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[1]A weighted average gives more weight to wages in x because industry x is the

Table 6.2

Percentage Changes in Input Prices

	Regionally Mobile	Specific to Michigan
Goods-mobile	$\hat{P}_K$=0.00%	
Housing services Specific	N/A	$\hat{P}_{Nh}$=2.08% $\hat{P}_{Lh}$=0.51%
Good X Specific	N/A	$\hat{P}_{Nx}$=0.53% $\hat{P}_{Lx}$=0.08%

for a given level of factor shares (a) and the larger is the coefficient for the elasticity of substitution (y), the higher is the likelihood that wages will increase. That is, producers can pass along wage increases to consumers of x and h with little change in consumers' demand. Thus, the increase in housing services wages is high because h is relatively inelastic. In terms of Proposal A this implies that the increase in wages due to capital inflow is also capitalized—passed along—to the price of housing services. This is the essence of the excise tax effects.

Land rents in the x industry increased by an average of 0.53 percent (0.47 percent in Model 4A and 0.58 percent in Model 4B). Land rents were expected to decrease because of the reduced commercial property taxes assuming that the benefits of lower property taxes are passed along to land owners. It also implies that the capitalized value of land was expected to increase. Land rents in housing industry also increased by an average 2.08 percent (1.96 percent in Model 4A and 2.19 percent in Model 4B). An increase in land rents was expected because of the increase in demand for housing services due to lower housing prices. The adjustment mechanism in the land market is similar to that in the labor

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major employer.

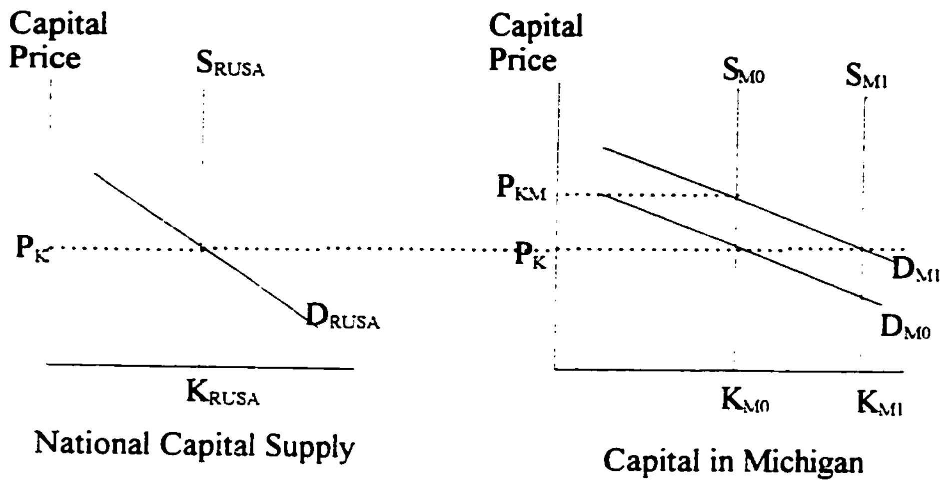
market. There is no supply function for land in both industries, implying that supply is fixed; hence, land prices, rather than quantity, are adjusted to equate land demand to supply.

This mechanism works through "excise-tax" effects. Considering the "New View" theory of property taxation, it was hypothesized that the 24 percent Michigan decrease in commercial property tax and a 64 percent decrease in residential property tax create a statewide capital inflow due to "profit-tax" and "excise-tax" effects. The "excise-tax" effects are expected to dominate—"profit-tax" effects are minimal because Michigan cannot lower the national average after-tax price of capital. As shown in Figure 6.3 below, Proposal A could not change the national after-tax price of capital (P_k). Instead, it temporarily created an after-tax price of capital differential (P_{KM} - P_K) between the return in Michigan and the average national return because after the reform, the statewide property-tax rate was 10 percent lower than the national rate. The low property tax rate increases property demand from D_{M0} to D_{M1} which increases the after-tax price of capital in the short run to P_{KM}. The capital price differential attracts capital and the supply of capital shifts from K_{M0} to K_{M1} until the capital price differential is eliminated. This capital inflow generated "excise-tax" effects. The "excise-tax" effects include changes in land and labor prices as described above because there is more capital to work with the other inputs. In addition, the housing services price also changes as some of the property-tax is capitalized into the price of housing services.

Capital in Michigan was assumed to be fully employed in equilibrium, therefore any more increase in capital demand should be met with out-of-state supply but not sectoral relocation. Inter-industry relocation has not been explicitly modeled here but it

Fig. 6.3

Initial Change in Capital Demand



cannot be ruled out as a possible cause of capital excesses and deficits.[2]

6.5 Change in Output Prices

Based on Equation 3.14, before any income effects, the price of housing services depends on the magnitude of the property-tax change (t) and the elasticity of substitution (y) between capital and other inputs, especially labor. If capital is easily substituted with labor, then labor absorbs most of the capital effects and hence they are not reflected in the product price.

In the final equilibrium, the price of housing services decreased by -0.52 percent (-0.55 percent in Model 4A and -0.48 in Model 4B). This was due to the reduction in residential property taxes. The postulation is that the decrease in property-tax is partly capitalized in property values if housing demand is elastic. Reduction in the price of housing

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[2]Morgan et al. (1989) found a high propensity for capital to relocate to housing services and agriculture whenever state and local taxes are reduced because these indus-

services increases the demand for housing. Capitalization also depends on supply elasticities. If supply is elastic, capitalization is likely to be minimal because high prices attract more housing supply. The increase in supply offsets any increase in property prices (Goodman, 1983 and Kindahl, 1983).

The capitalized value (H) of housing services is related to real estate as $H = Dp_h h - t_{hr}H$ where D is a capitalization factor and t_{hr} is the residential property tax. Property values are then $H = \frac{Dp_h h}{1+t_h}$. Assuming no change in the capitalization parameter (D), then in comparative statics terms the capitalized value of real estate changes by $\hat{H} = p_h + \hat{h} - \hat{\tau}_h =$ -0.0052 + 0.0109 -(-0.0142) = 0.0199 = 1.99 percent where 1.09 percent is the mean increase in the quantity of housing services. That is, property values increased by 1.99 percent due to the property tax reform. Table 6.3 summarizes output prices changes.

Table 6.3

Change in Output Prices

	Initial Price Level	Michigan Percentage Change
Housing Services	1.00	-0.52%
Composite (x)	1.00	0.00% (numeraire)

6.6 Change in Output Supply

The results in Table 6.4 indicate a 1.09 percent (0.93 percent in Model 4A and 1.25 percent in Model 4B) average increase in housing services, while the composite (x)

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tries are traditionally highly taxed by local governments.

increases by 0.05 percent (0.05 percent in Model 4A and 0.08 percent in Model 4B). There are no supply functions in Model 4A as constant returns conditions were assumed. Quantity as used in the model was obtained by splitting up state value added (gross state product, VA = PQ) into quantity (Q) and price (P) where a unit price was assumed. Therefore, it is necessary to reconstruct the new value added based on the new price and quantity rates of change. The rate of change in value is the sum of the rates of change in price and quantity. Thus, value added in the housing services industry increases by 0.57 percent($\hat{p} + \hat{h}$, -0.52% + 1.09% = 0.57%). Similarly, the value added of the composite good increases by ($\hat{p}_x + x$, 0.00% + 0.07% = 0.07%). Therefore, the hypothesis that there was a relative increase in housing services in gross state product (GSP) is supported. The hypothesis that there is an overall absolute increase in value added is also supported. Total output increased by 0.13 percent.[3] Table 6.4 summarizes the output results.

Table 6.4

Change in Output Supply

Industry	Initial Level ('000 model units)	Percentage Quantity	Percentage Price	Value Added
Housing Services	7,150,186	1.09%	-0.52%	0.57%
Composite x	111,677,089	0.07%	0.00%	0.07%

6.7 Income Increase

Fiscal reform should generate income from the sources and uses sides as a result of

[3]This is the weighted average of the percentage increases in output where the weights are the industry's proportion in GSP, thus 0.13% = (0.12*0.57%)+(0.88*0.07%).

input and output price changes (McLure, 1969). The sources side income is from sale of factor endowments, while uses-side income is savings from consumption expenditures. The uses side of income depends on what happens to the cost of living for each consumer group as a result of the fiscal reform. Savings from consumption are generated whenever there is a decrease in output price. There was a uses-side income increase in terms of the housing prices decrease. This is discussed below under welfare.

The sources-side income for Group 1 and Group 2 increased by 0.42 percent and 0.29 percent respectively. The difference in income increases among groups is due to differences in factor shares in personal incomes. Generally the proportion of income from land is low: 8 percent for Group 1 and 5 percent for Group 2. Therefore, changes in land rents do not generate much visible income. Most income comes from labor: 77 percent for Group 1 and 88 percent for Group 2. The 0.42 percent and 0.29 percent increase in sources income largely reflects the 0.51 percent increase in housing wages and 0.08 percent increase in x wages. Notice that capital inflow does not generate income for Michigan residents. The capital belongs to the out-of-state residents.

6.8 Welfare Changes

The optimality of any tax reform is judged by its welfare implications. The hypothesis was that this fiscal reform would hurt low-income people more because the sales tax compared to property taxes is a large portion of their expenditures. The concept of compensating variation is used to assess this assertion. Compensating variation is the income consumers need to maintain their pre-reform utility level whenever a reform changes consumer prices. When the income needed is negative, then residents are willing to pay for the reform to be adopted. If the income is positive, then residents must be paid in order to maintain their pre-reform utility levels. The latter case would constitute a loss in welfare.

Consumer prices used in this study are represented by the true-cost-of-living index for each consumer group. This index is a weighted composite of the price of x and the price of h. The weights are the proportion of income spent on each item by each consumer group, see Table 4.7.

Compensating variation (CV) is a function of income level (Y) and the cost of living price index ($\overline{P}$). Equation 6.1 below shows this relation as

$$CV = Y_{j1}(U_0, \overline{P}_1) - Y_{j0}(U_0, \overline{P}_0) = U_0(\overline{P}_1 - \overline{P}_0) \tag{6.1}$$

where $Y_j(P_n, U)$ is the minimum income required to maintain initial utility U_0 at prices P_n. Also, if an individual needed income $Y_{j0}(U, \overline{P}_0)$ in the benchmark period to obtain utility U, then the same individual will need $Y_{j1}(U, \overline{P}_1)$ after the fiscal reform to maintain that utility level.

Assuming a Cobb-Douglas utility function, the cost of living for each income group "d" is inferred from the expenditure function Equation 6.2 below:

$$Y_j = U\prod\left(\frac{P_i}{\rho_i}\right)^{\rho_i} \tag{6.2}$$

where i = x, h.

Equation 6.2 is rewritten as $Y_j = U\overline{P}$, where $\overline{P} = \prod\left(\frac{P_i}{\rho_i}\right)^{\rho_i}$ is interpreted as the true-cost-of-living or the composite price for each consumer group and it is expanded below as Equation 6.3.

$$\overline{P}_d = \left(\frac{p_x}{\rho_{dx}}\right)^{\rho_{dx}} \left(\frac{p_h}{\rho_{dh}}\right)^{\rho_{dh}} \tag{6.3}$$

The parameter r_{di} is the proportion of income spent on item i by group d in Table 4.7 reproduced here.

