

The Effects of Land Value Taxation in a Computable General Equilibrium Model *

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Abstract

The paper reports on the application to land taxation, of the RELU-TRAN model, a spatially detailed general equilibrium model of a regional economy that treats labor and building markets, production of goods and services and real estate development. The model is used to investigate the efficiency gains that can be obtained by switching from the conventional ad-valorem property tax (CPT) to a uniform ad-valorem land tax (ULT) on residual imputed land value. The ULT is not a perfectly neutral tax but it has the advantage that it is relatively easily implementable and the fact that it is proportional to imputed land value, makes the ULT fair and defensible. The simulations are done by using the Los Angeles version of RELU-TRAN, calibrated for the year 2000. Three types of tax switches are evaluated. In the first, the CPT revenue is fully replaced by the ULT revenue and higher levels of the ULT are examined. In the second and third simulations the ULT is used in place of the CPT. In the second, 10% of the revenue from the combined Federal and State income tax is replaced by the ULT and in the third, 10% of the sales tax revenue is replaced by the ULT. Except for the third simulation, all the others show that the switch to the ULT does increase total welfare calculated as the sum of an approximate measure of consumer surplus, total tax revenues from all tax bases and aggregate change in the value of real estate (the only source of non-zero producer surplus in the model).

Keywords: land value taxation, sales tax, property tax, income tax, CGE models,

About the Author

Alex Anas has been a professor of economics at the State University of New York at Buffalo since 1991. Prior to joining the faculty at Buffalo, Dr. Anas was on the faculty at Northwestern University from 1975 to 1991 and had visiting appointments at Stanford University in 1981-82 and the University of Illinois at Urbana-Champaign in 1986-88. Dr. Anas obtained his BA and BS from Carnegie Mellon University in 1972, and his MA, MCP in 1974 and Ph.D. in 1975 from the University of Pennsylvania.

Dr. Anas' research interests over the years have spanned theoretical, empirical and applied urban economics. He has contributed to understanding dynamic land use adjustment with durable housing and the abandonment of housing in central cities, the effects of transportation including public transportation on property values and urban land use, the effects of traffic congestion and congestion pricing on land use, dynamic housing market models, the effects of regulations on the housing market, models with dispersed jobs and residences, theories of systems of cities with intercity trade, urban agglomeration, ethnic segregation and ghettos, and the beneficial effects of urban sprawl.

At Buffalo, Anas completed development of RELU-TRAN (Regional Economy, Land Use and Transportation), a computable general equilibrium model that treats the interconnections of spatially disaggregated labor markets, the markets for housing and non-housing floor space, industry location, real estate development, work and non-work related personal transportation and energy utilization and CO₂ emissions in personal transportation. Development of the model was funded by the National Science Foundation Urban Research Initiative's award SES 9816816, followed by award RD-83184101-0 from the United States Environmental Protection Agency's 2004 Science to Achieve Results (STAR) competition, and award 142934, of the Multi-campus Research Program and Initiative (MRPI) competition of the University of California which supported application of the RELU-TRAN model to the Greater Los Angeles Region. An application to Paris is also underway.

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The Effects of Land Value Taxation in a Computable General Equilibrium Model

Alex Anas

1. Introduction

The purpose of the research reported in this working paper is to study the effects of land value taxation in a spatially detailed computable general equilibrium (CGE) model, in order to see how the urban economy will adjust to a shift toward land value taxation and to examine how efficient such taxation is.

In an ideal world one may be able to design a perfectly neutral tax on land, but such a tax if it can be devised would be difficult to administer or not acceptable. It is therefore important to consider feasible deviations from conventional property taxation which may not be perfectly neutral. Two types of such feasible deviations are considered.

- (1) A shift from the *Conventional Property Tax* (CPT) to a *Uniform Land Tax* (ULT) on residual land value.
- (2) A higher *Uniform Land Tax* (ULT) to substitute for a lower income tax, or a lower sales tax.

The CPT refers to property taxation as it is practiced in the US and many other countries: an annual tax is levied on the total value of real property as a percentage of its market value (ad-valorem tax). The ULT refers to a tax studied in this article and well understood in the theoretical literature on land taxation. It is also an ad-valorem tax that is levied on the estimated market value of the land part of real property. The word “estimated” is key here since the value of the land on which a building sits is not directly observed. Hence, how this value should be estimated is a key aspect of the possible implementation of the ULT. Furthermore, in the context of our study – because we are using a CGE model — how the value of land in a property should be estimated in a CGE model is a key question. This issue of how to estimate land value under existing buildings is discussed in section 3. We use the assumption that land value can be estimated as the residual value of the land after subtracting the depreciated construction cost.

