# The Economic Effects of Land Value Taxation in an Urban Area With Large Lot Zoning: A Literature Review

by
Ki-Whan Choi

## 1.1 INTRODUCTION

The analysis of land value taxation (LVT) has a long history. Many classical and neoclassical economists advocated the heavy taxation of rent or land values (or the increments in land values), including Adam Smith, James Mill, John Stuart Mills, H.H. Gossen, Alfred Marshall, Leon Walras, John R. Commons, H.G. Brown, A.C. Pigou, and Harold Hotelling.[1] These classical economists recognized that, in theory, LVT, unlike other taxes, causes no distortions in economic decision-making and therefore does not lower the efficiency of a market economy. While there have been various challenges to this conclusion[2], it seems that the neutrality of LVT has been proven. Another well-known effect of LVT is the reduction in the incentive for land speculation.

There have been two types of studies for LVT. One is the type of studies that try to prove the neutrality of LVT, and the other is the type of studies that empirically tests the significance of LVT effects. Studies such as Arnott (2005) and Tideman (1999; 1982) prove the neutrality of LVT employing dynamic optimization techniques within first-best and partial equilibrium frameworks. Other studies such as Nechyba (2001) and DiMasi (1987) try to test the significance of LVT effects employing computable general equilibrium (CGE) models with no particular distortions. Unlike other studies, I study the economic, spatial, and welfare effects of LVT in second-best situations employing a spatial CGE model. In addition, I examine the distributional effects among different income groups and the dynamic aspects of LVT as well. In this paper, I try to incorporate second-best situations that include large (minimum) lot zoning (LLZ) and growth boundary. Because of the spatial and second-best features in an urban area, the present model can be categorized into an urban economic model. Several authors such as Anas (2003) and Braid (2001) developed sophisticated urban CGE models with the features of durable housing, demolition, reconstruction and the other. However, only a few among them address the issues of LVT. The papers are discussed below.

There are well-known advantages to adopting CGE models in this type of research. These include: 1) numerical representations of economic theory and intuition, 2) ability to address a broad range of policy issues, 3) ability to track the distributional consequences of policy choices across factors and locations, There are also disadvantages to the use of CGE models, particularly their complexity and data demands.

---

[1] Feder (1993), Chap. 1

[2] For details, Feder (1993) is excellent. Or look at Ladd (1998).

The contribution to the literature of this paper and further work I intend to do is the development and adoption of urban CGE models with some special characteristics that include large lot zoning, growth boundary, and/or three income groups, and/or dynamic housing capital adjustment within the context of the CGE model, and the presentation of modified effects of LVT in various situations. I consider the economic effects of LVT and/or graded property tax systems in which land is taxed higher than improvements. The main questions are as follows:

1. How does LVT (and/or any degree of graded property tax) affect economic efficiency and welfare of residents in an urban area with and without LLZ and/or with and without other realistic features such as endogenous boundaries of city and CBD and growth boundary? Can LVT be welfare reducing in any one of the various second-best situations?

2. How does LVT (and/or any degree of graded property tax) affect urban spatial structure such as city size, population density, and other spatial variables such as land value and housing service price under the settings described above?

3. Does LVT (and/or any degree of graded property tax) enhance of the welfare of poor people under the settings described above?

4. How does tax incidence change with the introduction of LVT (and/or any degree of graded property tax) under the settings described above?

In other (unpublished) work that I have completed, the computation or the assumptions about parameters for the current CGE model are made on the data with demographic, physical, economic features of the Atlanta urban area in Georgia. Based on that work, I have concluded the following; 1) LVT is neutral and efficient, 2) LVT helps to reduce the urban sprawl, 3) LVT increases the welfare of resident and particularly the welfare of 'poor income group' more than increases the welfare of 'rich income group', 4) LLZ and property tax causes the sprawl of metro city, 5) LLZ tends to increase the prices of land and housing.

## 2.1. Major Issues of LVT

I first discuss the major issues of LVT and then survey the related literature. There are two major arguments for LVT. First, tax on land value is neutral and efficient.[3] There have been long debates on this. Second, LVT is fair in the sense that landowner as an exclusive taxpayer is also the person who derives the benefits and takes the whole rents

[3] Studies about this issue are discussed in detail in the next sections.

from using land.[4] Although, as of now, most economists do not dispute that tax on land value is neutral, efficient, and fair, there have been several objections raised that need to be addressed. The objections include that LVT is not fair because it would be unfair to single out landowners for taxation[5]; LVT will have no notable effects on economic activity[6]; LVT will not yield enough revenue to finance today's government[7] because the value of all taxable land might be too low; LVT is not administratively feasible because it is not possible to empirically divide property value between land value and building value[8]. Additional interest centers on the effect of LVT on land speculation[9].

The present dissertation will address the neutrality, efficiency among the above, and the spatial aspects of LVT not shown above. The scope of literature dealing with the issues of LVT is vast. However, I restrict my attention to the literature that deals with the neutrality and efficiency, and to studies that deal with the spatial aspects of LVT. In addition, since the current dissertation adopts CGE models, I also review the literature adopting CGE models with LVT.

## 2.2. Literature adopting Non-CGE models with LVT

### 2.2.1. Literature about the neutrality of LVT

According to Tideman (1982) and Georgists' idea, the definition of LVT is a tax on the present value of all present and future rents of land. The valuation is the current, annual, perfect market rental value of the land alone, disregarding buildings and other improvements. Tideman (1999) again defines the value of land as the opportunity cost of leaving used land unused, to point out that the base of LVT must be independent of land use decision. A subsequent work, Arnott (2000) contributes to the clarification of the LVT base by distinguishing 'raw site value' from 'residual site value'. He wrote, "A pure land value tax — one which is imposed on the 'intrinsic' value of the land, independent of the developer's decision concerning the timing and density of development — is neutral. … The essential difference between raw site value and residual site value taxation should now be apparent. Post-development raw site value is unaffected by the

---

[4] George (1923), Gaffney (1973), and Harriss (1970a).
[5] Rothbard (1957)
[6] Bourassa (1990)
[7] DiMasi (1987)
[8] Anas (2003) and Mills (1998)
[9] Becker (1969), Harriss (1970b), and Brown (1927)

density of development, while in the neighborhood of the optimum post-development residual site value is increasing in the density of development. Thus, imposition of a raw site value tax has no effect on the development density condition, while imposition of a residual site value tax discourages density."

Let me discuss more about the model of Arnott (2000). He considers the model as an extension of Arnott and Lewis (1979), and starts by considering the landowner-developer's problem in the absence of taxation. An atomistic landowner owns a unit of area of undeveloped land. He must decide when to develop the land and at what density to build the structure. Once built, the structure is immutable. He makes his decision under perfect foresight. Arnott assumes for simplicity that land prior to development generates no rent. I first list the definition of each variable he adopted.

*t* time (t = 0 today)

*T* development time

*K* development density (the capital-land ratio)

*Q(K)* structure production function

*r(t)* rent per unit of structure at time t

*p* price per unit of capital

*n(t)* site rent

*V(t)* pre-development market value of (vacant) land

*P(t)* post-development property value

*S(t)* residual site value

*RS(t)* raw site value

The developer's problem in the absence of taxation is

$$\max_{T,K} \prod(T,K) = \int_{T}^{\infty} r(t)\cdot Q(K)\cdot e^{-it}\,dt - p\cdot K\cdot e^{-iT} \qquad (2\text{-}1)$$

The first-order conditions are

$$T:\quad (-r(t)\cdot Q(K) + ipK) = 0 \qquad (2\text{-}2)$$

$$K \;:\; \int_T^{\infty} r(t)\cdot Q'(K)\cdot e^{-i(t-T)}dt - p)\cdot e^{-iT} = 0 \qquad (2\text{-}3)$$

Equation (2-2) means that, with K fixed, development time should be such that the marginal benefit from postponing construction one period (the one-period opportunity cont of construction funds) equals the marginal cost (the rent forgone). Equation (2-3) means that, with T fixed, capital should be added to the land up to the point where the increase in rental revenue due to an extra unit of capital, discounted to the development time, equals the cost of the unit of capital.