Table 4.7

Consumer Expenditure Shares on the Model's Sectors

Industry	**Group's ρ**	
	1	**2**
Composite(x)	0.80	0.88
Housing (h)	0.20	0.12

Thus, the rate of change in the cost of living for each income group is $\overline{P}_d = r_{xd}\ \hat{p}_x + r_{hd}\ \hat{p}_h$ and the compensating variation from Equation 6.1 is CV = Y_{d0} ($r_{dx}\ \hat{p}_x + r_{hd}\ \hat{p}_h$). The mean incomes for each income group are obtained from Table 4.3 by dividing total income for each group by the Michigan population in that group as follows:

$$Y_1 = \frac{31{,}055{,}817}{2{,}631{,}886} = \$11{,}800 \qquad Y_2 = \frac{88{,}790{,}553}{1{,}236{,}188} = \$71{,}826$$

The following compensating variations are obtained if $\hat{p}_x$ = 0.00 percent and $\hat{p}_h$ = -0.52 percent:

CV1 = 11,800 (0.80 x 0.00 + 0.20 x -0.0052) = -\$12

CV2 = 71,826 (0.88 x 0.00 + 0.12 x -0.0052) = -\$45

Overall, there is an increase in welfare from this reform. The negative CVs, -\$12 for the low income group and -\$45 for the high income group, mean that individuals were willing to pay for the reform. The high-income earners are about four times better off than the low-income earners in spite of the fact that the high income group's income is six times higher than that of the low income group. Thus, the low income group benefited relatively more than the high income group. The major reason for the overall increase in welfare is the decrease in the price of housing services and that the price of x is the numereire.

The CV measurement for the increase in welfare ignores what happens on the income side, however. The expenditure function used in computing welfare in the literature simply looks at income from the uses side. It would more appropriate to tie in the sources-side income too; that is, the change in income discussed in Section 6.7 above. Group 1 gained a 0.42 percent increase in income that is equivalent to $50 (0.0042 percent x 11,800) while Group 2's 0.29 percent increase is equivalent to $208 (0.0029 x 71,826). These sums partly add to the compensating variations (CV) gains obtained above. The $12 welfare gain for the low income group is enhanced by the $50 increase in income leading to a net $62 total gain in welfare. The high income class is also completely compensated by income increase of $208 adds to the $45 welfare gain leading to a $253 total welfare gain.

6.9 Government Budget

One of the binding constraints in the model was that government has to keep its budget at the pre-Proposal A balance throughout the tátonnement process if there is to be no change in public goods (education) provision. In the model some endogenous increases in the revenues are expected as the tax bases change. Housing services quantity (h) increased by 1.09 percent while the composite good (x) increased by 0.07 percent. The price of h decreased by -0.52 percent and the price of x increased is the numeraire. Thus the housing services tax base increased by (1.09% - 0.52% = 0.57%) while the composite (x) base increased by (0.07% + 0.00% = 0.07%).

Thus considering the effective changes, property tax revenues net decrease is -17.50 percent [that is, $\phi_{hr}(\hat{t}_{hr} + \hat{h} + \hat{p}_h) + \phi_{hk}(\hat{t}_{hk} + \hat{K} + \hat{P}_K) + \phi_{hn}(\hat{t}_{hn} + \hat{N} + \hat{P}_n) =$ 0.158 (-64% +1.09% - 0.52%) + 0.158 (-24%+1.97%) + 0.158(-24%+2.08%) = -17.50%] while sales tax increase is 17.32 percent [that is, $\phi_x(\hat{p}_x + \hat{x} + \hat{t}_x)$, 0.346(0.00% + 0.07% + 50%) =17.32%] where f_t is the proportion of the respective tax in total state tax revenues. $\hat{K}$ is the average increase in capital demand and $\hat{N}$ p_n is the average increase in land rents for h and x industries. The actual proportion for sales tax in the state budget is 0.26 percent but in the model only two tax revenue sources were considered. In addition, the budget was constrained to balance. Therefore, the sales tax proportion was first scaled to 37 percent and property taxes to 63 percent of the model government budget. However, these proportions were forced to 34.60 percent for sales and 47.40 percent for property sales to keep the government budget balanced in the model. The implications of these results are discussed in Chapter 7.

CHAPTER 7

CONCLUSIONS AND OTHER IMPLICATIONS

7.1 Introduction

This chapter links the model results to the actual state budget where it is shown that the fiscal effects are mainly in the School Aid Fund. It also compares the results to the recent developments in Michigan's economy. The obtained results are consistent with the recent developments in Michigan's economy. In addition limitations of the study are discussed, both in terms of the common problems found in computable general equilibrium analysis and in terms of the assumptions specific to this model. Extensions of the implications of the reform are also discussed. These extensions include the possibility and appropriateness of exporting the tax reform effects, and the implications of reduced federal-deductible local taxes on the tax price of local public goods.

7.2 Linking the Model Results to the Actual State Budget

The government budget in the model was constrained to balance. The budget structure from the model is somewhat different from the real Michigan's fiscal budget. First, the state residential property tax revenues are not from housing services (h) as is the case in the models but from capitalized value of housing services (H). The same applies to land (N). Second, the proportion of sales tax revenues (36%) as used in the model far exaggerates their real proportion in state budget because other revenue sources are not modeled. However, the results obtained here can still be linked to the state budget once some assumptions are relaxed.

Maintaining the model's budget at the pre-Proposal A balance depends on the exogenous tax rates and the endogenous changes in housing services h and x outputs and their prices–the effective tax bases. Considering the 1990-91 state budget in Table 6.5A in Appendix I, the -17.50 percent $(\phi_{hr}(\hat{t}_{hr}+\hat{h}+\hat{p}_h)+\phi_{hk}(\hat{t}_{hk}+\hat{K}+\hat{P}_K)+\phi_{hn}(\hat{t}_{hn}+\hat{N}+\hat{P}_n))$ effective decrease in property tax in the model is about $1,425,150,000 while a 17.32 percent $(\phi_x(\hat{p}_x+\hat{x}+\hat{t}_x))$ effective increase in sales tax is about $552,755,000.[1] Clearly, in absolute terms, the sales tax increase by itself cannot offset the decrease in property revenues. That is, using the model parameters and the actual state and local government's budget amounts, there is a financing gap of $872,395,400. Therefore, a deficit should have been expected in the state and local budgets if no consideration is given to other revenue sources. That is the assumption of having only two tax bases should be relaxed.

As shown in Table 6.6A in Appendix I, there are other tax revenue sources earmarked for schools' expenditures that were not included in the model, namely, the Housing Services Transfer Tax and the Tobacco Tax (marked *). The earmarked sources amount to about $485,000,000. After allowing for the earmarked sources in the School Aid Fund, it is likely that the deficit derived above will persist. The replacement revenue (based on the model) of about $1,037,755,000, i.e., ($552,755,000 (sales tax) + $485,000,000 (other sources)) cannot offset the lost property revenues of $1,425,150,000 per annum. A financing gap of $387,395,000 still exists. Therefore, additional funding

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[1]-17.50% multiplied by state property revenues and 17.32% multiplied by the state sales tax revenues.

other than that already earmarked, is needed for school finance. Indeed, Fisher and Wassmer (1996) mention that it is probable that there might be a General Fund annual reallocation to the Education Fund to the tune of $600 to $800 million.

Another reality is that Proposal A did not affect the entire state and local government's budget except the School Aid Fund—a major fund of the state budget. (The reform was basically a school financing reform.) This fund's expenditures increased to replace the decreased property taxes and at the same time its revenues were increased as shown in Table 6.6A largely by the increase in sales tax increase. Essentially, the government budget constraint referred to in the model is basically the School Aid Fund budget and the public good provided in the model is K-12 education.

7.3 Some Recent Developments in Michigan's Economy

The credibility of the above findings is heightened when the results are matched with the actual economic developments in Michigan after the tax reform. Some related data, such as gross state product, are not yet published and consumer price indices for Michigan are not readily available. Efforts to get housing services price indices at state level were futile. Other available data shows Michigan's economy was among the fastest-growing states and its total personal income increased by 6.8 percent in the 1994-1995 period (Survey of Current Business, May 1996). Output in the models increased by 0.13 percent and most of it biased towards housing.

According to King (1996), the housing market is Southeastern Michigan boomed in the early and mid 1990s.[2] The reasons cited included low property taxes, low interest

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[2]Michigan's property tax reform was implemented in 1994.

rates and job growth. Between 1995 and 1996 property values increased by 10.1 percent in Wayne county, by 14.2 percent in Macomb county, and by 9.2 percent in Oakland county. The average increase in the capitalized value of housing services ($\hat{H}$) from the present model is 1.99 percent. Considering the model results, roughly one quarter of the increase in property values is attributable to the property tax reform. For housing services. King(1996) says that "you are also seeing people remodel their homes or put on additions." This is a clear sign of how housing services responded to the tax stimulus.

Before 1994, Michigan's unemployment rate was above the national average. In 1994 it fell below the national average for the first time in 25 years. In addition, Michigan's population increased by 200,000 between 1990 and 1994. This is far higher than the 33,000 increase in the 1980s decade. These assessments are based on the Michigan Treasurer's Report (Roberts, 1996a, 1996b). The assumption of labor immobility across regions in the model is weakened by this observation. The state treasurer believes that the tax policy changes were responsible for the structural changes in Michigan's economy. Based on the model framework, part of the job growth constitutes the excise tax effects on labor Granted the above information, one can conclude that the results obtained herein are generally consistent with the reality.

7.4 The Tax Exporting Possibility

If the referendum to replace the lost property-tax revenue (Proposal A) had failed at the ballot, the back-up plan was to automatically adopt another legislation that called for a raise in the income tax rate from four percent to six percent, an increase in the Single Business Tax (SBT) from 2.35 percent to 2.75 percent, an increase in the cigarette tax by

15 cents, no imposition of housing service assessment cap, and a statewide property tax to be 24 mills on non-homesteads and 12 mills on homesteads.[3] Thė appropriateness of this alternative can be discussed in light of the fiscal need to reduce the above projected state budget deficit and Michigan's ability to export capital taxes.

The increase in the Single Business Tax would have been appropriate in that it could be possible to export some of the tax, assuming that the Single Business Tax is mostly a capital tax.[4] McLure (1969) discusses the circumstances under which a jurisdiction can export some of its tax burden. The most opportune circumstance is when a state is a net debtor; that is, the state uses more capital than it owns. During data construction in Chapter 4, it was discovered that indeed Michigan is a debtor state. The total value added of capital in Michigan 1990 GSP was $42 billion, of which only $18 billion was found to be from residents' ownership. The implication is that Michigan imported capital to the tune of $24 billion in the early 1990s. Michigan, therefore, has the ability to export some of its taxes by taxing capital.

Exporting taxes on the sources side is feasible if it is possible to change the price of capital; that is, if it is possible to tax capital owners. This is not possible in the present model; therefore, the benefits (burden) of Proposal A cannot be exported, nor can the benefits of low housing prices be exported from the uses side, as housing services sector are non-traded.

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[3]SBT is, in substance, a value added tax.

[4]The SBT is a tax on value added regardless of which input is used. However, Michigan SBT provisions are more favorable to labor than to capital value added.

7.5 Federal Tax-Revenue Exported and Its Local Implications

The effects of federal deductibility of local government taxes from federal income taxes have been discussed by Holtz-Eakin and Rosen (1990) and other sources therein. The focus of these studies has been the effect of local property taxes deductibility provision on the level of local tax revenues and local property tax rates. Results are still mixed. Little attention has been paid to cases where a local jurisdiction endogenously reduces the local deductible taxes as it was in Michigan's case. The following section uses Holtz-Eakin and Rosen (1990) tax price equation to show that the property tax price related to public goods in Michigan increased as a result of the fiscal reform.

If the proportion of taxpayers that itemizes is χ, then the community "tax price", P_g, of the public good is as follows:

$$P_g = U_x g(\tau_f - 1)[\chi(1-\tau_f) + (1-\chi)] \tag{7.1}$$

where U is the individuals' utility function, g is the pure public good, τ_f is the federal tax rate.

The statewide property tax reduction in Michigan reduced the amount of itemized deductions on federal individual income taxes.[5] Accordingly, Michigan's federal tax liability increased. In order to analyze the extent of this state tax revenue export, Michigan federal individual income tax data for the 1993-1994 period is used. Proposal A was implemented in 1994, thus the deductible state and local property taxes started to decline in 1994.

[5]Since local property taxes are deductible from federal taxable income if a taxpayer takes itemized deductions, any reduction in payable property taxes will reduce the itemized deductions.