Both types of deviations from the CPT mentioned above are of interest, because both can generate efficiency gains.

Under (1), the efficiency gain comes about because, assuming reasonably accurate imputation, the UPT is more efficient than the CPT since the part of the CPT that falls on the value of structures causes a distortion, raising the after-tax cost of structural capital. Hence, substituting the ULT for the CPT should offset the deadweight loss of the CPT, provided the ULT itself does not cause a bigger distortion than does the CPT as it should not. In the simulations that we will report we will indeed see that this is the case.

Under (2), the efficiency gains come about because the same aggregate tax revenue is raised by a higher ULT while the existing income taxes are lowered. This is a tax substitution

policy shifting from a distorting tax like the income tax to one that is less distorting (though not perfectly neutral). Under (2), substituting for the sales tax instead of the income tax produces a welfare loss because the ULT we are using is more distorting than is the sales tax.

2. Land taxation in theoretical spatial equilibrium models

Since we will be applying a spatial CGE model to examine the efficiency of a shift towards land value taxation, it is important to review what has been done in the theoretical literature of spatial equilibrium models prior to the present study.

Economists have been interested in the effects of switch to land taxation on capital-land substitution. See, for example, Nechyba (1999) for an analysis of distributional and efficiency effects of such a switch in the U.S. economy. In a separate line of inquiry, there has also been interest on the effects of land taxation on the timing of land development, e.g. Bentick (1979) and on the spatial effects of the property tax, e.g. Carlton (1981).

Arnott and MacKinnon (1977) used a general equilibrium model of residential land use in which they assumed that all jobs were located downtown (the monocentric model) to study the effects of the property tax in a city closed in total population. The model was too complex to be solved in closed form, but an efficient computational technique based on simplicial search was developed to solve it numerically.

Such a monocentric model of spatial equilibrium also assumes that buildings are not durable but completely malleable. That is the city adjusts instantly to changes in the property tax rate rather than gradually over time. In subsequent theoretical studies, this assumption was not changed and hence the articles briefly reviewed below are all subject to the same limitation, but they have contributed – nevertheless – to a better understanding of how a conventional property tax and a pure land tax would affect cities under ideal conditions.

Mills (1988) presented a theoretical analysis of the switch from the conventional property tax to the land tax in a monocentric city model. He showed that the switch would increase the structural density of land use, reduce urban sprawl and raise the total output of the city by encouraging the substitution of structural capital for land in buildings.

This line of inquiry was continued by Brueckner (2001) and Brueckner and Kim (2003) who applied the concept to residential land use. In the first article they showed the same result identified by Mills, that a switch to a land tax would increase structural density reducing sprawl, assuming that apartment sizes per household were fixed. In the second paper they extended this result showing that since the switch would decrease the cost of structural capital, it could in turn cause an increase in the size of an apartment demanded by consumers, thus creating a second effect. Whether urban land area is increased by the switch would depend on the tug-of-war between the increase in structural density of buildings caused by the increase in the price of land relative to the price of structural capital, and the increase in the demand for floor space (apartment size) inducing a decrease in population density caused by the decrease in the relative price of floor space.

In addition to being focused on monocentric cities with completely malleable building stocks, all of the above spatial equilibrium studies consider only the real estate market, hence being partial equilibrium. Labor, production and other markets are ignored, when studying a shift to the land tax. The presence of taxes other than the conventional property tax is also ignored.

A completely different line of inquiry into property taxation and its reform is based on models that require neither monocentricity, nor malleable capital. Such models treat housing and other durable building stocks by modeling construction and demolition, e.g. Anas and Arnott (1991). The Chicago Prototype Housing Market Model (Anas and Arnott, 1997) was applied to the housing market of Chicago and several other cities (but without treating spatial detail except as city and suburb location). The model was used to show that the extension of housing allowances to low income renters offset in part the distortion caused by the incidence of the conventional property tax on them. The utility of such models to more deeply examine the effects of property taxation was advocated in Anas (2003). Since then, this type of modeling has been incorporated into the RELU-TRAN model used in this study.