To see that tax on 'raw' land value (or rent) is neutral, it is important to define several concepts as follows. First, regarding land rent, prior to development, site rent equals the market rent on vacant land. Post-development site rents equals property rent minus amortized construction cost. In this definition, the rent prior to development and that of post-development are not equal to each other. If government levies a tax on this type of base, the developer will change development time (T) and density (K) so as to maximize profits (2-1) and satisfy the equations (2-2) and (2-3) which are to be adjusted with the tax. In other words, because of the tax, marginal benefit from postponing construction one period (the one-period opportunity cost of construction funds) may be reduced when K is fixed, and the density of housing (K) may be reduced when T is fixed.

$$n(t) = \begin{Bmatrix} 0 & t < T \\ r(t)\cdot Q(K) - i\cdot p\cdot K & t > T \end{Bmatrix} \qquad (2\text{-}4)$$

Regarding the equation (2-4), predevelopment 'residual site value' is the pre-development market value of land. Regarding the equation (2-5), post-development residual site value equals property value minus depreciated structure value which was assumed to be zero. In this case as well, the same argument as the above applies.

$$S(t) = \begin{Bmatrix} V(t) & t < T \\ p(t) - p\cdot K & t > T \end{Bmatrix} \qquad (2\text{-}5)$$

Pre-development 'raw site value' is the market value of vacant land. Post-development raw site value is what the site would sell for were there structure on it even though there in fact is. Thus, the site value by this definition does not change but is constant regardless of development, so the tax on 'raw site value' is neutral because the tax payable is independent of the developer's decisions.

$$RS(t) = \begin{Bmatrix} V(t) & t < T \\ \Omega(t) = V(t) & t > T \end{Bmatrix} \qquad (2\text{-}6)$$

The neutrality and efficiency of LVT relies on the fact that the supply of land is fixed. Taxes on wages and profits distort behavior, leading to welfare losses. With land, however, the obligation to pay rent to the community ultimately falls exclusively on the owner, because the supply of land is fixed. The fixity of land supply and the resultant neutrality of LVT are guaranteed on the condition that a central government applies 'uniform' rate of payment on perfectly competitive market based rents of the land throughout the whole area of an economy.

Although the history about the effects of LVT may date back to the time of classical economists such as Adam Smith, there is a recent history of arguments about LVT until we reach the clear and reconfirmed conclusion above for the neutrality of LVT. According to Tideman (1999), some economists, including Shoup (1970), Skouras (1974), and Bentick (1982) have failed to define the base of LVT correctly, which has lead to wrong conclusions about the neutrality and efficiency of LVT. For example, Bentick (1982) claimed that taxes on the value of land distort land development decisions by advancing the time of development. According to Bentick, if the land tax depends on the current market value of the land and developers have to choose among mutually exclusive development projects with different time streams, the tax raises the carrying cost of the land and increases the attractiveness of current relative to future development. Tideman (1999) concluded that these authors have made logical errors regarding the definition of LVT base. If the value of land for tax purposes were based not on its chosen use but on its highest and best use, the LVT would not distort the timing of investment decisions. Feder (1993) in his Ph.D. dissertation also confirmed the neutrality of LVT clearly and similarly to that of Tideman (1999). Feder exposed that the Shoup (1970) model can't be interpreted as a proof of non-neutrality of LVT because, according to Feder, Shoup failed to distinguish between full development value and after-tax development value and Shoup's model was set up so that the landowner can reduce his (or her) tax by controlling development timing. Ladd (1998, chapter 2) also added a good comment on this issue, "True believers in the neutrality of the LVT argue that a tax affecting the timing of the development decision should not be called a LVT, but rather should be referred to as a tax on the present value of planned net income. In practice, the neutrality of any specific tax on land values will depend on how the tax assessors determine the value for tax purposes."

#### 2.2.2. Literature that includes study about the urban, spatial aspects of LVT

There are three notable papers in this category. Those include Bruckner (1986), Colwell and Turnbull (2003), Anas (2003). Although Anas (2003) suggests a CGE model, he raises a couple of questions about the effect of LVT rather than explains the details of his model, and so I included the review of his paper in this subsection.

Brueckner (1986) analyzed the incidence effects of LVT, employing a simple model with housing, capital and land markets and conducting comparative-statics analysis not found in the previous studies of LVT. We can discuss this more efficiently by looking at major algebraic expressions of his model. I first list the definitions of variables and parameters he adopted.

$H$ : Housing supply

$h$ : Housing supply per-acre-of-land

$p$ : Price of housing

$S$ : Improvements per acre

$r$ : Net land rent

$\tau$ : Tax rate on improvements

$\theta$ : Tax rate on land rent

$i$ : Net rental price of capital

$N$ : Capital

$L$ : Land

$\sigma$ : The elasticity of substitution between capital and land in housing production

$\mu$ : Land's factor share

Assuming that housing price (p) is fixed, the level of housing supply per acre of land is

$$H(N,L)/L \equiv H(N/L,1) \equiv h(S) \qquad (2\text{-}7)$$

Profit per acre for a housing producer operating in the tax zone is

$$\pi = p \cdot h(S) - (1+\tau) \cdot i \cdot S - (1+\theta) \cdot r \qquad (2\text{-}8)$$

First order condition to derive the maximize profit is

$$p \cdot h^{'}(S) - (1+\tau) \cdot i \qquad (2\text{-}9)$$

Maximized profit per acre of land is

$$p \cdot h(S) - (1+\tau) \cdot i \cdot S - (1+\theta) \cdot r = 0 \qquad (2\text{-}10)$$

He did comparative statics to derive the effects of LVT. By totally differentiating (2-9) and (2-10), we get the following four equations:

$$\frac{\partial S}{\partial \tau} = \frac{i}{p \cdot h^{"}} < 0 \qquad (2\text{-}11)$$

$$\frac{\partial S}{\partial \theta} = 0 \qquad (2\text{-}12)$$

$$\frac{\partial r}{\partial \tau} = \frac{-i \cdot S}{1+\theta} < 0 \qquad (2\text{-}13)$$

$$\frac{\partial r}{\partial \theta} = \frac{-r}{1+\theta} < 0 \qquad (2\text{-}14)$$

From the equation (2-11), an increase in r reduces improvements (housing) per acre. From the equation (2-12), the land tax has no impact on the level of structure. From the equation (2-13), the higher tax on structure depresses land rent. From the equation (2-14), the higher land tax lowers land rent and the higher land tax is fully capitalized, leaving $(1+\theta)\cdot r$ unchanged. To reserve the tax revenue ($(\tau \cdot i \cdot S + \theta \cdot r)$) for equal yield analyses, the derivative (change) of revenue with respect to land tax must be zero. With this condition and by total differentiating the revenue with respect to land tax rate, we get the following.

$$\frac{\partial \tau}{\partial \theta} = \frac{-r}{i \cdot S} \cdot \left(1 - \frac{(1+\theta)\cdot \tau \cdot \sigma}{(1+\tau)\cdot \mu}\right) \qquad (2\text{-}15)$$

The sign of (2-15) is ambiguous, and so a revenue-preserving change in tax rate on structure due to a change in land tax rate may require either a decrease or an increase. However, when $\sigma$ is a very small number, the sign of (2-15) is negative, while when $\sigma$ is sufficiently large, the sign of (2-15) is positive. Brueckner mentions that the negative sign would be more plausible. In addition, from the equations (2-13), (2-14), and (2-15), we find the following relationship.

$$\frac{dr}{d\theta} = \frac{\partial r}{\partial \theta} + \frac{\partial r}{\partial \tau} \cdot \frac{\partial \tau}{\partial \theta} \gtrless 0 \quad as \frac{\partial \tau}{\partial \theta} \gtrless 0 \quad (2\text{-}16)$$

The equation above tells us that when the housing price is fixed, in the plausible case ($\frac{\partial \tau}{\partial \theta} < 0$) the higher land tax causes the higher land value under the revenue reserving condition.