Data from the Statistics of Income Bulletin (Internal Revenue Service, 1993,1994) show a decrease in Michigan itemized returns as a percentage of total Michigan federal individual income tax returns from 33 percent in 1993 and 1992 to 30 percent in 1994 as indicated in Table 7.1 below. This means that the percentage of taxpayers who took the standard deduction increased by three percentage points. State and local taxes paid decreased by $1,578,061,000 from 1993 to 1994.

Table 7.1

Trend in Michigan's Itemized Deductions ('000 dollars)

Year	Percentage Itemizing	Michigan Itemized Deductions	State/Local Taxes Paid
1992	33%	17,054,265	NA
1993	33%	18,239,320	8,351,193
1994	30%	16,493,441	6,773,132

Source: Statistics of Income: Internal Revenue Service, U. S Department of the Treasury.

This means that the statewide federal individual income tax had a potential to increase by $441,857,000 in 1994 if one assumes an individual income tax rate of 28 percent.[6] But some of this was offset by the standard deduction as shown below.

Based on Equation 7.1 the comparative static "tax price" is as follows:

$$\hat{P}_g = \hat{U}_x + \hat{g} + \frac{d\tau_f}{\tau_f - 1} - \frac{\chi d\tau_f}{1-\tau_f} + (1-\tau_f)\hat{\chi} - \hat{\chi} \qquad (7.2)$$

Assuming that there was no change in the federal marginal tax rate, marginal utility of the private good, and the provision of the local public good, then $\hat{P}_g = -\tau_f \hat{\chi}$. Considering a

[6] 28 percent of 1,578,061,000 equals 441,857,000

federal marginal tax rate of 28 percent and a decrease in the proportion of itemizers from 33 percent to 30 percent; that is, $\hat{\chi}$ = -9% then $\hat{P}_g = -\tau_f \hat{\chi} = 2.52\%$ increase in the local price of the public good due to lost deductible federal taxes.

Table 7.2 shows the actual Michigan federal income tax liability in 1993 and 1994. The individual income tax liability increased by $2,375,938,000. This 12 percent increase in the tax liability would partly be due to the increase in the tax base and the federal individual tax rate. However, only 7.5 percent of the 12 percent can be explained by the increase in the tax base—adjusted gross income (AGI). There was no significant change in individual federal income tax rates in that period. This implies that 4.5 percent (about $107 million) increase in Michigan's federal income tax liability was attributable to Proposal A in the form of lost federal tax deductions. One can safely conclude that some of the property tax revenue saved by Proposal A was exported to Washington. However, this portion of about $100 million is small when compared to the $3-4 billion net decrease in property taxes.

Table 7.2

The 1993-1994 Michigan Federal Individual Income Tax Liability

Year	Adjusted Gross Income (AGI)	Michigan Individual Federal Income Tax
1993	137,426,632,000	19,234,274,000
1994	147,738,878,000	21,610,212,000
Change	10,312,246,000	2,375,938,000
Percentage Change	7.5%	12.0%

Source: Statistics of Income: Internal Revenue Service, U. S Department of the Treasury (1993-1994)

By income class, the \$30,000-75,000 income class was affected most as far as itemized deductions are concerned. The percentage of taxpayers in this income class decreased by an average of eight percentage points from 80 percent in 1993 to 72 percent in 1994. The low income class (<\$30,000) itemizing decreased by three percentage points from 12 percent in 1993 to 9 percent in 1994. For the upper income class (>\$75,000), taxpayers itemizing decreased by one percentage point from 99 percent to 98 percent. Thus the welfare gains already discussed were partly offset by the federal income tax for the higher income class.

The appropriateness of this federal tax export to Washington D. C should be judged in light of the other benefits of Proposal A. It cannot be determined, in the present study, whether some of the above benefits of Proposal A are offset at all by the increase in the state federal taxes.

7.6 Limitations of the Results

The above conclusions should be interpreted in light of the following limitations. Some of these limitations are typical to applied general equilibrium analysis while others are specific to the present modeling.

The fact that no labor supply function was used makes the increase in wages appear higher than it should be.[7] This means that other variables related to wages, such as income, are higher than what they ought be.

Regarding the budget constraint, the property tax in the model was considered to

[7]Elasticity of labor supply can be used to find the increase in labor supply.

be replaced by the sales tax increase only. The reality is that in addition to sales taxes, the School Aid Fund was also to be financed by the new housing services 0.75 percent transfer tax, and the increased excise tax on cigarettes from $0.25 to $0.75 per pack and other earmarked sources as indicated in Table 6.6A in Appendix I. These earmarked funds are still not sufficient, as was the case prior to Proposal A, to finance all the expenditures from the School Fund.

The time frame to see these results is not easy to determine, but it is likely to be in the intermediate future (1995-1998). A dynamic analysis, which is not performed here, would be a more appropriate approach to deal with the time frame issue. In addition, dynamic analysis would be more appropriate to handle personal savings. Savings here have been treated as a consumption item. Taking the issue of savings further, the conclusions drawn on welfare should be treated with caution. Part of the composite good was savings, yet it was argued that the high income group spends 92 percent of its income on the composite good. The reality is that part of the 92 percent is saved, not consumed.

Throughout the simulation, perfectly competitive conditions were assumed to hold. This is a typical practice in applied general equilibrium. No effort has been made to control for non-competitive characteristics in either market. Market imperfections in computable general equilibrium models have been modeled before (Baldwin and Krugman, 1988; Cox and Harris, 1985; Dixit, 1984; and Smith and Venables, 1988, 1989.) In addition, the use of the Cobb-Douglas function both for the demand and supply sides is very restrictive; it limits the ability to perform sensitivity analyses with respect to various elasticities of inputs and consumption substitution.

The composite good treatment assumes that the prices of all the other goods move in the same direction and the same rate (Silberburg, 1978). There is nothing in the model to ensure that there were no relative changes in price movements for the goods in the composite good industry.

7.7 Summary and Conclusions

The goal of this study was to assess the budget and non-budget effects of a statewide fiscal reform and to put some numerical flesh to the existing general equilibrium analytical frameworks of interjurisdictional property tax incidence. The project used a computable general equilibrium model to assess the impact of the 1994 Proposal A on Michigan's economy. Specifically, a two-product, four-input, and two-consumer state general equilibrium model was constructed under perfectly competitive market assumptions. The physical endowments were assumed to be fixed except capital which flows in due to the differential between the state and national after-tax return on capital. The Cobb-Douglas function was used for both the production and utility functions. The government was assumed to remain with a balanced budget. No change in the level of public goods supply was expected either. The benchmark data were based on Michigan's 1990 gross state product (GSP).[8]

Property tax revenues were modeled using the "New View" theory of property tax incidence. Specifically, the "New View" theory of property taxation was used by partly following Henderson's (1985) analytical one industry model of property tax incidence in an a regional economy. Henderson's one industry model was modified into a multi-industry

[8] Another model (see Chapter 4 Part B) that analyzes each market in isolation was also used independently.

model in order to assess the "excise tax" effects of property tax incidence in a general equilibrium framework.

By analyzing the effects of the reform on capital, labor, land and the product market, this study provided an input to property tax reform initiatives that may be adopted in other states considering similar reforms. The benefits of Proposal A were found to be shared between capital, labor, land and consumers of housing services. Specifically, a 24 percent statewide decrease in commercial property taxes, a 64 percent decrease in residential property taxes and a concurrent two percentage point increase in the statewide sales tax, results in a 1.09 percent increase in housing services (h).[9] The increase in housing services is in the form of remodeling, extensions and making more space available for rent (King, 1996). The composite good (x) increases by 0.07 percent. That is, the quantity of goods other than housing increase by 0.07 percent in the immediate years proceeding the reform. A 2.08 percent increase in housing land rents is reflected in property values. A 0.53 percent increase in composite good land rents is also reflected in commercial property values.

A 0.51 percent increase in the housing industry wages means that a worker in the real estate industry who makes an average of $10 per hour may see a 5 cents increase per hour attributable to Proposal A. A 0.08 percent increase in the composite industry wages implies that a worker in other industries who makes $10 per hour may see 0.8 cents wage increase per hour in the ensuing years after the reform. A 1.03 percent average increase in quantity of capital inflows about 90 percent of which flows into the housing services industry. This means that value added by capital; that is, interest, dividend, and retained

[9]All the results are based on both models.

profits increased by 1.03 percent. For every $10 in interest, dividend or retained earnings, there is an increase of about 10 cents attributable to this reform. The price of the composite good x is the numeraire and the price of housing services—whose residential property tax was reduced by the fiscal reform—decreased by -0.52 percent leading to a 1.99 percent increase in capitalized values of housing. Although many other factors, such as low interest rates, and jobs growth contributed to the overall increase in property values, it is evident that two percentage points are attributable to property taxes. All these changes are basically the excise tax effects that Mieszkowski (1972) predicts in an interjurisdictional property tax change.

These results are consistent with the "New View" predictions. The "excise-tax" effects dominate the "profit tax" effect since Michigan cannot lower the national average price for capital. Instead, it is the "excise-tax" effects that cause variables such as wages, land rents and output prices, to change. Thus this study has served as an empirical test of the "New View" in a computable general equilibrium framework.[10]

After relating the model results to the actual state budget, it has been shown that there is a state government internal deficit of about $480m from the School Aid Fund in the final equilibrium. The effective increase in property tax and sales tax bases is not enough to offset the decrease in the property tax revenues. This deficit was there before the reform: the School Aid Fund had no sufficient funds to finance schools' expenditure. The replacement revenue from Proposal A is also insufficient to eliminate the School Aid Fund deficit. This financing gap is likely to be funded from other state revenues via the General Fund. Otherwise, it is also probable that this deficit might be experienced by local

[10]The "New View" has already been econometrically tested somewhere else

governments that lost their property tax sovereignty and revenues.

Notice that the city and county property tax were not affected by the reform, save the property value assessment cap introduced by the reform. Therefore, the deficit may be experienced only in school districts' jurisdictions. Experiencing fiscal distress is not surprising in such tax reforms: it happened in the case of California's Proposition 13. In California, local governments, after losing their revenues, had to make budget cuts and expand other tax bases such as the local sales tax, fees, and special property tax assessments (Reeves, January 1994; and Editors Notes, August 1994). Michigan school districts may also find themselves in such fiscal distress.

The present study suggested that including the Single Business Tax in Proposal A, as had been done in the back-up plan, could have provided additional tax revenue at no extra cost to the economy because this tax is exportable. In the data analysis, it was found that Michigan is a debtor state—it uses more capital than its residents own. McLure (1969) shows this as one of the necessary conditions for a tax jurisdiction to export taxes. which then implies that Michigan has the capability to export taxes. It is uncertain whether this strategy was given any consideration when formulating the tax reform policy. Again, as mentioned above, increasing the Single Business Tax from 2.35 percent to 2.75 percent as was planned in the legislative alternative back-up plan to Proposal A, could have been included in Proposal A with no any adverse economic effect.[11] This could have reduced the financing gap in the School Aid Fund.

The present study has also shown that there was a related $102 million increase in

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(Wassmer, 1993a)

[11]Save the political effect. The conservatives in the state legislature argued that the SBT was driving out the auto industry, the key to Michigan's economy.

Michigan residents' federal individual income tax liability in 1994 related to Proposal A. The middle income ($30,000-$75,000) group was the most affected by the reform as far as the federal individual income tax is concern. No analysis has been performed to judge the extent to which this increase in federal income liability offset the statewide property tax reform benefits.

The study showed that reducing property tax rates increased the state's aggregate individual federal income tax. Because the proportion of taxpayers who itemize on the federal returns decreased from 33 percent to 30 percent between 1993 and 1994, the community's "tax price" of public goods financed by property taxes increased by about 2.52 percent due to this reform.