3. The RELU-TRAN model

The **Regional Economy, Land Use and Transportation Model (RELU-TRAN) is a spatially detailed computable general equilibrium model of a metropolitan economy, designed to treat the effects of a variety of changes and policies on a metropolitan area. Based on microeconomic theory, the model treats the decisions of consumers, firms and real estate developers. The government is treated as a levier of various taxes and as a regulator of land use, building stocks and environmental quality. The equations of the model are published in Anas and Liu (2007) and in the appendices of subsequent publications.**

Consumers in RELU-TRAN make decisions on where in a metropolitan area to work and where to reside, how much housing floor space to consume at the place of residence and how many non-work trips to make to various destinations where goods and services can be acquired. Hours supplied to a workplace compete against travel time allocated to commuting and to non-work trips or can be treated as fixed per day depending on how one wants to specify the model. Consumers also decide which mode of transportation (car, public transit or non-motorized) to use on a trip and what travel route of the transport network to utilize in the case of a car trip. Car type and route choices involve a fuel economy decision and travel is subject to traffic congestion. The fuel economy of the vehicle and the level of congestion determine the level of gasoline consumed and the CO₂ and other pollutants emitted. RELU-TRAN treats consumer types by income and can treat them by family size and other characteristics.

Firms in RELU-TRAN are classified into industries. These industries can export their outputs and are interconnected via inter-industry demand relationships to each other but also to industries in the rest of the world. The inter-industry relations are not driven in part by product prices and by travel cost and are not based on fixed coefficients as is common in input-output models. The retail industry sells directly to the consumer but can also export and import. In addition to the intermediate inputs purchased from the other industries, the primary input groups of an industry include business capital, buildings and land and labor of all skill levels.

Developers in RELU-TRAN are the investors in developable land and existing buildings.

Income from consumers or firms renting these assets and expected capital gains or losses from redevelopment, construction or demolition combine to determine the profitability of each type of real estate investment and how much developers would construct, demolish or redevelop land by converting it from one building type to another (as in Anas and Arnott, 1991).

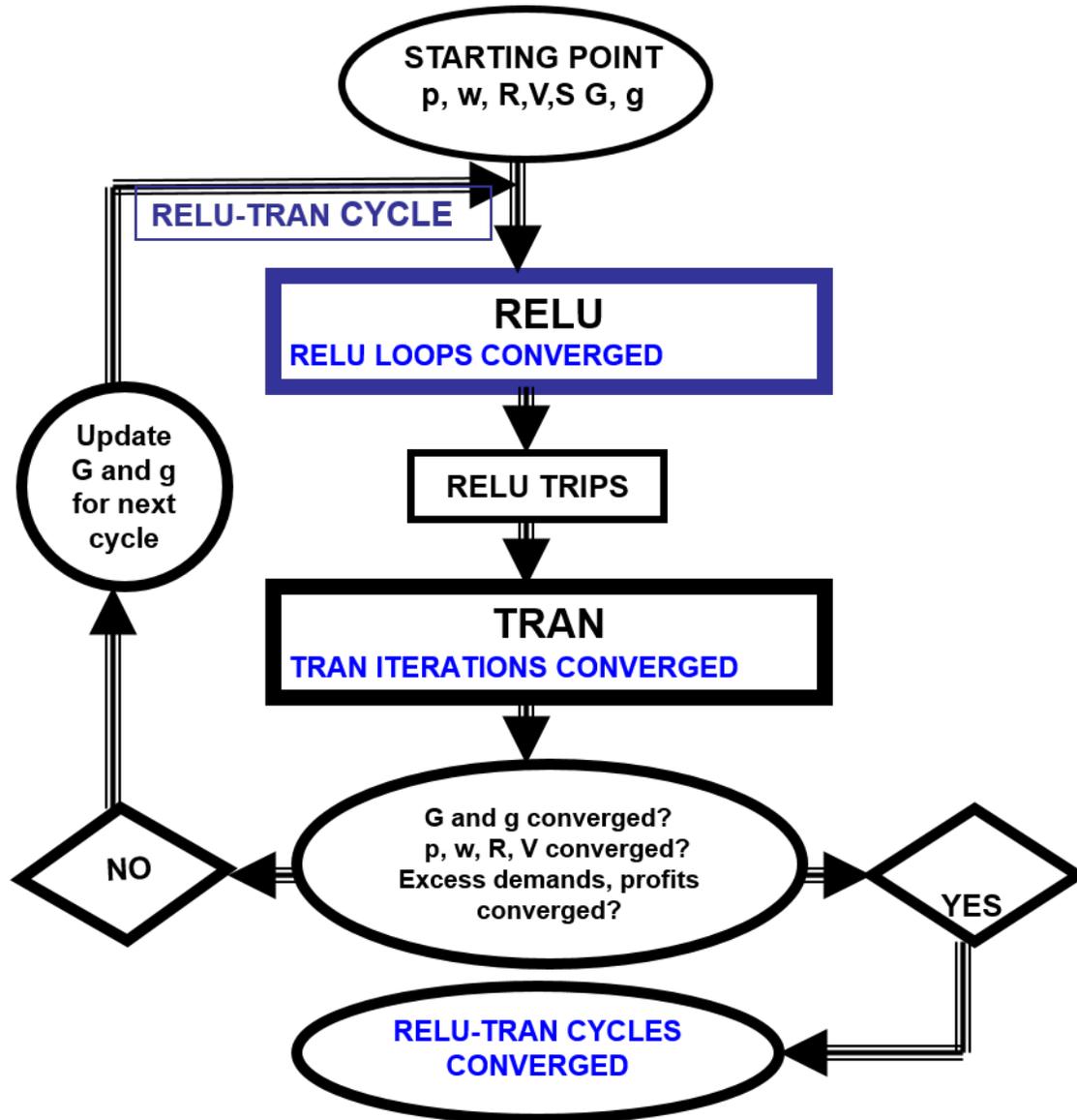
The government sector of RELU-TRAN controls a number of tax instruments such as income tax, ad-valorem property tax, quasi-Pigouvian tolls on traffic congestion, taxes on parking, cordon tolls and tax on gasoline, while a variety of other taxes on consumers and firms can be treated and the revenue from such taxation can be distributed among the consumers. The government can also control land-use specific lot size or floor-area-ratio zoning regulations as well as controls on aggregate land use such as those of urban growth boundaries. The model is designed to evaluate the costs and benefits of such policies or change and scenarios, and to produce measures of welfare changes.