Until now, we have seen the results for the case of exogenous housing price. But for the case of endogenous housing price, the housing market clearing condition is added to the system above. After deriving the same derivatives with this new system, Brucekner finds that when housing demand is not elastic, graduation toward land tax depresses land value in a revenue-reserving tax system. Finally, Brucekner concludes his paper by discussing about short-run gains and losses by distance from the CBD in a metropolitan area. Here 'short-run' means that unlike 'long-run', the levels of 'S' and 'r' are frozen at their equilibrium levels, according to him. His conclusion is that in the short-run, due to land tax, the most intensively developed parcels (near central business district) suffer windfall losses in the form of higher taxes, assuming that the area near CBD has a relatively higher land value, while the least intensively developed parcels (far from central business district) benefit from windfall gains. Since his model is a partial equilibrium model, some other important features that affect the gradient of land value in an urban area are not reflected, as labor-leisure choice and, transportation costs.

Colwell and Turnbull (2003) examined the relationship between residential land use and city size, focusing on the roles of lot dimensions and the total area of land developed in the market. They studied the consequences of differential taxes on lot dimensions and their relationships with property and land taxes. Although they did not determine the effects of LVT (tax on 'raw site value') directly, their results show indirectly the effects of LVT in an urban economic feature. They distinguish 'developable land' from 'raw land'. The developable land is the land with infrastructures such as water irrigation system, but the raw land is the land without any improvements. The supply of the developable land depends on 'lot dimension'. The basic equations of their model are as follows.

m : money income,

p : price of land consumed,

r : price of housing capital,

k : housing capital applied to developable land in the form of structure,

q : land consumption,

u : utility of a household

h : housing production

y : non-housing consumption

F : Frontage

D : Depth

C : The cost of preparing a parcel of land for development

$\alpha, \beta, \delta$ : Parameters in the cost function C

$$u = u(y, k, q) \qquad (2\text{-}17)$$

$$h = h(k, q) \qquad (2\text{-}18)$$

$$C = \alpha + \beta \cdot F + \delta \cdot F \cdot D \qquad (2\text{-}19)$$

$$\{q(p,r,m); k(p,r,m); y(p,r,m)\} \equiv \arg\max\{u(y,k,q)\} s.t. m = y + rk + pq$$

$$(2\text{-}20)$$

The equations (2-17) and (2-18) are standard and general type of equations for household utility and housing production. Equation (2-19) tells us that the cost of preparing a parcel of land for development depend on the levels of frontage and the area. And equation (2-20) tells us that the demand for land, housing capital, and non-housing good are derived from the maximization of utility subject to an income constraint. And then they draw the effects of various taxes such as frontage tax, area tax, and tax on developable land from the results of comparative statics analyses after total differentiating the equations above. One relevant result to the current dissertation is that shifting from the tax on 'developable land value' to a tax on 'raw land value' leads to a lower price of developable land, greater land consumption by households, and a larger urban area. I note that since the tax on 'developable land value' is not neutral and not efficient due to the involvement of improvements, the tax on 'raw land value' should still be encouraged, nonetheless, as the tax on raw land value is neutral and efficient.

According to Anas (2003), "static models unrealistically pretend that all the land is available in the market at all points in time. To properly treat dynamics, a generalized perfect-foresight model of real estate markets solvable by simulation is presented." He constructs his model under his premises that Henry George's single tax on land is an elusive concept to implement. He argues that land is occupied by a variety of buildings or is undeveloped, and that land value is undefined since the value of land lying under buildings is difficult to estimate and does not respond to real market values. He tries to show that LVT on vacant land only among many types of land could possibly discourage an excessive use of structural capital over time by decreasing structure (plus its lot) values more than decreasing the value of vacant land. His treatment for the tax on land reminds me of the fact that LVT needs to be applied to all types of lands uniformly to keep its neutrality. His model is very complex and hard to understand[10] because it includes the choices of various housing qualities, demolition and construction costs, and housing structural density under prefect foresight dynamics with stochastic variables.

[10] As the author himself mentions in his paper, due to too much complexity, unusual function types, and stochastic features of his model, it is said that the existing urban economic society considers his model as a heterodox.

## 2.3. CGE Models that Deal with the Issues of LVT

I turn now to the literature on CGE models that study the economic efficiency and other economic effects of LVT. There are many regional CGE models and numerous national level CGE models used in the evaluation of general tax policy, however, only a few published papers that employ regional or urban CGE models consider the land value tax. The qualitative results of the studies are generally consistent with those of past theoretical studies. The major reason for developing CGE models is to overcome analytical intractability and try to employ more realistic features.

### 2.3.1. Studies with Non-Urban CGE Models

In this section I review the papers that employ non-urban and non-spatial CGE models to explore the effects of LVT. Because the models of these papers do not consider 'urban area' and do not include 'the factor of location' to explore the effects of LVT, I categorized these models as 'non-spatial and 'non-urban' CGE models. The following studies positively shows the effects of LVT under diverse CGE settings.

Follain and Tamar (1986) measured the effects of a reduction of the Jamaican income tax in favor of either a LVT or a capital value tax (CVT) using a static national level CGE model. As far as I can determine, this is the first paper using a CGE model to directly study the issues of LVT. The model consists of three production factors - land, capital, labor- an intermediate good, housing, and a non-housing composite final good. Consumers demand final goods as well as supply primary factors. Follain and Tamar assume perfect competition in factor and product markets, as most CGE models do, and analyzed both open and closed economy cases. Some major findings include the following. 1) A switch to LVT from income tax reduces the current excess burden by 36 percentage under the heaviest LVT[11] while the excess burden is increased by the same amount under the heaviest CVT. 2) Both the income tax rates and the LVT rates necessary to raise the same level of real revenue are lower in an open economy than in a closed economy. This is because the substitution from income tax to LVT in an open economy increases the supply of capital and labor. 3) Housing becomes less expensive relative to the composite non-housing good and stimulates production as the LVT increases, while CVT hurts production.

Nechyba (1998) developed a static one-sector CGE model to pursue land tax issues within the entire U.S. His paper deviates from some prior papers in that it revisits the issue of land taxation in the context of a reform package that simultaneously lowers taxes on capital in a small, open economy. His focus is on the impact of such tax reforms under various assumptions about the nature of land in production and the degree of heterogeneity of land across space. The production function consists of land and capital and has a CES functional form. Capital is assumed to be perfectly mobile while land is taken as perfectly immobile. His major findings include: 1) land taxes are more efficient than capital taxes (i.e., output is larger); 2) land values rise for many types of land under a reform policy aimed at replacing capital income taxes with taxes on land rents; 3) results critically depend on the elasticity of substitution between capital and labor; and 4) distributional consequences are not very clear and depend on the elasticity of substitution between capital and labor. His qualitative findings are consistent with most other studies.