Regarding welfare, low and high income earners were made better off. Welfare conclusions are also drawn after adjusting for the endogenous increase in agent's income. The hypothesis that low income earners, as it was usually discussed in the media, were made worse off by the reform is not supported. Housing services, the item on which low income earners spend a larger portion (20%) of their income than the higher income group (12%), became cheaper. The increase in income also enhanced the welfare gains. Some welfare was lost, mainly by the $30,000-$70-000 income group, due to the increase in the tax-price of property tax financed public goods. The tax-price increased because of the some lost deductible property taxes.

Recent developments in Michigan's economy have been found to be generally consistent with the findings in the model except that labor seems to be spatially mobile, not immobile across regions as was assumed in Model 4A. However, this mobility could be due to other non-tax related factors. Some studies Wilson (1985), Henderson (1985) show that mobility of labor may not be critical in determining the outcome of a property tax reform.

Finally, limitations of the study have been discussed and some conclusions, especially on welfare, should be interpreted cautiously given the aggregation of savings with the composite good. Other limitations include absence of dynamic equilibrium analysis, which makes it hard to attach a time frame as to when these results will be effective.

APPENDIX I

TABLES AND CHARTS

Table 4.1A

Michigan's 1990 Current GSP and its Components ($millions)

	Current GSP	Proprietors' Income	Capital Charges	Indirect Taxes	Compensation
Agriculture	2.381	1.814	(395)	215	747
Mining	1.237	78	705	91	362
Construction	7.114	1.388	635	92	5.000
Manufacturing	51.360	318	6.571	1.731	42.741
Transportation. Communication and Utility	13.663	493	5.577	1.207	6.386
Wholesale	12.206	307	2.138	2.070	7.691
Retail	17.213	1.286	2.363	2.690	10.873
Finance. Insurance. and Real Estate	29.830	3.575	14.324	5.906	6.025
Finance and Insurance	8.720	243	2.686	549	5.242
Real Estate	21.110	3.332	11.638	5.357	783
Services	31.914	4.324	2.794	517	24.278
Govt. less State	20.238	0	294	0	19.944
Fed govt.	2.863	0	(213)	0	3.076
State	17.375	0	507	0	16.868
Total	187.155	13.582	35.007	14.51 8	124.048

Source: U.S Department of Commerce, Bureau of Economic Analysis: Regional Economic Analysis Division (BE-61), (1994) Washington D.C.

Table 4.14A
Consumer Expenditure Shares

Consumer Good	**Consumer Groups**[1]			
	1	**2**	**3**	**4**
Food	0.24	0.16	0.13	0.09
Shelter	0.24	0.15	0.12	0.11
Utilities, fuels, and public services	0.14	0.08	0.05	0.03
Household supplies, apparel and services	0.05	0.03	0.03	0.03
Durables (furnishings and equipment)	0.04	0.03	0.04	0.03
Transportation	0.25	0.19	0.16	0.13
Reading and education	0.01	0.01	0.01	0.03
Healthcare, personal care products, services, household operations, entertainment, tobacco supplies	0.04	0.06	0.02	0.03
Cash contributions and miscellaneous	0.05	0.03	0.02	0.02
Personal insurance and pensions	0.05	0.08	0.10	0.10
Savings[2]	0.08	0.18	0.32	0.43

Source: Computed from the Survey of Consumer Expenditures 1990.

[1] Shares are over income, not expenditures, because it is assumed all income is spent. Therefore, if expenditures exceed income, the sum of shares exceeds unity. This happens for Group 1. A zero is assigned to the savings share, and the rest are scaled down by a factor their sum exceeds unity. For the rest of consumer groups, income exceeds expenditures; therefore, the sum of the respective shares is less than one. The gap is considered to be savings share.

[2] Savings are computed as gross income less annual average expenditures. Zero share for savings means negative or no savings for the respective consumer group.

Table 4.16A
Consumer Expenditure Shares

Sector	Group's ρ			
	1	2	3	4
Agricultural	0.0277	0.0183	0.0148	0.0108
Industrial	0.2995	0.2015	0.1544	0.1259
Commercial	0.5151	0.4272	0.3801	0.3369
Residential	0.0861	0.0538	0.0430	0.0394
Utilities	0.1250	0.0801	0.0612	0.0426
Government	0.0147	0.0091	0.0065	0.0045
Savings	0.0800	0.1800	0.3200	0.4300

Table 6.1

Selected Variables Vs Iterations for Model 4A*

Iter.	Govt. const.	Wagesx	Wagesh	Renth	Rentx	Khhatss	Kxhatss	phhat	px	xhatss	Hhatss
1	0.0092	0.00203	0.3223	0.09562	0.01203	0.07706	0.01384	0.00026	0.019	0	0
2	0.01605	0.00158	0.31388	0.0872	0.0236	0.06706	0.02384	-0.00383	0.019	0.01174	-0.00273
3	0.01366	0.00189	0.30577	0.07909	0.01549	0.06706	0.01384	-0.00736	0.019	0.01202	0.00165
4	0.01418	0.00145	0.29722	0.07054	0.02694	0.06706	0.02384	-0.01151	0.019	0.01066	0.00382
5	0.01196	0.00177	0.28898	0.0623	0.01871	0.06706	0.01384	-0.01509	0.019	0.01131	0.00861
6	0.01285	0.00207	0.28106	0.07438	0.01078	0.06706	0.02384	-0.01159	0.019	0.00994	0.01083
7	0.01231	0.00162	0.27268	0.066	0.0224	0.06706	0.01384	-0.01566	0.019	0.01073	0.00812
8	0.0116	0.00194	0.26461	0.05794	0.01434	0.06706	0.02384	-0.01917	0.019	0.00997	0.01143
9	0.01254	0.00149	0.2561	0.06943	0.02583	0.06706	0.01384	-0.01635	0.019	0.01003	0.01501
10	0.01218	0.00181	0.24791	0.06123	0.01764	0.06706	0.02384	-0.01992	0.019	0.00998	0.01212
11	0.01104	0.0024	0.24031	0.07363	0.0024	0.06706	0.01384	-0.01611	0.019	0.01003	0.01575
12	0.01099	0.0024	0.23271	0.06603	0.0024	0.06706	0.02384	-0.01958	0.019	0.00919	0.0111
13	0.00934	0.0024	0.22511	0.05843	0.0024	0.06706	0.01384	-0.02305	0.019	0.00952	0.01491
14	0.01105	0.0024	0.21751	0.07083	0.0024	0.06706	0.02384	-0.01957	0.019	0.00844	0.0173
15	0.00977	0.0024	0.20991	0.06323	0.0024	0.06706	0.01384	-0.02304	0.019	0.00949	0.01486
16	0.00457	0.0024	0.20231	0.0024	0.0024	0.06706	0.02384	-0.04501	0.019	0.00841	0.01725
17	0.00264	0.0024	0.19471	0.0024	0.0024	0.06706	0.01384	-0.04584	0.019	0.00686	0.03767
18	0.00111	0.0024	0.18711	0.0024	0.0024	0.06706	0.00384	-0.04667	0.019	0.00605	0.03769
19	0.00179	0.0024	0.17951	0.0024	0.0024	0.06706	0.01384	-0.04749	0.019	0.00524	0.0377
20	0.001	0.0024	0.17191	0.0024	0.0024	0.06706	0.00384	-0.04832	0.019	0.00584	0.03914
21	0.00168	0.0024	0.16431	0.0024	0.0024	0.06706	0.01384	-0.04915	0.019	0.00503	0.03916
22	0.00089	0.0024	0.15671	0.0024	0.0024	0.06706	0.00384	-0.04998	0.019	0.00564	0.04059
23	0.00158	0.0024	0.14911	0.0024	0.0024	0.06706	0.01384	-0.05081	0.019	0.00483	0.04061
24	0.00079	0.0024	0.14151	0.0024	0.0024	0.06706	0.00384	-0.05164	0.019	0.00544	0.04205
25	0.00147	0.0024	0.13391	0.0024	0.0024	0.06706	0.01384	-0.05247	0.019	0.00463	0.04206
26	0.00068	0.0024	0.12631	0.0024	0.0024	0.06706	0.00384	-0.05329	0.019	0.00523	0.0435
27	0.00136	0.0024	0.11871	0.0024	0.0024	0.06706	0.01384	-0.05412	0.019	0.00442	0.04352
28	0.00057	0.0024	0.11111	0.0024	0.0024	0.06706	0.00384	-0.05495	0.019	0.00503	0.04495
29	0.00126	0.0024	0.10351	0.0024	0.0024	0.06706	0.01384	-0.05578	0.019	0.00422	0.04497
30	0.00047	0.0024	0.09591	0.0024	0.0024	0.06706	0.00384	-0.05661	0.019	0.00483	0.0464
31	0.00115	0.0024	0.08831	0.0024	0.0024	0.06706	0.01384	-0.05744	0.019	0.00402	0.04642
32	0.00036	0.0024	0.08071	0.0024	0.0024	0.06706	0.00384	-0.05826	0.019	0.00462	0.04786
33	0.00104	0.0024	0.07311	0.0024	0.0024	0.06706	0.01384	-0.05909	0.019	0.00381	0.04788
34	0.00025	0.0024	0.06551	0.0024	0.0024	0.06706	0.00384	-0.05992	0.019	0.00442	0.04931
35	0.00093	0.0024	0.05791	0.0024	0.0024	0.06706	0.01384	-0.06075	0.019	0.00361	0.04933
36	0.00014	0.0024	0.05031	0.0024	0.0024	0.06706	0.00384	-0.06158	0.019	0.00422	0.05076
37	0.00083	0.0024	0.06271	0.0024	0.0024	0.06706	0.01384	-0.06023	0.019	0.00341	0.05078
38	0.00018	0.0024	0.05511	0.0024	0.0024	0.06706	0.00384	-0.06105	0.019	0.00428	0.05031
39	0.00086	0.0024	0.04751	0.0024	0.0024	0.06706	0.01384	-0.06188	0.019	0.00347	0.05032
40	0.00007	0.0024	0.05991	0.0024	0.0024	0.06706	0.00384	-0.06053	0.019	0.00408	0.05176
41	0.00089	0.0024	0.05231	0.0024	0.0024	0.06706	0.01384	-0.06136	0.019	0.00353	0.04986
42	0.0001	0.0024	0.06471	0.0024	0.0024	0.06706	0.00384	-0.06001	0.019	0.00414	0.0513
43	0.00093	0.0024	0.05711	0.0024	0.0024	0.06706	0.01384	-0.06084	0.019	0.0036	0.04941
44	0.00014	0.0024	0.04951	0.0024	0.0024	0.06706	0.00384	-0.06166	0.019	0.0042	0.05084
45	0.00082	0.0024	0.06191	0.0024	0.0024	0.06706	0.01384	-0.06031	0.019	0.00339	0.05086
46	0.00017	0.0024	0.05431	0.0024	0.0024	0.06706	0.00384	-0.06114	0.019	0.00427	0.05038
47	0.00086	0.0024	0.04671	0.0024	0.0024	0.06706	0.01384	-0.06197	0.019	0.00346	0.0504

See definition of variables on page 151.