The RELU-TRAN model has been calibrated for the Chicago and Los Angeles MSAs and for Paris, France. Anas and Hiramatsu (2012) have used the Chicago version to examine the effects of an increase in the price of gasoline on the adjustments of consumers and firms along many margins. In Anas and Hiramatsu (2013) the model was used to study hypothetical cordon pricing to reduce congestion in the Chicago MSA focusing on the efficiency gains of such a policy as well as on how it affected the distribution of jobs and residences within the metropolitan area.

It is useful to consider how the model is solved, the Los Angeles version having 97 distinct geographical zones to represent the MSA. This is done by reproducing here three figures from Anas and Liu (2007). The RELU model consists of the regional economy and the land use submodels which also include land development equations to be discussed below in some more detail. The TRAN model includes travel for commuting and non-commuting (shopping) purposes by cars, public transit and other modes. These two models are converged in each of many iterative cycles until they produce mutually consistent equilibrium results (Figure 1). Figure 2 shows the internal structure (modules) of the RELU model and in what order they are solved iteratively, although the result does not depend on the order. Inside RELU the real estate value and stock modules are the ones directly relevant to this study, although the entire model is solved for the simulations to be reported here. Figure 3 shows the internal structure of the TRAN model. The RELU model relies on discrete choice modeling of consumer choices with continuous good choices such as floor space and quantities of retail goods for each discrete alternative. Figure 4 is a summary flow chart of the consumer's decision tree.