Plassmann and Tidemann (1999) have made an initial attempt to develop a more realistic regional CGE model to explore the issues of LVT and other issues.[12] Actually, the paper suggests the desirable principles and properties that regional CGE models should have. For example, they suggest that CGE models should include at least five factors of production – land, labor, buildings, machines, and infrastructure - and be dynamic. The five factors of production differ from each other with respect to mobility and durability. However, they have yet to not apply their ideas to a real economy.

Nechyba (2001) extended his earlier work (Nechyba 1998). Extensions are made to encompass state level effects and interactions among states, by assuming that each state is a small and open economy. The general equilibrium impact of revenue neutral tax reforms that raise the tax on unimproved land rents was simulated. His major findings include: 1) the impact of such reforms varies widely across different states that face different economic conditions and that rely on different sources of current tax revenues; 2) under plausible yet conservative assumptions, reforms of tax systems toward greater taxation of land rents hold promise for substantial efficiency gains in the states, especially

[11] The heaviest LVT case means when the land portion of tax revenue occupies the 30 percentage of the whole revenue of property tax, while the heaviest CVT case means when the land portion of tax revenue occupies the 20 percentage of the whole revenue of property tax.

[12] Actually, the model can be flexibly applied to explore most public finance issues.

when states undertake such reforms unilaterally; 3) states that have relatively low initial output and make heavy use of taxes on capital are likely to benefit the most from tax reforms that increases the tax on land. One of the strengths of his study is that he assumes heterogeneity of land across the states but not within a state. In other words, the model allows for different types of land to have different expected future rents.

Tideman et al. (2002) attempted to measure the excess burden of a current U.S. tax system using a dynamic national level CGE model. His production function has three factors (land, labor, and capital) and a CES functional form. The household receives utility in a given period from three goods (private goods, public goods, and leisure). His conclusions include: 1) significant increases in the efficiency of the U.S. economy could be attained by flattening the income tax and by shifting from land and capital taxes to a land tax; 2) in the short run, the greatest increase in after-tax wages is achieved by shifting taxes from wages to land while in the long run the greatest increase in wages is achieved by shifting taxes from capital to land; 3) even if conservative estimates of parameters are used, the potential gains are estimated at 6.6 percentage of NDP (Net Domestic Product) per year and rise to 9.9 percentage of NDP per year after 30 years.

While the models reviewed in this section show the economic effects of LVT conspicuously, the urban CGE models discussed next enrich the literature in different ways. The urban CGE models can reflect migration, transportation costs, zoning regulations, and housing characteristics more meaningfully, which might add realism. However, due to relatively more complexities of urban CGE models, it is difficult to solve them and difficult to include many sectors in a model.

### 2.3.2. Studies with Urban CGE Models

DiMasi (1987) generalized and extended the long-run analysis of Brueckner (1986) through the use of an urban spatial general equilibrium model with an endogenous amount of land in urban use. Because his model is the closest to the basic model I developed, I review it in detail. Although the study was published in 1987, DiMasi's model is still unique in two respects. First, it is an urban spatial general equilibrium model. There have been many CGE models or simple urban general equilibrium models constructed, but relatively few spatial and urban CGE models that consider LVT. Second, it explores the effects of site value tax in an urban area. Existing land tax literature has addressed issues by and large in partial equilibrium frameworks and, except for those discussed above, rarely in CGE models. Until DiMasi, 'space' was not incorporated in models designed to measure the effects of LVT.

Basically, DiMasi's model is a mono-centric model of spatial location in an urban area. The urban area consists of a set of concentric rings, the first being relatively large and meant to encompass a CBD (Central Business District) and the rest being of equal thickness. There are three sectors: industry, residence, and agriculture. The industrial sector produces a composite non-housing good while the residential sector produces housing services. The rent on agricultural land and the price of the agricultural product are exogenously given. The assumed economic activities include production, consumption, renting of lands, and taxation. The price of the non-housing good is exogenously given because an urban economy is small enough so that a national market sets the price. The urban area contains a fixed population of identical households with identical preferences and labor skills. He adopted 'non-nested' CES (Constant Elasticity of Substitution) functional forms for production and utility functions. And he tried to calibrate parameters using data for the Boston area.

Table 2-1 presents information about tax rates on land and capital, tax bases, and differential land rent[13] for both his base case and the optimal case. The optimal case is the case of a graded property tax system that gives maximum welfare to residents. We see that there is a difference between land in residential use and land in industrial use regarding 'effective' tax rates in Boston. The difference is given from the benchmark (base case). We also see that compared with the base case, in the optimal case, wage increases, tax on land increases, tax on capital decreases, land tax base decreases, but capital tax base increases. The graded property tax stimulates the demand for labor and results in increased wage, too. In other words, to provide a maximum welfare to residents, the tax on land should increase considerably while the tax on capital should decrease.

His results (table 2-2) imply that there are considerable incentive effects of a site value tax. In other words, when a local government adopts the graded property tax system in which land is taxed higher than improvements, land and housing prices fall while improvement per unit of land in housing and population density rise. And also the boundary of city contracted due to the graduation of property tax. Thus, the welfare gain of residents for a metropolitan-wide move to the graded tax system was found to be 6.6 percent of the tax revenues raised. For the measures of welfare changes, compensating and equivalent variation measures were adopted. He included the change in differential land rents created by moving from a general property tax system to the graded property tax system in the overall welfare measures, which according to the author, generated greater household welfare. In addition, the results show that the graded property tax suppresses urban expansion. Sensitivity analyses were conducted to explore robustness of the conclusions.

---

[13] Differential land rent means the difference between actual land rents in the urban area and what they would be if all land in urban use were rented to the agricultural sector.

*TABLE 2-1 Wage Rate, Tax Rates, and Some Outcomes (DiMasi)*

| | Base Case | Optimal Case |
|---|---|---|
| Wage rate ($/hr) | 7.18 | 7.21 |
| Effective tax rate on land in residential use (%) | 24.7 | 67.9 |
| Effective tax rate on capital in residential use (%) | 24.7 | 22.6 |
| Effective tax rate on land in industrial use (%) | 33.9 | 93.3 |
| Effective tax rate on capital in industrial use (%) | 33.9 | 31.1 |
| Residential land tax base ($) | 288,161,000 | 220,360,000 |
| Residential capital tax base ($) | 3,735,646,000 | 3,798,084,000 |
| Industrial land tax base ($) | 72,725,000 | 50,502,000 |
| Industrial capital tax base ($) | 2,005,493,000 | 2,062,411,000 |
| Non-housing good industry bid land rent ($) | 12,052 | 8,369 |
| Differential land rent ($) | 262,843,000 | 187,206,000 |