Table 6.2A

Selected Variables Vs Iterations for Model 4B*

ter		Govt.	Wagesh	an h	php	Hhatss	hat	hat	Khhat
1	0.01235	0.00271	0.03314	0.01894	-0.0001	0.01894	0.00384	0.00276	0.03314
2	0.01205	0.00265	0.03281	0.01871	-0.0002	0.01881	0.00382	0.00274	0.03291
3	0.01175	0.00258	0.03247	0.01847	-0.0003	0.01867	0.0038	0.00273	0.03267
4	0.01145	0.00251	0.03214	0.01824	-0.0004	0.01854	0.00378	0.00271	0.03244
5	0.01115	0.00245	0.03181	0.01801	-0.0005	0.01841	0.00375	0.0027	0.03221
6	0.01085	0.00238	0.03147	0.01777	-0.0006	0.01827	0.00373	0.00269	0.03197
7	0.01056	0.00231	0.03114	0.01754	-0.0007	0.01814	0.00371	0.00267	0.03174
8	0.01026	0.00225	0.03081	0.01731	-0.0008	0.01801	0.00369	0.00266	0.03151
9	0.00996	0.00218	0.03047	0.01707	-0.0009	0.01787	0.00367	0.00265	0.03127
10	0.00966	0.00212	0.03014	0.01684	-0.001	0.01774	0.00365	0.00263	0.03104
11	0.00936	0.00205	0.02981	0.01661	-0.0011	0.01761	0.00363	0.00262	0.03081
12	0.00906	0.00198	0.02947	0.01637	-0.0012	0.01747	0.00361	0.0026	0.03057
13	0.00876	0.00192	0.02914	0.01614	-0.0013	0.01734	0.00359	0.00259	0.03034
14	0.00846	0.00185	0.02881	0.01591	-0.0014	0.01721	0.00357	0.00258	0.03011
15	0.00817	0.00178	0.02847	0.01567	-0.0015	0.01707	0.00355	0.00256	0.02987
16	0.00787	0.00172	0.02814	0.01544	-0.0016	0.01694	0.00352	0.00255	0.02964
17	0.00757	0.00165	0.02781	0.01521	-0.0017	0.01681	0.0035	0.00253	0.02941
18	0.00727	0.00158	0.02747	0.01497	-0.0018	0.01667	0.00348	0.00252	0.02917
19	0.00697	0.00152	0.02714	0.01474	-0.0019	0.01654	0.00346	0.00251	0.02894
20	0.00667	0.00145	0.02681	0.01451	-0.002	0.01641	0.00344	0.00249	0.02871
21	0.00637	0.00139	0.02647	0.01427	-0.0021	0.01627	0.00342	0.00248	0.02847
22	0.00608	0.00132	0.02614	0.01404	-0.0022	0.01614	0.0034	0.00247	0.02824
23	0.00578	0.00125	0.02581	0.01381	-0.0023	0.01601	0.00338	0.00245	0.02801
24	0.00548	0.00119	0.02547	0.01357	-0.0024	0.01587	0.00336	0.00244	0.02777
25	0.00518	0.00112	0.02514	0.01334	-0.0025	0.01574	0.00334	0.00242	0.02754
26	0.00488	0.00105	0.02481	0.01311	-0.0026	0.01561	0.00332	0.00241	0.02731
27	0.00458	0.00099	0.02447	0.01287	-0.0027	0.01547	0.00329	0.0024	0.02707
28	0.00428	0.00092	0.02414	0.01264	-0.0028	0.01534	0.00327	0.00238	0.02684
29	0.00399	0.00085	0.02381	0.01241	-0.0029	0.01521	0.00325	0.00237	0.02661
30	0.00369	0.00079	0.02347	0.01217	-0.003	0.01507	0.00323	0.00235	0.02637
31	0.00339	0.00072	0.02314	0.01194	-0.0031	0.01494	0.00321	0.00234	0.02614
32	0.00309	0.00066	0.02281	0.01171	-0.0032	0.01481	0.00319	0.00233	0.02591
33	0.00279	0.00059	0.02247	0.01147	-0.0033	0.01467	0.00317	0.00231	0.02567
34	0.00249	0.00052	0.02214	0.01124	-0.0034	0.01454	0.00315	0.0023	0.02544
35	0.00219	0.00046	0.02181	0.01101	-0.0035	0.01441	0.00313	0.00229	0.02521
36	0.00189	0.00039	0.02147	0.01077	-0.0036	0.01427	0.00311	0.00227	0.02497
37	0.0016	0.00032	0.02114	0.01054	-0.0037	0.01414	0.00309	0.00226	0.02474

* See definition of variables on page 151.

Table 6.5A

Michigan State and Local Government Revenues, 1990-91 ('000 Dollars)

Revenue Source		**Revenue**	**Revenue**
Intergovernmental			5,682,842
Taxes	Property	8,373 385	
	Sales	3,190,647	
	Income	5,768,083	
	Other	2,398,739	11,365,842
Current Charges			4,832,460
Miscellaneous Revenues			3,657,547
Utility Revenue			1,203,671
Liquor Store Revenue			442,668
Insurance Trust Fund			3,986,732
Employee Retirement			2,743,054
Total			33,914,816

Source: Government Finances (1990-1991): State and Local Finances

Table 6.6A

Earmarked Revenues, Michigan School Aid Fund, 1994-95 and Future

Tax	**Estimated Amount (millions of dollars) and Percentage**
Sales and Use Tax @4% (60% of Revenue)	2,080 (30.3%)
*Sales and Use Tax @2%(100% of Revenue) (Residential utilities exempt)	1,735 (25.3%)
*6 Mill State Property Tax	1,075 (15.7%)
State Personal Income Tax, earmarked portion	863 (12.6%)
*Housing services Transfer Tax (0.75%)	109 (1.6%)
*Tobacco Tax (0.75 per pack cigarettes; 16% of price for others)	376 (5.5%)
Lottery Net Revenue	457 (6.7%)
Other (excise taxes on interstate phone use, liquor, subsidized property taxes on development properties, etc.)	161(2.3%)
Exhibit:	
Local School Property Tax	2,230
State Payment from General Fund	667

Source: Fisher andWassmer (1996) " An Evaluation of the Recent Move to Centralize the Finance of Public Schools in Michigan." Forthcoming Public Budgeting and Finance (Fall 1996).

Notes:
*These are the author's. They represent the additional revenues to the School Aid Fund due Proposal A.

APPENDIX II

THE SOURCE CODES

Definition of Variables Used in the Source Code:

PK, PLX, PLH, PNX, PNH	Absolute prices of capital, labor and land in x and h industries
PNXhat, PNHhat Plxhat, Plhhat, PNhat	Comparative statics prices of land and labor in the respective industries
Plhat, PNhat	Industry input average prices
Khat	Average rate of change in capital demand
yhat, yhat1, yhat2	Average income, income for group 1 and income for group2, respectively
iter	Iterations counter
NH,NX,KX,LX,KH LH	Absolute benchmark land (L), capital(K) and labor (L) valued added in each industry;
VAXC,VAHC	Value added used to check whether the calibration equations reproduce the benchmark value added.
alphaKh α_{kh}, alphaLh α_{lh}, alphaLx α_{lx}, alphaNx α_{nx}, alphaNh α_{nh}, alphaKx α_{kh}	Proportions of inputs in the production function
delta1N (δ_{1n}), delta2N (δ_{2n}), delta1K (δ_{1k}), delta1L (δ_{1l}), delta2K (δ_{2k}), delta2L (δ_{2l})	Proportions of income from each input for each income group.
Khhatdd,Kxhatdd	Capital demand in the respective industry
h1hatdd,h2hatdd	Housing demand by each income group
Xhatss,Hhatss	Composite good and housing supply respectively
elh	Excess demand/supply in the housing market
w1,w2,w3,w4	Weights to get average wage and land rents changes
txhat	Percentage change sales tax
thhat	Percentage change residential property tax
thhatp	Percentage change commercial property taxes
taux	Infinitesimal change in sales tax
tauh	Infinitesimal change in residential property taxes
tauk	Infinitesimal change in commercial property taxes
omegx,omegh	Proportions of composite x and housing in the government tax base
eg,eg1,eg2	Temporary variables, used to shorten long equations in the code
totalk,totall,totaln	Sum of capital, labor and land from each industry
phix,phih	Technological efficiency parameter (θ) in Cobb-Douglas function for the respective industries
lambdakh,lambdakx	Proportion of capital in total Michigan capital used in each industry;

	and used to obtain the average increase in capital.
pxp,php	Prices of composite (x) and housing (h), respectively