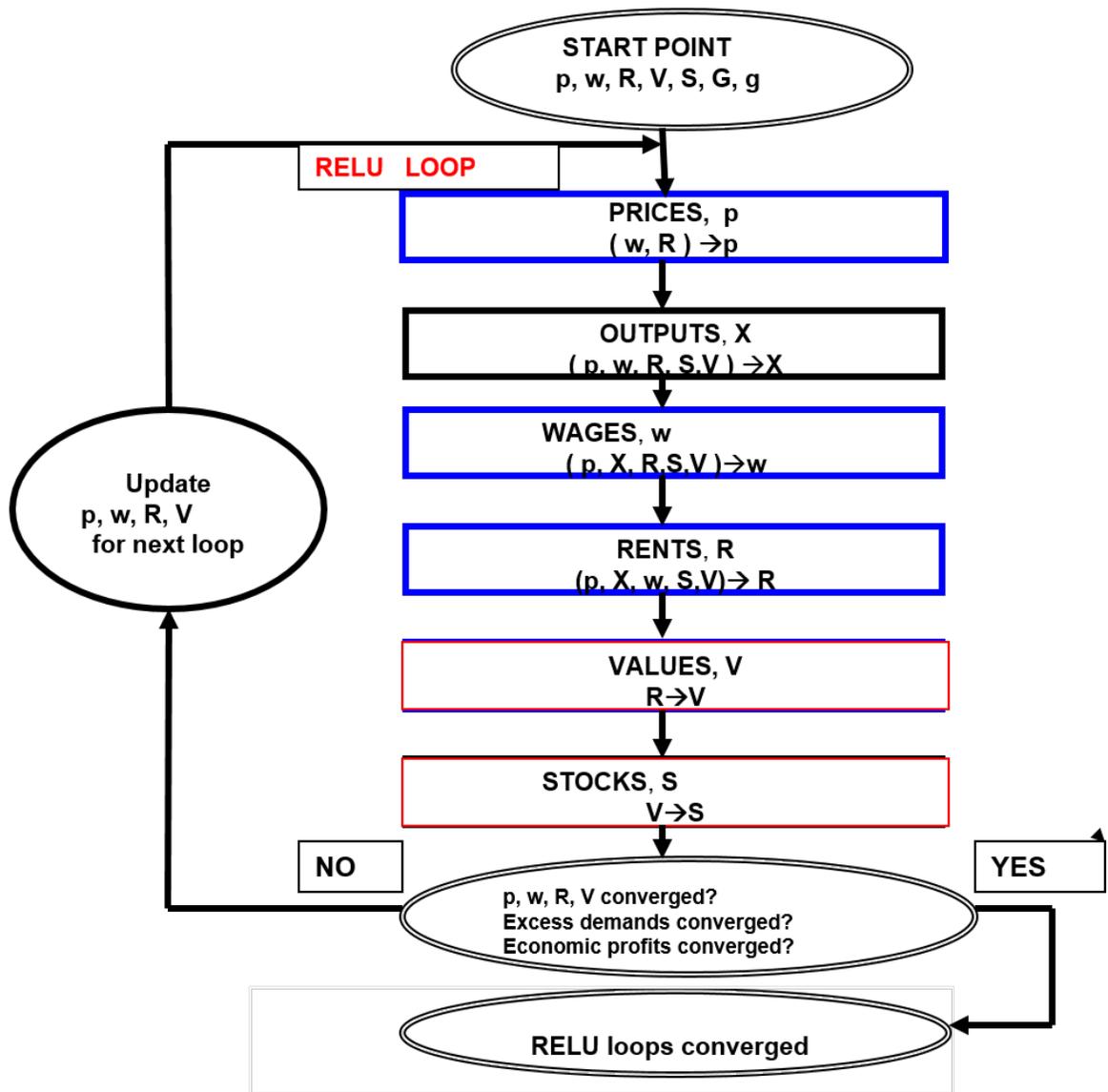
The LA version of RELU-TRAN covers six counties: LA, Orange, Ventura, Riverside, San Bernardino and Imperial. The area covered by these counties is divided into 97 zones. The model divides consumers into income quartiles for the year 2000. There are two housing types (single family and multiple family structures) and commercial, industrial and public buildings and vacant developable land. Nine industries employ workers from all four quartiles. The nine industries are: agriculture and extractive industries; finance-insurance-real estate; manufacturing; public administration; services; transportation and warehousing; retail; wholesale; utilities. A project web site where additional information can be found is: <http://vcpa.ucr.edu/> The Paris version of RELU-TRAN covers the Greater Paris (Ile-de-France) region which is divided into 54 zones (recently a 1300 commune level version has been made operational), there are again two

housing type (houses and apartments), commercial, industrial and public buildings and vacant land, the Paris version treats private sector and public sector jobs. Figures 5 and 6 illustrate important features of the LA and Paris study regions. In the former jobs are widely dispersed and job sub-centers connected by highways; in Paris jobs are heavily concentrated in the center served by a very dense public transit network. Table 1 summarizes the nature of job dispersion in Chicago, LA, Paris.