*TABLE 2-2 Comparisons of base case and optimal case(DiMasi)*

| Ring | Population Density(Households per acre of land) | | K/L rations for housing(Units of capital per acre of land) | | Housing service Prices(Dollars per unit of housing services per year | | Housing Land Rent(Dollars per acre per year) | |
|---|---|---|---|---|---|---|---|---|
| | Base | Optimal | Base | Optimal | Base | Optimal | Base | Optimal |
| 1 | 0 | 0 | 0 | 0 | 6523 | 6444 | 6794 | 5250 |
| 2 | 20.9 | 21.48 | 586.97 | 612.27 | 6517 | 6439 | 6719 | 5193 |
| 12 | 17.65 | 18.17 | 494.02 | 516.28 | 6404 | 6327 | 5339 | 4136 |
| 22 | 14.72 | 15.19 | 410.94 | 430.38 | 6292 | 6215 | 4177 | 3245 |
| 32 | 12.12 | 12.54 | 337.4 | 354.12 | 6180 | 6105 | 3210 | 2502 |
| 42 | 9.83 | 10.19 | 272.64 | 287.04 | 6069 | 5995 | 2417 | 1891 |
| 52 | 7.83 | 8.15 | 216.49 | 228.67 | 5959 | 5887 | 1777 | 1397 |
| 62 | 6.1 | 6.38 | 168.34 | 178.5 | 5850 | 5778 | 1271 | 1004 |
| 72 | 4.64 | 4.87 | 127.65 | 136 | 5742 | 5671 | 879 | 699 |
| 82 | 3.43 | 3.62 | 93.93 | 100.63 | 5634 | 5565 | 584 | 468 |
| 87 | 2.91 | | 79.49 | | 5581 | | 467 | |

There are two other papers that are similar to DiMasi in the structure of their model, although the two papers do not directly explore the effects of LVT but indirectly captures the efficiency of LVT. Sullivan (1985) analyzed the incidence and excess burden of residential property tax in an urban CGE framework. Because a land tax is non-distortionary, Sullivan takes the approach of measuring incidence effects and excess burden when an urban economy switches from a pure LVT to the property tax. While DiMasi's model assumes a small and closed city in the sense that population is fixed, Sullivan's model assumes a small and open city in the sense that population is not fixed and households are fully mobile within and between rings. So, both the labor supply and the labor demand are variable in Sullivan's model. Sullivan conducts the same analyses again under the setting that there are three cities with the same structure in a closed region. Another difference of Sullivan's model is that it employs a Cobb-Douglas function in the household's utility while DiMasi's model employs a CES function. The other characteristics of the model are basically the same as those for DiMasi. Sullivan's model is not stylized to fit a particular city, so the data for the model is chosen artificially.

The major findings of Sullivan for the simple open city case in which the emigrants simply disappear into the rest of the world when there is an incentive to do so include: the property tax reduces the aggregate labor supply causing the city's wages and population to decrease; since the city is open and labor is fully mobile between cities, landowners bear the entire burden of both the property tax and the land tax; the property tax reduces the net return on land by an amount equal to 164.9 percent of the total tax revenue, so landowners are worse off with the adoption of property tax. On the other hand, the major findings of the study for the case of three cities in a closed region include: the other two cities that employ the non-distortionary land tax grow at the expense of the city that switched into the property tax; housing prices increase everywhere, with the largest increase in the city that employs the property tax; the welfare loss of regional residents totals 100.1 percent of the city's property tax revenue; the net return of landowners in the city that employs the property tax decreases by 2.2 percent, while the net returns on landowners in the other cities that employ the land tax increase by 2.99 percent; in the aggregate, the property tax generate an excess burden equal to 6.5 percent of the city's property tax revenue.

According to Altmann (1981), the case in which adopting Cobb Douglas production or utility function is adopted produces greatly different results from the case with a CES (Constant Elasticity of Substitution) production or utility function, even though there is no qualitative difference between the two cases. So, the estimation of the excess burden in Sullivan's model, which uses Cobb Douglas functions needs to be redone using CES functions.

Sullivan (1984) is almost the same as his later article (Sullivan 1985) in model structure and research questions. The differences are: Sullivan (1984) measures the incidence effects and excess burden of the 'industrial property tax' in that taxes are levied on capital and land in the industrial sector only; the production factors of the industrial sector include equipment capital in addition to structural capital, land, and labor; taxes are levied on the land and the structural capital. But the model does not properly reflect differences between the two types of capitals with respect to durability and mobility because the model is static and the characteristics of durability and mobility can be properly reflected only in a dynamic setting. The results are consistent with his other work (Sullivan, 1985). The urban CGE models described above shows the efficiency effects of LVT in an urban area clearly.

The present study is different from the previous research in the following ways. First, I consider a model in which there exists Large Lot Zoning in some of the suburban areas, which distorts the effects of LVT. Second, by adopting three income groups (rich, middle, and poor) in the model, the distributional effects of policy changes can be captured. Third, I assume that all households are landowners while the studies above assume absentee landowners. Fourth, I consider a case with a growth boundary by which the boundaries of both city and CBD are fixed. Fifth, I consider a dynamic adjustment process of housing capital to see the dynamic changes of spatial variables.

## References

Altmann, J. L. 1981. Analysis and comparison of the Mills-Muth urban residential land-use simulation models. Journal of Urban Economics, 9(3): 365.

Anas, A. 2003. Taxes on Buildings and Land in a Dynamic Model of Real Estate Markets. In N. Dick (Ed.), The Property Tax, Land Use and Land Use Regulation. Cambrideg: Edward Elgar in association with Licoln Institute of Land Policy.

ARC(Atlanta Regional Commission). 2004. Atlanta Region Transportation Planning: Fact Book 2004.

Arnott, R. 1979. Optimal city size in a spatial economy. Journal of Urban Economics, 6(1): 65.

Arnott, R., Braid, R., Davidson, R., & Pines, D. 1999. A general equilibrium spatial model of housing quality and quantity. Regional Science and Urban Economics, 29(3): 283.

Arnott, R. 2005. Neutral Property Taxation, Journal of Public Economic Theory, Vol. 7: 27: Blackwell Publishing Limited.

Arnott, R. J. & MacKinnon, J. G. 1977. The effects of the property tax: A general equilibrium simulation. Journal of Urban Economics, 4(4): 389.

Arnott, R. J. & Lewis, F. D. 1979. The Transition of Land to Urban Use. Journal of Political Economy, 87: 161-169.

Ballard, C. L., Fullerton, D., Shoven, J. B., & Whalley, J. 1985. A General Equilibrium Model for Tax Policy Evaluation: The University of Chicago Press.

Ballard, C. L., Shoven, J. B., & Whalley, J. 1985. THE TOTAL WELFARE COST OF THE UNITED STATES TAX SYSTEM: A GENERAL EQUILIBRIUM APPROACH, National Tax Journal, Vol. 38: National Tax Association.

Bentick, B., L. 1979. The Impact of Taxation and Valuation Pratices on the Timing and Efficiency of Land Use. Journal of Political Economy, 87: 859-868.

Bentick, B. L. 1982a. REPLY TO TIDEMAN, National Tax Journal, Vol. 35: National Tax Association.

Bentick, B. L. 1982b. A TAX ON LAND VALUE MAY NOT BE NEUTRAL, National Tax Journal, Vol. 35: National Tax Association.

Bentick, B. L. & Pogue, T. F. 1988. The Impact on Development Timing of Property and Profit Taxation, Land Economics, Vol. 64: 317: University of Wisconsin Press.

Bentick, B. L. 1996. The Differential Incidence of an Urban Land Tax Depends on the Travel Intensities of Substitutes for Land, Urban Studies, Vol. 33: 1729: The Editors of Urban Studies.

Bentick, B. L. 1997. The Economic Effects (Neutrality) of Taxes on Land: They Depend Neither on Non Pecuniary Returns Nor on Capital Market Imperfections, American Journal of Economics & Sociology, Vol. 56: 369: Blackwell Publishing Limited.