1. MODEL A SOURCE CODE

```
/*THIS PROGRAM COMPUTES THE GENERAL EQUILIBRIUM FOR A TWO
SECTOR MODEL */
 /*Date 9/4/96 */

 #include <stdio.h>
 #include <math.h>
 #include <conio.h>
 #include <float.h>

FILE *fp;

 main(void)

        {     /*Defining Variables */

        double alphaKh, psi;
        double PK,PNX,PNH,phhat,pxhat,PNXhat,PNHhat,PLhat,yhat,yhat1, yhat2, iter;
        double NH,NX,KX,LX,KH,LH;
        double alphaLh, alphaLx,alphaNx,alphaNh,alphaKx;
        double delta1N,delta2N,delta1K,delta1L,delta2K,delta2L;
        double Nhhatss,Nxhatss,Kxhatss,Khhatss,Lhhatss,Lxhatss;/*Inputs Supply*/
        double Khhatdd,Kxhatdd,Lhhatdd,Lxhatdd,Nhhatdd,Nxhatdd;/*Inputs Demand*/
        double h1hatdd,h2hatdd,x1hatdd,x2hatdd;/*output demands*/
        double Xhatss,Hhatss; /*output supplies*/
        double ekh,ekx,elx,elh,enx,enh; /*excess demand/supplies*/
        double w1,w2,w3,w4,w5,w6;
        double txhat,tauk,taux,thhat,thhatp,tauh;/*tax parameters */
        double PLhat1,PNHhat1,PNXhat1,PLhat2,PNhat;
        double omegx,omegh,eg,eg1,eg2;
        double walras,totalk,totall,totaln;
        double phix,phih,lambdanh,lambdanx,lambdakh,lambdakx,lambdalh,lambdalx;
        double VAXC,VAHC;
        double PKhat =0,px,ph,pxp,php;
        double Khhatss1,Khhatss2,Khhatss3,Kxhatss1,Kxhatss2,Kxhatss3,Khhatss4;
        double alphatx,alphath,PLxhat,PLhhat,PLX,PLH,Khat,PN;
        double vklx,vknx,vklh,vknh;

 fp = fopen ("a:\output.new","w");

printf("This Section Calibrates the Equilibrium Benchmark Data\n\n\n");
```

```
/*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$*/
fprintf(fp,     "          BENCHMARK DATA\n");
fprintf(fp,     "          ---------------\n");


            /*all benchmark prices are initially set to one */
PLX=1.0; PLH=1.0;  PK=1.0;  PNX=1.0;   PNH=1.0; px = 1.0; ph =1.0;
fprintf(fp,"PLH= %3.3f,PLX=%3.3f;PK= %3.3f,PNX = %3.3f,PNH=%3.3f, px = %3.3f,
ph = %3.3f\n\n", PK,PLH,PLX,PNX,PNH,px,ph);

                /*Total factor endowments from Table 4.6 */

fprintf(fp,"Value Added in each sector plus indirect taxes");
fprintf(fp,"already adjusted for consistency\n\n");

KX=22404000000.0;KH=7099000000.0;
totalk = KX + KH;

LX=124048000000.0; LH=783000000.0;
totall = LX + LH;

NX=12603000000.0; NH=4539000000.0;
totaln = NX + NH;

fprintf(fp,"        Composite(x)     Housing     Total\n");
fprintf(fp,"Capital  %14.1f   %14.1f   %14.1f\n",KX,KH,totalk);
fprintf(fp,"Labor    %14.1f   %14.1f   %14.1f\n",LX,LH,totall);
fprintf(fp,"Land     %14.1f   %14.1f   %14.1f\n\n",NX,NH,totaln);

fprintf(fp,"        CALIBRATION\n");
fprintf(fp,"        -----------\n\n");

 /*Parameter evaluations */

alphaLx=(PLX*LX)/((PLX*LX)+(PK*KX)+(PNX*NX));
alphaLh=(PLH*LH)/((PLH*LH)+(PK*KH)+(PNH*NH));

alphaKx=(PK*KX)/((PLX*LX)+(PK*KX)+(PNX*NX));
alphaKh=(PK*KH)/((PLH*LH)+(PK*KH)+(PNH*NH));

alphaNx=(PNX*NX)/((PLX*LX)+(PK*KX)+(PNX*NX));
alphaNh=(PNH*NH)/((PLH*LH)+(PK*KH)+(PNH*NH));

phih=((PLH*LH)+(PK*KH)+(PNH*NH))/(pow(KH,alphaKh)*pow(LH,alphaLh)*pow(N
H,alphaNh));
```

```
phix=((PLX*LX)+(PK*KX)+(PNX*NX))/(pow(KX,alphaKx)*pow(LX,alphaLx)*pow(N
X,alphaNx));

fprintf(fp,"The Following are the Parameters Obtained from Calibration\n");
fprintf(fp,"alphaLx = %3.4f,  alphaLh= %3.4f\n", alphaLx,alphaLh);
fprintf(fp,"alphaKx= %3.4f,  alphaKh= %3.4f\n", alphaKx,alphaKh);
fprintf(fp,"alphaNx= %3.4f,  alphaNh= %3.4f\n", alphaNx,alphaNh);
fprintf(fp,"phix  = %3.4f,   phih= %3.4f\n\n\n", phix,phih);


/*Checking to see whether calibrated values reproduce benchmark data */

VAXC=phix*pow(KX,alphaKx)*pow(LX,alphaLx)*pow(NX,alphaNx);
VAHC=phih*pow(KH,alphaKh)*pow(LH,alphaLh)*pow(NH,alphaNh);

printf("VAXC=%12.0f, VAHC= %12.0f\n",VAXC, VAHC);


/*#################################################################*/
 /*Rates of change in demand for Housing (h) and Composite(x) */
 /*but one needs to calculate income and wages first */

yhat=0; /*initially there is no change in income */
yhat1=yhat; yhat2=yhat;

/*From Table 4.7a for inputs income shares*/
 //alphaKh=0.5435; alphaLh=0.1090; alphaNh=0.3475;
// alphaKx=0.0665; alphaLx=0.8961; alphaNx=0.0374;
 alphatx = 0.01; alphath = 0.15;/* (PROPORTION OF PROPERTY TAXES
ASSUMED)*/

fprintf(fp, "Property and Sales Tax Changes:\n");
tauk= -0.0050;   /*commercial property taxes */
tauh = -0.0142; /*residential property taxes */
taux = 0.0190;  /*sales tax */


fprintf(fp, "Property =%3.4f, Sales =%3.4f\n\n", tauk, taux);

PNHhat=0.0; PLhhat=0.0; PLxhat=0.0; PNXhat=0.0; PLhat=0.0;
/*Input price changes initially set to zero; that is unit absolute prices */


/*From Table 4.13b */

lambdakh=0.344;lambdakx=0.656;lambdalh=0.008;lambdalx=0.992;
```

```
lambdanh=0.373;lambdanx=0.627;


printf("Output prices\n");
/*Initially set to zero but it will adjust according to */
/* Producer price change initial set zero, therefore consumer price*/
/*increases by the tax policy change as follows in housing */

//php = (alphaKh + alphaNh)*tauh;
//pxp =(alphaKx + alphaNx)*tauk;

php=0.0;
pxp=0.0;

thhat = -0.64; /*average percentage decrease in residential property taxes */
thhatp = -0.24;
txhat = 0.50; /*percentage increase in sales tax */

iter=0.0; /*Initialize iteration counter */
psi = 1; /*Cobb-Douglas elasticity of subsitution */

fprintf(fp,"          CHANGE IN INITIAL INPUTS SUPPLY\n");
Lhhatss= 0.0; /*labor supply/in i does not change (immobile)*/
Lxhatss= 0.0; /*labor supply in x does not change (immobile)*/
Nhhatss= 0.0; /*no change in land supply either */
Nxhatss= 0.0; /*no change in land supply either */

/*no change in initial factor demands */
Lhhatdd= 0.0;
Lxhatdd= 0.0;
Nhhatdd= 0.0;
Nxhatdd= 0.0;
Khhatdd= 0.0;
Kxhatdd= 0.0;

PLhhat = (php - (alphaKh + alphaNh)*tauh )/alphaLh;
PLxhat = -((alphaKx+alphaNx)*tauk)/alphaLx;
PNHhat = (php - (alphaKh+alphaNh)*tauh)/alphaNh;
PNXhat = -((alphaKx+ alphaNx)*tauk)/alphaNx;


/*Initial capital inflow in h (Equation 4.34*/
vklh = 0.2; vknh =0.8;/*ASSUMED*/
Khhatss1 = (vklh * Lhhatdd) + (vknh * Nhhatdd);
Khhatss2 = (vknh*alphaLh*psi - alphaNh *psi*vklh)* PNHhat/alphaLh;
Khhatss3 = vklh*psi *(php - tauh)/alphaLh;
```

```
Khhatss  = Khhatss1 + Khhatss2 + Khhatss3;

/*Initial Capital inflow in x (Equaion 4.34)*/
vklx = 0.5; vknx =0.5; /*ASSUMED*/
Kxhatss1 = (vklx * Lxhatdd) + (vknx * Nxhatdd);
Kxhatss2 = (vknx*psi - vklx*psi)* PNXhat/alphaLx;
Kxhatss3 = vklx*psi*(tauk)/alphaLx;
Kxhatss = Kxhatss1 + Kxhatss2 - Kxhatss3;


fprintf(fp,"        Composite(x)  Housing \n");
fprintf(fp,"Capital    %3.3f     %3.3f   tax induced\n",Kxhatss,Khhatss);
fprintf(fp,"Labor      %3.3f     %3.3f   \n",Lxhatss,Lhhatss);
fprintf(fp,"Land       %3.3f     %3.3f   \n\n\n\n",Nxhatss,Nhhatss);

/* input prices (equations 4.25-d with PL=0*/

/* START THE ITERATION LOOP */

do {
 iter++;


/*NEW OUTPUT DEMANDS */
/*Equations 4.8 */
h1hatdd = yhat1- php;          /*housing demand by group 1*/
h2hatdd = yhat2- php;          /* "     "    "   "   */

x1hatdd = yhat1- pxp; /*demand for the composite good (x) */
x2hatdd = yhat2- pxp; /* "    "  "    "     "    */


/*NEW SUPPLY OF h AND x */
/*step-up total supply of output to equal average rate of change in demand */
/*assuming the proportion of output demanded in total output by each group */
/*is 0.5 */
//Hhatss= (h1hatdd + h2hatdd)/2;
//Xhatss= (x1hatdd + x2hatdd)/2;

//Hhatss= alphaKh*Khhatdd ;
//Xhatss= alphaKx*Kxhatdd ;

Hhatss= alphaKh*Khhatdd + alphaLh*Lhhatdd + alphaNh*Nhhatdd;
Xhatss= alphaKx*Kxhatdd + alphaLx*Lxhatdd + alphaNx*Nxhatdd;
```

```
/*NEW INPUTS DEMANDS */


/*From the new supply rates calculate derived factor demands rates */
/* (Equations 4.17-c)*/
/*alpha, beta and gamma are obtained by calibration */
/*after the first iteration, demand changes if disequilibrium exceeds a particular value*/
if (iter ==1)   Khhatdd= Hhatss -(alphaLh +
alphaNh)*(tauh)+alphaLh*PLhhat+alphaNh*(PNHhat+tauh);
if ((ekh > 0.001)&&(iter !=1)) Khhatdd= Hhatss -(alphaLh +
alphaNh)*(tauh)+alphaLh*PLhhat+alphaNh*(PNHhat+tauh);
if ((ekh <-0.001)&&(iter !=1)) Khhatdd= Hhatss -(alphaLh +
alphaNh)*(tauh)+alphaLh*PLhhat+alphaNh*(PNHhat+tauh);

if (iter ==1) Kxhatdd= Xhatss -(alphaLx +
alphaNx)*(PKhat+tauk)+alphaLx*PLxhat+alphaNx*(PNXhat+tauk);
if ((ekx > 0.001)&&(iter !=1)) Kxhatdd= Xhatss -(alphaLx +
alphaNx)*(tauk)+alphaLx*PLxhat+alphaNx*(PNXhat+tauk);
if ((ekx < -0.001)&&(iter !=1)) Kxhatdd= Xhatss -(alphaLx +
alphaNx)*(tauk)+alphaLx*PLxhat+alphaNx*(PNXhat+tauk);

if (iter ==1) Lhhatdd=Hhatss-
(alphaNh+alphaKh)*PLhhat+alphaNh*(PNHhat+tauh)+alphaKh*(PKhat+tauh);