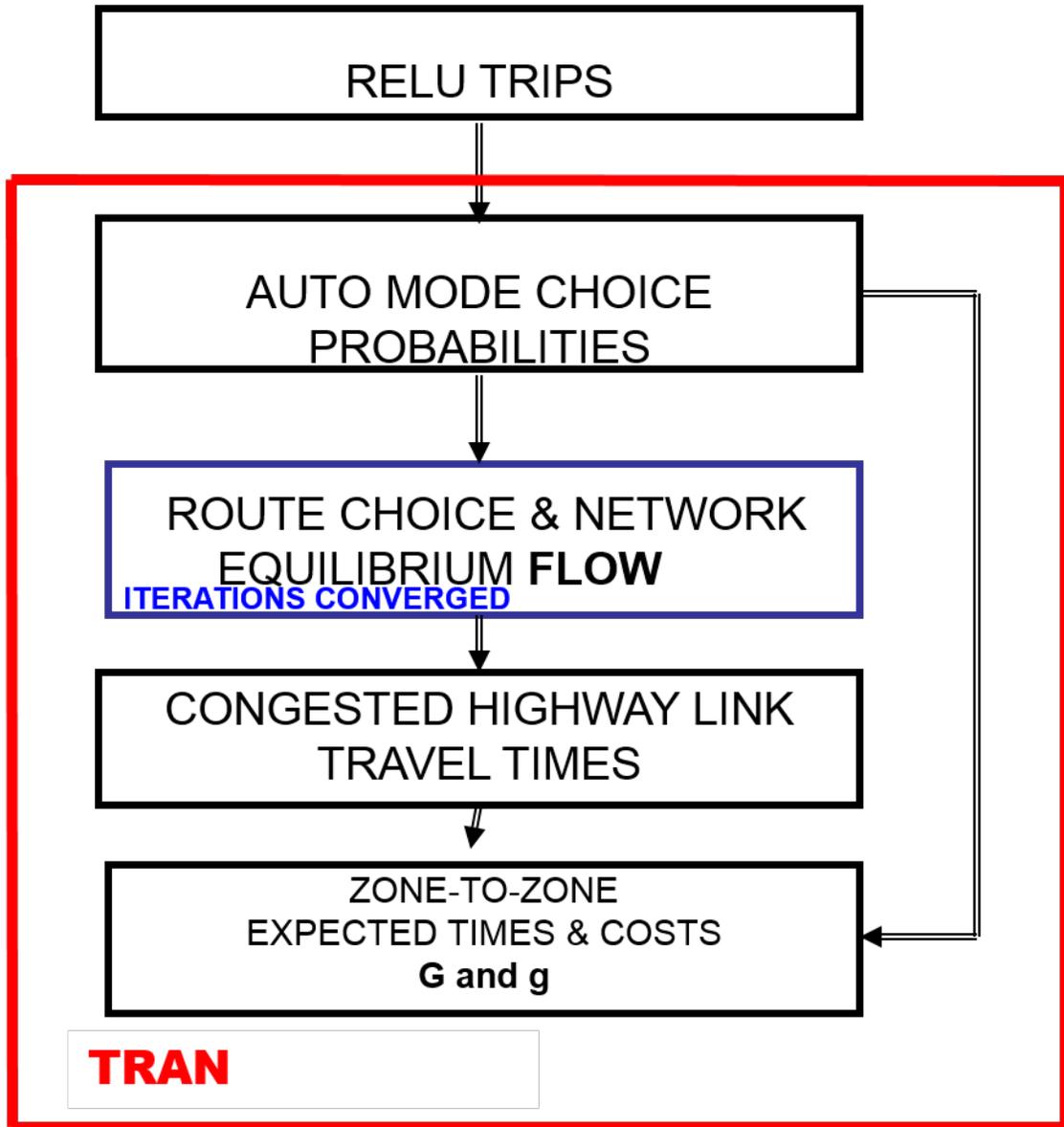
Cyclical linking of the RELU and TRAN algorithms in RELU-TRAN

FIGURE 1
Source: Anas-Liu (2007)



The RELU algorithm

FIGURE 2
Source: Anas-Liu (2007)



The TRAN Algorithm

FIGURE 3
Source: Anas-Liu (2007)