Braid, R. M. 1988. Uniform spatial growth with perfect foresight and durable housing. Journal of Urban Economics, 23(1): 41.

Braid, R. M. 1991. Residential spatial growth with perfect foresight and multiple income groups. Journal of Urban Economics, 30(3): 385.

Braid, R. M. 2000. A Spatial Model of Tax Competition with Multiple Tax Instruments. Journal of Urban Economics, 47(1): 88.

Braid, R. M. 2001. Spatial Growth and Redevelopment with Perfect Foresight and Durable Housing. Journal of Urban Economics, 49(3): 425.

Braid, R. M. 2002. The Spatial Effects of Wage or Property Tax Differentials, and Local Government Choice between Tax Instruments. Journal of Urban Economics, 51(3): 429.

Braid, R. M. 2003. A three-input model of the spatial effects of a central-city wage tax. Journal of Urban Economics, 54(1): 89.

Brueckner, J. K. 1986. A MODERN ANALYSIS OF THE EFFECTS OF SITE VALUE TAXATION, National Tax Journal, Vol. 39: 49: National Tax Association.

Brueckner, J. K. 1987. The Structure of Urban Equilibria: a Unified Treatment of the Muth-Mills Models. In E. S. Mills (Ed.), Handbook of Regional and Urban Economics, Vol. 2: Elsevier Science Publishers B.V.

Brueckner, J. K. 1990. Growth Controls and Land Values in an Open City, Land Economics, Vol. 66: 237: University of Wisconsin Press.

Brueckner, J. K. 1996. Welfare gains from removing land-use distortions: An, Journal of Regional Science, Vol. 36: 91: Blackwell Publishing Limited.

Bullard, R. D., Johnson, G. S., & Torres, A. O. 2000. Sprawl City: Race, Politics, and Planning in Atlanta: Island Press.

Bureau of Labor Statistics. America Time Use Survey, Summary Table 2-A. Number of persons and average hours per day by detailed activity classification, 2003 annual averages, unpublished.

Bureau of Transportation Statistics; Your driving costs; www.bts.dot.gov/publications/national_ transportation_statistics/2004/excel/table_03_14.xls.

Bureau of U.S.Census. American Housing Survey.

Carmean, P. A. 1980. Site Value Taxation. Chicago: International Association of Assessing Officers.

Chris Chung and Georgia MLS; http://www.atlantamls.com/.

Clark, G. & Jamelske, E. 2005. The efficiency gains from site value taxes: the Tithe Commutation Act of 1836, Explorations in Economic History, Vol. 42: 282.

Colwell, P. F. & Turnbull, G. K. 2003. Frontage tax and the optimally compact city. In N. Dick (Ed.), The Property Tax, Land Use, and Land Use Regulation. Cambridge(MA): Edward Elgar, in association with Lincoln Institute of Land Policy.

Conder, S.; Residential Lot Values and the Capital-Land Substitution Parameter – Some Recent Results from the Portland Metro Area; http://www.metro-region.org/library_docs/maps_data/capital-land_substitution1998.pdf.

Condon, T., Dahl, H. & Devarajan, S. 1987. Implementing a Computable General Equilibrium Model in GAMS: The Careroon Model: Development Research Department, Economics and Research Staff, World Bank.

Cord, S. 1973. How Land Value Taxation Would Effect Homeowners, American Journal of Economics & Sociology, Vol. 32: 153: Blackwell Publishing Limited.

Crebtegny, L., Horridge, K., Pearson, K., & Rutherford, T. 2004. Solving MPSGE Models Using GEMPACK.

Diewert, W. E. 1984. The Measurement of Deadweight Loss in an Open Economy, Economica, Vol. 51: 23: Blackwell Publishing Limited.

DiMasi, J. 1984. The Welfare Effects of Property Tax Classification in an Urban Area: a General Equilibrium Computational Approach. Boston College.

DiMasi, J. A. 1987. THE EFFECTS OF SITE VALUE TAXATION IN AN URBAN AREA: A GENERAL EQUILIBRIUM COMPUTATIONAL APPROACH, National Tax Journal, Vol. 40: 577: National Tax Association.

DiMasi, J. A. 1988. Property Tax Classification and Welfare in Urban Areas: A General Equilibrium Computational Approach, Journal of Urban Economics, Vol. 23: 131: Academic Press Inc.

Ding, C., Knaap, G. J., & Hopkins, L. D. 1999. Managing Urban Growth with Urban Growth Boundaries: A Theoretical Analysis. Journal of Urban Economics, 46(1): 53.

Dixon, P. B., Powell, A. A., & Wilcoxen, P. J. 1992. Notes and Problems in Applied General Equilibrium Economics.

Douglas Jr, R. W. 1980. Site Value Taxation and the Timing of Land Development, American Journal of Economics & Sociology, Vol. 39: 289: Blackwell Publishing Limited.

FDIC(Federal Depoist Electronic Source); State Pofile (Summer 2003): Georgia; http://www.fdic.gov/bank/analytical/stateprofile/2003_summer/At/Georgia/GA.pdf.

Feder, K. A. 1993. Issues in the Theory of Land Value Taxation. Temple University.

Fischel, W. A. 1993. The Economics of Zoning Laws: a Property Rights Approach to American Land Use Controls: The Johns Hopkins University Press.

Follain, J. R. & Miyake, T. E. 1986. LAND VERSUS CAPITAL VALUE TAXATION: A GENERAL EQUILIBRIUM ANALYSIS, National Tax Journal, Vol. 39: 451: National Tax Association.

Friesz, T. L., Harker, P. T., & Tobin, R. L. 1984. ALTERNATIVE ALGORITHMS FOR THE GENERAL NETWORK SPATIAL PRICE EQUILIBRIUM PROBLEM, Journal of Regional Science, Vol. 24: 475: Blackwell Publishing Limited.

Fujita, M. & Hamaguchi, N. 2001. Intermediate goods and the spatial structure of an economy. Regional Science and Urban Economics, 31(1): 79.

George, H. 1923. Progress and Poverty. London: Kegan Paul Trench Trubner & Co. Ltd.

Ginsburgh, V. & Keyzer, M. 2002. The Structure of Applied General Equilibrium Models: The MIT Press.

Glaeser, E. & Gyourko, J. 2002. Zoning's Steep Price, Regulation, Vol. 25: 24: Cato Institute.

GMLS. Internal Data for Residential Land Prices in the metro Atlanta.

Gyourko, J. 1991. Impact fees, exclusionary zoning, and the density of new development. Journal of Urban Economics, 30(2): 242.

Harriss, C. L. 1994. An Address on Land Taxation as an Evasion-proof Revenue Source, American Journal of Economics & Sociology, Vol. 53: 97: Blackwell Publishing Limited.

Hartzok, A. 1997. Pennsylvania's Success With Local Property Tax Reform: The Split Rate Tax, American Journal of Economics & Sociology, Vol. 56: 205: Blackwell Publishing Limited.

Horton, J. & Chisholm, T. 1991. The Political Economy of Henry George: Its Ethical and Social Foundations, American Journal of Economics & Sociology, Vol. 50: 375: Blackwell Publishing Limited.

Ihlanfeldt, K. R. 1982. PROPERTY TAX INCIDENCE ON OWNER-OCCUPIED HOUSING: EVIDENCE FROM THE ANNUAL HOUSING SURVEY, National Tax Journal, Vol. 35: National Tax Association.