if ((elh > 0.001)&&(iter !=1))  Lhhatdd=Hhatss-
(alphaNh+alphaKh)*PLhhat+alphaNh*(PNHhat+tauh)+alphaKh*(tauh);
if ((elh < -0.001)&&(iter !=1)) Lhhatdd=Hhatss-
(alphaNh+alphaKh)*PLhhat+alphaNh*(PNHhat+tauh)+alphaKh*(tauh);

if (iter ==1) Lxhatdd=Xhatss-
(alphaNx+alphaKx)*PLxhat+alphaNx*(PNXhat+tauk)+alphaKx*(tauk);
if ((elx > 0.001)&&(iter !=1))   Lxhatdd=Xhatss-
(alphaNx+alphaKx)*PLxhat+alphaNx*(PNXhat+tauk)+alphaKx*(tauk);
if ((elx < -0.001)&&(iter !=1))  Lxhatdd=Xhatss-
(alphaNx+alphaKx)*PLxhat+alphaNx*(PNXhat+tauk)+alphaKx*(tauk);

if (iter ==1) Nhhatdd= Hhatss -(alphaLh + alphaKh)*(PNHhat+tauh) + alphaLh*PLhhat +
alphaKh*(tauh);
if ((enh > 0.001)&&(iter !=1))  Nhhatdd= Hhatss -(alphaLh + alphaKh)*(PNHhat+tauh) +
alphaLh*PLhhat + alphaKh*(tauh);
if ((enh < -0.001)&&(iter !=1)) Nhhatdd= Hhatss -(alphaLh + alphaKh)*(PNHhat+tauh) +
alphaLh*PLhhat + alphaKh*(tauh);


if (iter ==1) Nxhatdd= Xhatss -(alphaLx + alphaKx)*(PNXhat+tauk) + alphaLx*PLxhat +
alphaKx*(tauk);
```

```
if ((enx > 0.001)&&(iter !=1)) Nxhatdd= Xhatss -(alphaLx + alphaKx)*(PNXhat+tauk) +
alphaLx*PLxhat + alphaKx*(tauk);
if ((enx < -0.001)&&(iter !=1)) Nxhatdd= Xhatss -(alphaLx + alphaKx)*(PNXhat+tauk) +
alphaLx*PLxhat + alphaKx*(tauk);

/* EXCESS DEMANDS AND PRICE ADJUSTMENTS*/

ekh = Khhatdd- Khhatss; /*Equation 4.13.0a */
        if (ekh > 0.001) Khhatss=Khhatss+ (0.001);
        if (ekh < -0.001) Khhatss=Khhatss- (0.001);

        /*the  Khhatss adjustment parameter (0.001) is arbitrary */
        /*decrease or increase capital supply (inflow)Khhatss, since capital price is fixed */


ekx = Kxhatdd- Kxhatss;
        if (ekx > 0.001)  Kxhatss = Kxhatss + (0.001);
        if (ekx < -0.001) Kxhatss = Kxhatss - (0.001);


elh = Lhhatdd- Lhhatss;
/*change PLhat so that it is not used in other equations*/

        if (elh > 0.001)  PLhat1 =PLhhat + (0.01);
        if (elh < -0.001) PLhat1 =PLhhat - (0.01);
 //     if ((elh >= -0.001)&&(elh<=0.001)) PLhat1=0.0;

/*adjust the wage instead of quantity since labor supply is fixed */
elx = Lxhatdd-Lxhatss;
        if (elx > 0.001)  PLhat2 =PLxhat+ (0.01);
        if (elx < -0.001) PLhat2 =PLxhat- (0.01);
 //     if ((elx >= -0.001)&&(elx<=0.001)) PLhat2=0.0;

/*adjust the wage instead of quantity if there is excess demand (elx)*/

PLhhat = PLhat1; /*Update the prices after iteration */
PLxhat = PLhat2;
w1=(alphaLh*0.12)/((alphaLh*0.12)+(alphaLx*0.88));/*wage weights are a*/
w2=(alphaLx*0.88)/((alphaLh*0.12)+(alphaLx*0.88));/*function of intensity*/

                                /*and share in GSP */
PLhat = (w1*PLhhat) + (w2*PLxhat);/*Mean Wage for Both Industries */


enh = Nhhatdd-  Nhhatss;
        if (enh > 0.001)  PNHhat1 = PNHhat + (0.01);
```

```
        if (enh < -0.001) PNHhat1 = PNHhat - (0.01);
        //if ((enh >= -0.001)&&(enh<=0.001)) PNHhat1=0.0;

 enx = Nxhatdd- Nxhatss;
   if (enx > 0.001)  PNXhat1 = PNXhat + (0.01);
   if (enx < -0.001) PNXhat1 = PNXhat - (0.01);
   //if ((enx >= -0.001)&&(enx<=0.001)) PNXhat1=0.0;

 /*Now income changes due to change in input prices */
 /*Income shares (pi) are:  */
 delta1L = 0.766; delta1K = 0.136; delta1N = 0.080;
 delta2L = 0.876; delta2K = 0.080; delta2N = 0.047;

/*For land income, we consider the weighted average price of land*/
w3=(alphaNh*0.12)/((alphaNh*0.12)+(alphaNx*0.88));/*land rent weights are a*/
w4=(alphaNx*0.88)/((alphaNh*0.12)+(alphaNx*0.88));/*function of intensity*/
                                                  /*and share in GSP */
PNHhat = PNHhat1;
PNXhat = PNXhat1;

PNhat= (w3*PNHhat) + (w4*PNXhat);

printf("w1=%3.5f,w2=%3.5f,w3=%3.5f,w4=%3.5f\n", w1,w2,w3,w4);

Khat = (lambdakh*Khhatss) + (lambdakx*Kxhatss);  /*average rate change in capital */

                              /*Equation .......*/

yhat1= (delta1L * PLhat) + (delta1N*PNhat);/*Equation 4.42*/
yhat2= (delta2L * PLhat) + (delta2N*PNhat); /*Michigan residents do
get any capital income from capital inflow */

yhat = (yhat1 + yhat2)/2; /* now the average rate of change in income starts to change */

/* OUTPUT DEMAND CHANGES on the next iteration BECAUSE OF A CHANGE IN
INCOME */
/*Change output prices according to Equation 4.1.1j */

/*convert update adjusting prices back before next iteration */


//phhat = yhat - Hhatss ; /*Price changes due to income impact*/
                          /*on housing demand.  No change for x*/

/*This changes output demand and hence starts off a new set of input demands*/
```

```
/*THE GOVERNMENT BUDGET CONSTRAINT */

/*Get the proportion of each revenue source in total state tax revenue */

omegx = 0.3464; omegh = 0.1580; /*These are adjusted until the budget is balanced*/
/* Government budget deficit/surplus Equation 4.38 */

eg1 = omegh*(thhatp + Khat);/*capital commercial property taxes*/

eg2 = omegh*(thhatp+ PNhat);/*land commercial property taxes*/

eg = omegx*(pxp +txhat+Xhatss)+ omegh*(thhat+ php + Hhatss)+ eg1 + eg2;

/* we cannot adjust the government deficit(surplus) (eg) constraint*/
/* instead it changes endogenously as Xhatss, phatss,php,yhat1 */

/*WALRAS CHECK */
/* Sum of the Value of Excess Demands */
/* Equation 4.13.1b */

/*Excess demand in product markets is left out */

walras = (ekx + ekh + elx + elh + enx + enh + eg)/7;

/*zero profit condition in the composite industry (Equation 4.23-b)*/
php = alphaLh*PLhhat + alphaNh*PNHhat + (alphaKh+alphaNh)*tauh;
pxp = alphaLx*PLxhat + alphaNx*PNXhat + (alphaKx+alphaNx)*tauk;

/* NORMALIZE PRICES before next iteration, or exit, where pxp is the numereire*/
php  = php - pxp;
PNXhat = PNXhat-pxp ;
PNHhat = PNHhat-pxp ;
PLhhat = PLhhat- pxp;
PLxhat = PLxhat - pxp;
pxp   = 0;

 printf("running\n");
 if (iter == 1)fprintf(fp, "    *******RESULTS**************\n\n");
 if (iter == 1)fprintf(fp, "    TRACKING SUM OF EXCESS DEMANDS/SUPPLY\n");

if (iter == 1)fprintf(fp,
"Sum,govt,Wagesx,Wagesh,Landh,php,Landx,Khhatss,Kxhatss,pxp,xhatss,Hhatss,yhat1,y
hat2,Khhatdd,Kxhatdd\n " );
fprintf(fp,"%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f
,%3.5f,%3.5f,%3.5f,%3.5f
```

```
\n",walras,eg,PLxhat,PLhhat,PNHhat,php,PNXhat,Khhatss,Kxhatss,pxp,Xhatss,Hhatss,yh
at1,yhat2, Khhatdd,Kxhatdd);

//if (iter == 1)fprintf(fp, "Sum,ekx,ekh,elh,elx,enx,enh,eg\n " );
//fprintf(fp,"%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f
\n",walras,ekx,ekh,elh,elx,enx,enh,eg);

// if (iter == 1)fprintf(fp, "sum,eg,Khat,PNhat,pxp,Xhatss,php,Hhatss,eg1,eg2\n " );
// fprintf(fp,"%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f
\n",walras,eg,Khat,PNhat,pxp,Xhatss,php,Hhatss,eg1,eg2);

//if (iter == 1)fprintf(fp, "Sum,Nxhatdd,Xhatss,PNXhat,PLxhat\n");
// fprintf(fp,"%3.5f,%3.5f,%3.5f,%3.5f,%3.5f\n",walras,Nxhatdd,Xhatss,PNXhat,PLxhat);
//if (iter == 1)fprintf(fp, "eg,pxp,txhat,Xhatss,omegh,thhat,php,Hhatss,eg1,eg2\n");
//fprintf(fp,"%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f\n",eg,pxp,t
xhat,Xhatss,omegh,thhat,php,Hhatss,eg1,eg2);

//if (iter == 1)fprintf(fp, "Sum,Lxhatdd,Lxhatdd\n");
 //fprintf(fp,"%3.5f,%3.5f,%3.5f\n",walras,Lxhatdd,Lhhatdd);

  } while
        (iter !=50); /*set number of iterations */

  printf("walras=%3.6f\n", walras);

if (fp == NULL)
        {printf("Error opening file.\n\n\n");}

        else
{
fprintf(fp,"               \n\n EXCESS DEMANDS\n");
fprintf(fp,"             Capital   Labor   Land\n");
fprintf(fp,"Housing    %3.6f    %3.6f   %3.6f\n",ekh,elh,enh);
fprintf(fp,"Composite   %3.6f    %3.6f   %3.6f\n\n",ekx,elx,enx);
fprintf(fp,"Sum of Excess Demands = %3.6f\n\n",walras);

fprintf(fp,"Government Deficit = %3.6f\n\n", eg);

fprintf(fp,"      CHANGE IN OUTPUT PRICES\n");
fprintf(fp,"Composite(x)= %3.6f, Housing = %3.6f \n\n", pxp,php);
fprintf(fp,"      CHANGE IN INPUT PRICES\n");
fprintf(fp,"Wages in x = %3.6f , Wages in h = %3.6f \n\n",PLxhat,PLhhat);
fprintf(fp,"Average Wages = %3.6f , Weight in h = %3.6f,Weight in x = %3.6f
\n\n",PLhat,w1,w2);

fprintf(fp,"Land Price in x = %3.6f , Land Price in h = %3.6f \n\n",PNXhat,PNHhat);
```

```
fprintf(fp,"       CHANGE IN CAPITAL SUPPLY\n");
fprintf(fp,"Kxhatss = %3.6f  Khhatss = %3.6f\n\n", Kxhatss, Khhatss);
fprintf(fp,"       CHANGE IN CAPITAL DEMAND\n");
fprintf(fp,"Kxhatdd = %3.6f  Khhatdd = %3.6f, Khat= %3.6f\n\n", Kxhatdd,
Khhatdd,Khat);
fprintf(fp,"       CHANGE IN INCOME \n");
fprintf(fp,"yhat1 = %3.6f  yhat2 = %3.6f  yhat = %3.6f\n\n", yhat1, yhat2,yhat);
fprintf(fp,"iterations = %3.6f \n\n", iter);
fprintf(fp,"       CHANGE IN OUPUT SUPPLY\n");
fprintf(fp,"Housing = %3.6f, Composite (x) = %3.6f \n", Hhatss, Xhatss);

 }
 fclose (fp);
return(0);
}
```