Ihlanfeldt, K. R. 2004a. Exclusionary Land-use Regulations within Suburban Communities: A Review of the Evidence and Policy Prescriptions, Urban Studies, Vol. 41: 261: The Editors of Urban Studies.

Ihlanfeldt, K. R. 2004b. Introduction: Exclusionary Land-use Regulations, Urban Studies, Vol. 41: 255: The Editors of Urban Studies.

Kau, J. B. & Sirmans, C. F. 1981. THE DEMAND FOR URBAN RESIDENTIAL LAND, Journal of Regional Science, Vol. 21: 519: Blackwell Publishing Limited.

Keyzer, M. A. 1997. Building Applied General Equilibrium Models with GAMS: Examples and Additional Utilities. In M. A. Keyzer (Ed.), The Structure of Applied General Equilibrium Models. Cambridge(MA): The MIT Press.

Ladd, H. F. (Ed.). 1998. Local Government Tax and Land USE Policies in the United States: Understanding the Links. Cambridge(MA): Edward Elgar in association with Lincoln Institute of Land Policy.

Lang, R. E.; Edgeless Cities: EXPLORING THE ELUSIVE METROPOLIS; http://www.peleast.org/images/RRSummer2002/edgeless.pdf, 2005.

Lee, K. S. 1984. THE DIRECTION OF MIGRATION: A DYNAMIC GENERAL EQUILIBRIUM MODEL, Journal of Regional Science, Vol. 24: 509: Blackwell Publishing Limited.

Levine, G. J. 1993. The Single Tax in Montreal and Toronto, 1880 to 1920: Successes, Failures and the Transformation of an Idea, American Journal of Economics & Sociology, Vol. 52: 417: Blackwell Publishing Limited.

Lim, D.-H. 1992. The nonneutrality of the land value tax: Impacts on urban structure. Journal of Urban Economics, 32(2): 186.

Lim, D.-H. 1999. The Relative Efficiency of Taxes in a Two-Period Model of Urban Growth. Journal of Urban Economics, 45(3): 403.

Lofgren, H., Harris, R. L., & Robinson, S. 2002. A Standard Computable General Equilibrium (CGE) Model in GAMS: International Food Policy Research Institute.

Metro Atlanta Chamber of Commerce; Business Taxes and Related Regulations; www.metroatlatachamber.com, or http://www.echolsgroup.com/echolswriting/Corptaxes.pdf.

Mieszkowski, P. 1972. THE PROPERTY TAX: AN EXCISE TAX OR A PROFITS TAX? Journal of Public Economics, Vol. 1: 73.

Mills, E. S. (Ed.). 1998. Land Value Taxation: Can it will work today? Cambridge(MA): Lincoln Institute of Land Policy.

Miyao, T. 1975. Dynamics and Comparative Statics in the Theory of Residential Location, Journal of Economic Theory, Vol. 11: 133: Academic Press Inc.

Morgan, W., Mutti, J., & Partridge, M. 1989. A REGIONAL GENERAL EQUILIBRIUM MODEL OF THE UNITED STATES: TAX EFFECTS ON FACTOR MOVEMENTS AND REGIONAL PRODUCTION, Review of Economics & Statistics, Vol. 71: 626: MIT Press.

Moss, W. G. 1977. Large lot zoning, property taxes, and metropolitan area. Journal of Urban Economics, 4(4): 408.

Muth, R. F. 1967. Cities and Housing. Chicago: University of Chicago Press.

Muth, R. F. 1975. Numerical solution of urban residential land-use models. Journal of Urban Economics, 2(4): 307.

Nechyba, T. J. 1998. Replacing capital taxes with land taxes: efficiency and distributional implications with an application to the United States Economy. In N. Dick (Ed.), Land Value Taxation: Can it will work today? Cambridge(MA): Lincoln Institute of Land Policy.

Nechyba, T. J. 2001. Prospects for land rent taxes in state and local tax reforms: Duke University and NBER.

Ohkawara, T. 1985. Urban residential land rent function: An alternative Muth-Mills model. Journal of Urban Economics, 18(3): 338.

Partridge, M. D. & Rickman, D. S. 1998. Regional Computable General Equilibrium Modeling: a Survey and Critical Appraisal. International Regional Science Review, 21(3): 205-248.

Pasha, H. A. 1992. Comparative statics analysis of density controls. Journal of Urban Economics, 32(3): 284.

Pasha Hafiz, A. & Ghaus, A. F. A. 1995. General Equilibrium Effects of Local Taxes. Journal of Urban Economics, 38(3): 253.

Pereira, A. M. & Shoven, J. B. 1988. Survey of dynamic computational general equilibrium models for tax policy evaluation. Journal of Policy Modeling, 10(3): 401.

Pessoa, S. D. A., Pessoa, S. M. P., & Rob, R. 2005. Elasticity of Substitution between Capital and Labor and Its Applications to Growth and Development, PIER Working Paper with number 05-012: Department of Economics, University of Pennsylvania.

Pigott, J. & Whalley, J. 1985. UK Tax Policy and Applied General Equilibrium Analysis: Cambridge University Press.

Plassmann, F. & Tidemann, N. 1999. A dynamic regional applied general equilibrium model with five factors of production: Department of Economics, Birmnigham University of New York.

Pogodzinski, J. M. 1988. Amenities in an urban general equilibrium model. Journal of Urban Economics, 24(3): 260.

Pogodzinski, J. M. & Sass, T. R. 1990. The Economic Theory of Zoning: A Critical Review, Land Economics, Vol. 66: 294: University of Wisconsin Press.

Pogodzinski, J. M. & Sjoquist, D. L. 1993. Alternative tax regimes in a local public good economy. Journal of Public Economics, 50(1): 115.

Pogodzinski, J. M. & Sass, T. R. 1994. The theory and estimation of endogenous zoning. Regional Science and Urban Economics, 24(5): 601.

Pogodzinski, J. M. undated. The Effects of Fiscal and Exclusionary Zoning on Household Location: A Critical Review. Journal of Housing Research, 24: 601-630.

Pollakowski, H. O. & Wachter, S. M. 1990. The Effects of Land-Use Constraints on Housing Prices, Land Economics, Vol. 66: 315: University of Wisconsin Press.

Pyatt, G. 1988. A SAM approach to modeling. Journal of Policy Modeling, 10(3): 327.

Richardson, H. W. 1977. On the possibility of positive rent gradients. Journal of Urban Economics, 4(1): 60.

Richter, D. K. 1978a. The computation of urban land use equilibria. Journal of Economic Theory, 19(1): 1.

Richter, D. K. 1978b. Existence and Computation of a Tiebout General Equilibrium. Econometrica, 46(4): 779-805.

Roakes, S. L. 1996. Reconsidering land value taxation: The golden key? Land Use Policy, 13(4): 261.

Rothbard, M. N. 1997. The Single Tax: Economic and Moral Implications and a Reply to Georgist Criticisms, The Logic of Action One: Applications and Criticisms from the Austrian School. London: Edward Elgar.

Rubinfeld, D. L. 1978. SUBURBAN EMPLOYMENT AND ZONING: A GENERAL EQUILIBRIUM ANALYSIS, Journal of Regional Science, Vol. 18: 33: Blackwell Publishing Limited.

Rutherford, T. F. 1997. Applied General Equilibrium Modeling with MPSGE as a GAMS susystem: an Overviwe of the Modeling Framewrok and Syntax: Department of Economics, University of Colorado.

Rutherford, T. F. 1999. Sequential Joint Maximization. In J. Weyant (Ed.), Energy and Environmental Policy Modeling, Vol. 18: Kluwer.

Rutherford, T. F. 2004. Dynamic General Equilibrium with GAMS/MPSGE, Introduction to GAMS/MPSGE Modeling Workshop. University of Colorado.

Saks, R. E. 2005. Job Creation and Housing Construction: Constraints on Employments Growth in Metropolitan Areas, Dissertation Fellowship Symposium. Cambridge(MA), Lincoln Institute of Land Policy.

scarf, L. H. 1973. The Computation of Economic Equilibria. New Havens: Yale University Press.

Scarf, L. H. & Shoven, J. B. 1984. Appplied General Equilibrium Analysis: Cambridge University Press.

Seung, C. K. 1996. A Dynamic General Equilibrium Analysis of State Tax Incentives for Economic Development. Ohio State University.

Shoup, D. C. 1970. The Optimal Timing of Urban Land Development. Papers of the Regional Science Association, 25: 33-44.

Shoup, D. C. 1999. The trouble with minimum parking requirements. Transportation Research Part A: Policy and Practice, 33(7-8): 549.

Shoven, J. B. & Whalley, J. 1977. Equal yield tax alternatives: General equillibrium computational techniques. Journal of Public Economics, 8(2): 211.

Shoven, J. B. & Whalley, J. 1984a. Applied General-Equilibrium Models of Taxation and International Trade: An Introduction and Survey, Journal of Economic Literature, Vol. 22: 1007: American Economic Association.

Shoven, J. B. & Whalley, J. 1984b. Applying General Equilibrium: Cambridge University Press.

Skouras, A. 1978. The non-neutrality of land taxation. Public Finance, 30: 113-134.

Steen, R. C. 1982. Effects of the Curent and Alternative Systems of Urban Public Finance. Princeton University.

Stull, W. J. 1974. Land Use and Zoning in an Urban Economy. American Economic Review, 64(3): 337-347.

Sullivan, A. M. 1984a. The general equilibrium effects of the industrial property tax: Incidence and excess burden. Regional Science and Urban Economics, 14(4): 547.

Sullivan, A. M. 1984b. LARGE-LOT ZONING AS SECOND-BEST POLICY, Journal of Regional Science, Vol. 24: 581: Blackwell Publishing Limited.

Sullivan, A. M. 1985. The general-equilibrium effects of the residential property tax: Incidence and excess burden. Journal of Urban Economics, 18(2): 235.

Sullivan, A. M. 1987. The spatial effects of a general capital tax: Property taxes and urban labor markets. Regional Science and Urban Economics, 17(2): 209.

Tideman, N. 2002. THE AVOIDABLE EXCESS BURDEN PF BROAD-BASED U.S.TAXES. Public Finance Review, 30(5): 416-441.

Tideman, T. N. 1982. A TAX ON LAND VALUE IS NEUTRAL, National Tax Journal, Vol. 35: National Tax Association.

Tideman, T. N. 1990. Integrating Land-Value Taxation with the Internalization of Spatial Externalities, Land Economics, Vol. 66: 341: University of Wisconsin Press.

Tidemann, N. (Ed.). 1994. Land and Taxation: Shepheard-Walwyn Ltd in association with Center for Incentive Taxation Ltd.

Tidemann, N. 1998. The Ethics of Coercion in Public Finance, Order and Chaos in the Development of Socio-Economic Systems: The Institute of Optical Monitoring.

Tidemann, N. 1999. Taxing Land is Better than Neutral: Land Taxes, Land Speculation, and the Timing of Development. In K. C. Wenzer (Ed.), Land Value Taxation: The Equitable and Efficient Source of Public Finance. Armonk, New York: SHARPE.

Turnbull, G. K. 1985. Residential development in an open city. Regional Science and Urban Economics, 18(2): 307.

Turnbull, G. K. & Niho, Y. 1986. The optimal property tax with mobile nonresidential capital. Journal of Public Economics, 29(2): 223.

Turnbull, G. K. 1988. THE EFFECTS OF LOCAL TAXES AND PUBLIC SERVICES ON RESIDENTIAL DEVELOPMENT PATTERNS, Journal of Regional Science, Vol. 28: 541: Blackwell Publishing Limited.

Turnbull, G. K. & Boyd, R. 1989. Dynamic adjustment to land taxation policy: Neutrality and welfare implications. Journal of Environmental Economics and Management, 16(3): 242.

Turnbull, G. K. 1991. A comparative dynamic analysis of zoning in a growing city. Journal of Urban Economics, 29(2): 235.

Turnbull, G. K. & Cathleen, J. 1995. A Statistical Analysis of Graded Property Taxes in Pennsylvania, Working Paper WP95NT2. Cambridge(MA): Lincoln Institute of Land Policy.

Turnbull, G. K. 2004. Urban growth controls: transitional dynamics of development fees and growth boundaries. Journal of Urban Economics, 55(2): 215.

U.S. Census Bureau. American Housing Survey, http://www.census.gov/prod/www/abs/h170sma.html.

U.S. Census Bureau; TABLE 3. SELECTED ECONOMIC CHARACTERISTICS, The 2003 American Community Survey.

U.S. Department of Commerce (Bureau of Economic Analysis); Input-Output Accounts Data; http://www.bea.doc.gov/bea/dn2/i-o.htm#annual.

U.S. Department of Labor (Bureau of Labor Statistics). 2003 November Metropolitan Area Occupational Employment and Wage Estimates, http://stats.bls.gov/oes/2003/november/oes_0520.htm.

U.S. Department of Labor (Bureau of Labor Statistics); Table 23. Selected southern metropolitan statistical: Average annual expenditures and characteristics (Consumer Expenditure Survey), http://www.bls.gov/cex/csxmsa.htm.

U.S.Department of Housing and Urban Development; The User Cost of Homeownership; http://www.huduser.org/periodicals/ushmc/summer2000/summary-2.html.

Urzua, C. M. 1994. Resuelve: a Gauss Program for Solving Computable General Equilibrium and Disequilibrium Models. Estudios Economics, 9: 273-294.

Vickrey, W. 1992. Meaningfully defining deficits and debt, American Economic Review, Vol. 82: 305: American Economic Association.

Vickrey, W. S. 1980. Defining Land Value for Taxation Purpose. In D. Holland (Ed.), The Assessment of Land Value: 25-36. Madison: University of Wisconsin.

Voith, R. & Gyourko, J. 2002. Capitalization of federal taxes, the relative price of housing, and urban form: density and sorting effects. Regional Science and Urban Economics, 32(6): 673.

Wassmer, R. W. (Ed.). 2000. Readings in Urban Economics: Issues and Public Policy: Blackwell.

Weitzman, M. L. 2003. Income, Wealth, and the Maximum Principle: Harvard University Press.

White, J. R. 1988. Large lot zoning and subdivision costs: A test. Journal of Urban Economics, 23(3): 370.

Wildasin, D. E. 1982. MORE ON THE NEUTRALITY OF LAND TAXATION, National Tax Journal, Vol. 35: National Tax Association.

Yang, F.; Consumption along the Life Cycle: How Different is Housing? http://www.econ.umn.edu/~fyang/durable12.pdf.

Zodrow, G. R. & Mieszkowski. 1983. The Incidence of the property tax: the benefit view and the new view. In G. R. Zodrow (Ed.), Local provision of public services: the Tiebout model after twenty-five years: 109-129. New York: Academic Press.

Zodrow, G. R. & Mieszkowski, P. M. 1986. The new view of the property tax A reformulation. Regional Science and Urban Economics, 16(3): 309.