2. MODEL B SOURCE CODE

The Source Code

```
/*THIS PROGRAM COMPUTES THE GENERAL EQUILIBRIUM FOR A TWO
SECTOR MODEL */
 /*Date 9/4/96 */

 #include <stdio.h>
 #include <math.h>
 #include <conio.h>
 #include <float.h>

FILE *fp;

 main(void)

        {    /*Defining Variables */

        double PK,PNX,PNH,PNXhat,PNHhat,PLhat,yhat,yhat1, yhat2, iter;
        double NH,NX,KX,LX,KH,LH;
        double alphaKh, alphaLh, alphaLx,alphaNx,alphaNh,alphaKx;
        double delta1N,delta2N,delta1K,delta1L,delta2K,delta2L;
        double Khhatdd,Kxhatdd;/*Inputs Demand*/
        double h1hatdd,h2hatdd;/*output demands*/
        double Xhatss,Hhatss;                    /*output supplies*/
        double elh;                              /*excess demand/supplies*/
        double w1,w2,w3,w4;
```

```
double txhat,tauk,taux,thhat,thhatp,tauh;/*tax parameters */
double PNhat;
double omegx,omegh,eg,eg1,eg2;
double totalk,totall,totaln;
double phix,phih,lambdakh,lambdakx;
double VAXC,VAHC;
double pxp,php;
double PLxhat,PLhhat,PLX,PLH,Khat;


fp = fopen ("a:\output.32","w");


printf("This Section Calibrates the Equilibrium Benchmark Data\n\n\n");


/*$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$*/
fprintf(fp,     "          BENCHMARK DATA\n");
fprintf(fp,     "          ---------------\n");


                /*all benchmark prices are initially set to one */
PLX=1.0; PLH=1.0;  PK=1.0;   PNX=1.0;   PNH=1.0; pxp = 1.0; php =1.0;
fprintf(fp,"PLH= %3.3f,PLX=%3.3f;PK= %3.3f,PNX = %3.3f,PNH=%3.3f, pxp = %3.3f,
php = %3.3f\n\n", PK,PLH,PLX,PNX,PNH,pxp,php);

                        /*Total factor endowments from Table 4.6 */

fprintf(fp,"Michigan' Value Added excluding Prioprietor's Income and indirect taxes\n\n");


KX=22404000000.0;KH=7099000000.0;
totalk = KX + KH;

LX=124048000000.0; LH=783000000.0;
totall = LX + LH;

NX=12603000000.0;  NH=4539000000.0;
totaln = NX + NH;

fprintf(fp,"        Composite(x)      Housing     Total\n");
fprintf(fp,"Capital  %14.1f    %14.1f   %14.1f\n",KX,KH,totalk);
fprintf(fp,"Labor    %14.1f    %14.1f   %14.1f\n",LX,LH,totall);
fprintf(fp,"Land     %14.1f    %14.1f   %14.1f\n\n",NX,NH,totaln);
```

```
fprintf(fp,"        CALIBRATION\n");
fprintf(fp,"        -----------\n\n");

 /*Parameter evaluations */

alphaLx=(PLX*LX)/((PLX*LX)+(PK*KX)+(PNX*NX));
alphaLh=(PLH*LH)/((PLH*LH)+(PK*KH)+(PNH*NH));

alphaKx=(PK*KX)/((PLX*LX)+(PK*KX)+(PNX*NX));
alphaKh=(PK*KH)/((PLH*LH)+(PK*KH)+(PNH*NH));

alphaNx=(PNX*NX)/((PLX*LX)+(PK*KX)+(PNX*NX));
alphaNh=(PNH*NH)/((PLH*LH)+(PK*KH)+(PNH*NH));

phih=((PLH*LH)+(PK*KH)+(PNH*NH))/(pow(KH,alphaKh)*pow(LH,alphaLh)*pow(N
H,alphaNh));
phix=((PLX*LX)+(PK*KX)+(PNX*NX))/(pow(KX,alphaKx)*pow(LX,alphaLx)*pow(N
X,alphaNx));

fprintf(fp,"The Following are the Parameters Obtained from Calibration\n");
fprintf(fp,"alphaLx = %3.4f,  alphaLh= %3.4f\n", alphaLx,alphaLh);
fprintf(fp,"alphaKx= %3.4f,  alphaKh= %3.4f\n", alphaKx,alphaKh);
fprintf(fp,"alphaNx= %3.4f,  alphaNh= %3.4f\n", alphaNx,alphaNh);
fprintf(fp,"phix  = %3.4f,    phih= %3.4f\n\n\n", phix,phih);


/*Checking to see whether calibrated values reproduce benchmark data */

VAXC=phix*pow(KX,alphaKx)*pow(LX,alphaLx)*pow(NX,alphaNx);
VAHC=phih*pow(KH,alphaKh)*pow(LH,alphaLh)*pow(NH,alphaNh);

printf("VAXC=%12.0f, VAHC= %12.0f\n",VAXC, VAHC);


/*###################################################################*/
 /*Rates of change in demand for Housing (h) and Composite(x) */
/*but one needs to calculate income and wages first */

yhat=0; /*initially there is no change in income */
yhat1=yhat; yhat2=yhat;

fprintf(fp, "Property and Sales Tax Changes:\n");
tauk= -0.0050;   /*commercial property taxes */
tauh = -0.0142; /*residential property taxes */
taux = 0.0190;   /*sales tax */
```

```
fprintf(fp, "Commercial Property =%3.4f, Residential Property =%3.4f\n\n", tauk, tauh);

PNHhat=0.0; PLhhat=0.0; PLxhat=0.0; PNXhat=0.0; PLhat=0.0;
/*Input price changes initially set to zero; that is unit absolute prices */


/*From Table 4.13b */

lambdakh=0.344;lambdakx=0.656;

printf("Output prices\n");
/*Initially set to zero but it will adjust according to */
/* Producer price change initial set zero, therefore consumer price*/
/*increases by the tax policy change as follows in housing */

php=0.0;
pxp=0.0;

thhatp = -0.24;/*thhatp is the decrease in commercial p. taxes */
thhat = -0.64; /*average percentage decrease in residential property taxes */
txhat = 0.50; /*percentage increase in sales tax */

iter= 0.0; /*Initialize iteration counter */


fprintf(fp,"        CHANGE IN INITIAL INPUTS SUPPLY\n");

PLxhat = (alphaKx*tauk)/(alphaKx-1);  /*Equation 4.53 */
PNXhat = (tauk)/(alphaKx-1);;         /*Equation 4.54 */

Kxhatdd = (1/(alphaKx-1))*tauk;               /* Equation 4.52 */


fprintf(fp,"        Composite(x)  Housing \n");
fprintf(fp,"Capital     %3.3f       %3.3f  tax induced\n",Kxhatdd,Khhatdd);

Xhatss = alphaKx*Kxhatdd ;    /*NEW SUPPLY OF h, Equation 4.55 */


/* START THE ITERATION LOOP */

do {
 iter++;
```

```
Khhatdd = (1/(alphaKh - 1)) * (tauh - php); /*Equation 4.65*/
PLhhat = php + (alphaKh/(alphaKh - 1)) * (tauh - php); /*Equation 4.66*/
PNHhat =  (1 /(alphaKh - 1)) * (tauh - php); /*Equation 4.67*/


w1=(alphaLh*0.12)/((alphaLh*0.12)+(alphaLx*0.88));/*wage weights are a*/
w2=(alphaLx*0.88)/((alphaLh*0.12)+(alphaLx*0.88));/*function of intensity*/

                                    /*and share in GSP */
PLhat = (w1*PLhhat) + (w2*PLxhat);/*Mean Wage for Both Industries */


/*Now income changes due to change in input prices */
/*Income shares (delta) are:  */
delta1L = 0.766; delta1K = 0.136; delta1N = 0.080;
delta2L = 0.876; delta2K = 0.080; delta2N = 0.047;

/*For land income, we consider the weighted average price of land*/
w3=(alphaNh*0.12)/((alphaNh*0.12)+(alphaNx*0.88));/*land rent weights are a*/
w4=(alphaNx*0.88)/((alphaNh*0.12)+(alphaNx*0.88));/*function of intensity*/

                              /*and share in GSP */
PNhat= (w3*PNHhat) + (w4*PNXhat);


printf("w1=%3.5f,w2=%3.5f,w3=%3.5f,w4=%3.5f\n", w1,w2,w3,w4);
Khat = (lambdakh*Khhatdd) + (lambdakx*Kxhatdd);  /*average rate change in */
/*total capital, Equation 4.40*/

yhat1=  (delta1L * PLhat) + (delta1N*PNhat);/*Equation 4.44*/
yhat2=  (delta2L * PLhat) + (delta2N*PNhat);

yhat = (yhat1 + yhat2)/2; /* now the average rate of change in income starts to change */

/* OUTPUT DEMAND CHANGES on the next iteration BECAUSE OF A CHANGE IN
INCOME */
/*Change output prices according to Equation 4.1.1j */
/*NEW OUTPUT DEMANDS */
/*Equations 4.1.1i */
h1hatdd = yhat1- php;         /*housing demand by group 1*/
h2hatdd = yhat2- php;         /* "      "    "   "    */

Hhatss = alphaKh*Khhatdd ;    /*NEW SUPPLY OF h, Equation 12h */

elh = Hhatss - h1hatdd - h2hatdd;  /*Excess Demand/Supply */
```

```
if (elh > 0.0001)  php = php - (0.0001); /*Supply exceeds demand */
if (elh < -0.0001) php = php + (0.0001); /*Demand exceeds supply */


/*THE GOVERNMENT BUDGET CONSTRAINT */

/*Get the proportion of each revenue source in total state tax revenue */

omegx = 0.3581; omegh = 0.1643; /*These are adjusted until the budget is balanced*/
/* Government budget deficit/surplus Equation 4.12.0 */

eg1 = omegh*(thhatp + Khat);/*capital commercial property taxes*/
eg2 = omegh*(thhatp+ PNhat);/*land commercial property taxes*/
eg = omegx*(pxp +txhat+Xhatss)+ omegh*(thhat+ php + Hhatss)+ eg1 + eg2;


 printf("running\n");
 if (iter == 1)fprintf(fp, "    *******OUTPUT**************\n\n");

 if (iter == 1)fprintf(fp,
"Sum,govt,Wagesh,Landh,php,Hhatss,yhat1,yhat2,Khhatdd,Hhatss\n " );
fprintf(fp,"%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f,%3.5f
\n",elh,eg,PLhhat,PNHhat,php,Hhatss,yhat1,yhat2,Khhatdd,Hhatss);



  } while
        (iter !=55); /*set number of iterations */

  printf("walras=%3.6f\n", elh);

if (fp == NULL)
        {printf("Error opening file.\n\n\n");}

        else
{
fprintf(fp,"Government Deficit = %3.6f\n\n", eg);

fprintf(fp,"      CHANGE IN OUTPUT PRICES\n");
fprintf(fp," Housing = %3.6f \n\n", php);
fprintf(fp,"      CHANGE IN INPUT PRICES\n");
fprintf(fp,"Wages in x = %3.6f , Wages in h = %3.6f \n\n",PLxhat,PLhhat);
fprintf(fp,"Average Wages = %3.6f , Weight in h = %3.6f,Weight in x = %3.6f
\n\n",PLhat,w1,w2);
```

```
fprintf(fp,"Land Price in x = %3.6f , Land Price in h = %3.6f \n\n",PNXhat,PNHhat);
fprintf(fp,"        CHANGE IN CAPITAL DEMAND\n");
fprintf(fp,"Kxhatdd = %3.6f  Khhatdd = %3.6f, Khat= %3.6f\n\n", Kxhatdd,
Khhatdd,Khat);
fprintf(fp,"        CHANGE IN INCOME \n");
fprintf(fp,"yhat1 = %3.6f   yhat2 = %3.6f   yhat = %3.6f\n\n", yhat1, yhat2,yhat);
fprintf(fp,"iterations = %3.6f \n\n", iter);
fprintf(fp,"        CHANGE IN OUPUT SUPPLY\n");
fprintf(fp,"Housing = %3.6f, Composite (x) = %3.6f \n", Hhatss, Xhatss);

 }
 fclose (fp);
return(0);
}
```

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ABSTRACT

A COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS OF A STATEWIDE FISCAL REFORM: THE CASE OF MICHIGAN'S 1993-4 PROPERTY TAX REFORM

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Major: Economics (Public Finance)

Degree: Doctor of Philosophy

A computable general equilibrium model analyzes the tax effects of simultaneously reducing property taxes by 44 percent and increasing the rate of sales taxation from four to six percent in Michigan in 1994. The dissertation fills the void in the literature for empirical regional computable general equilibrium models. It adds some numerical flesh to the existing general equilibrium analytical frameworks by Courant (1977) Henderson (1985), McLure (1969) and Kimbell, Shih and Shulman (1979). Most analytical frameworks use the "New View" theory of property tax incidence where property taxes, in an economy with fixed capital, are "profit-taxes" on capital rather than taxes on other inputs or output. The latter are affected indirectly through "excise tax" effects.

The dissertation uses the "New View" theory in the context where one jurisdiction (Michigan) unilaterally lowers its property tax while other states hold their rates fixed. The "profits-tax" effect cannot occur in this case because Michigan is relatively a small

jurisdiction. Instead, "excise-tax" effects occur when capital flows to Michigan to keep Michigan's after-tax price of capital at par with the national price. Capital inflows are modeled as a function of input elasticities of substitution; input share proportions; and property tax differentials. Michigan's 1990 gross state product is used as the benchmark data.

Results show a 1.09 percent increase in housing services; a 0.07 percent increase in the composite good; a 2.08 percent increase in housing land rents; a 0.53 percent increase in composite good land rents; a 0.51 percent increase in the housing industry wages; a 0.08 percent increase in the composite industry wages, and a 1.03 percent average increase in quantity of capital inflows. The price of the composite good is the numereire and the price of housing services decreases by -0.52 percent. Property values increase by 2.65 percent. The effective increase in property tax and sales tax bases are not enough to offset the decrease in the property tax revenues.

Taxpayers who itemize on federal taxes decreased from 33 percent to 30 percent. This increased the community's "tax price" of public goods financed through property taxes by 2.52 percent. Overall welfare improved after the reform.

Recent developments in Michigan's economy are generally consistent with the above findings.

AUTOBIOGRAPHICAL STATEMENT

Buagu was born on April 13, 1963, in Uganda. He obtained his B.Sc. (Econ.) from Makerere University, Kampala, in 1987. In 1988 he worked as a teaching assistant for the Department of Economics at Makerere University as well as an insurance officer/economist in Uganda's civil service. After one year, he got a Fulbright Scholarship in 1989 to attend the University of Michigan at Ann Arbor where he obtained his MA (Applied Economics) in 1991. In 1992 the author was awarded a Post-baccalaureate Fellowship at Wayne State University, Detroit, to study for a Ph.D. in economics which he completed in 1997 with this dissertation. In 1994 he changed his names from Bwagu Godfrey Ndugga to Buagu Godfrey Ndugga Musazi.

Dr. Musazi taught Principles of Economics at Wayne State University and Detroit College of Business/Warren from 1993 through 1997. His research interests are in economic modeling for taxation, accounting and healthcare. He also has an interest in actuarial science. His hobbies include traveling and science projects.