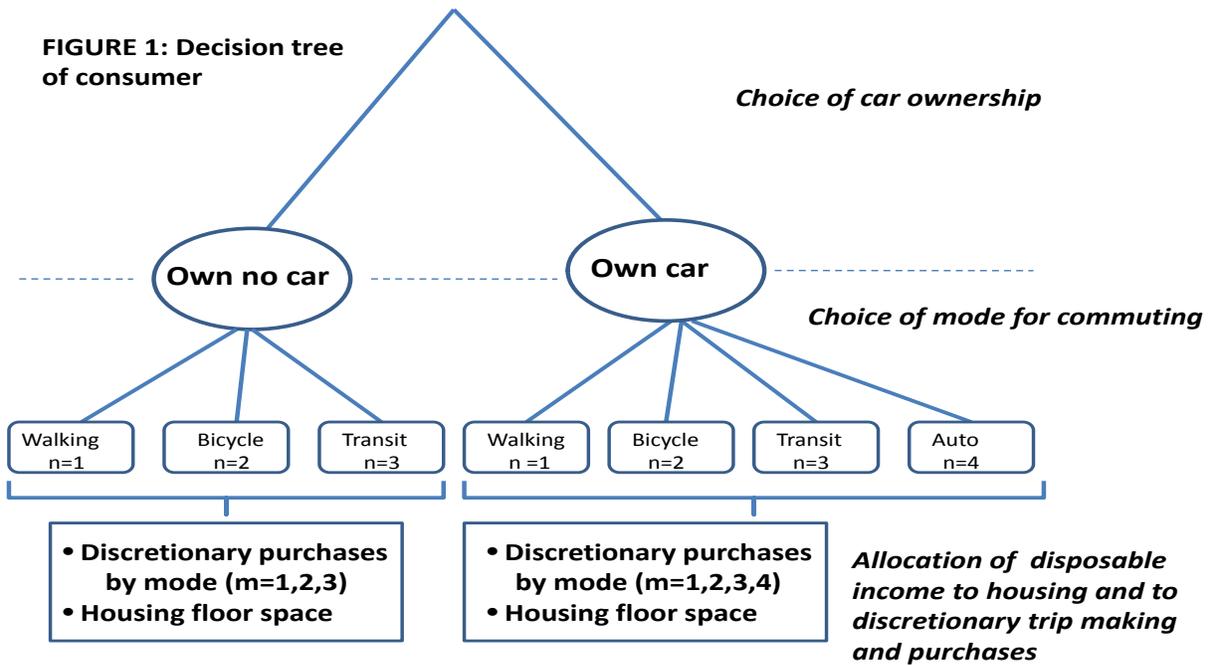


FIGURE 4
Decision tree of consumer in RELU-TRAN

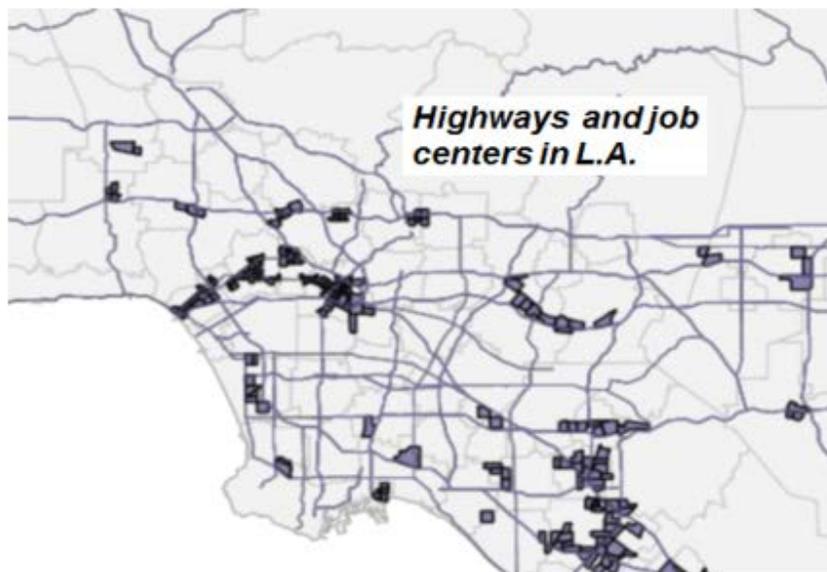


FIGURE 5
Highways and job centers in the LA model region

**Public transit
and job centers in Paris**

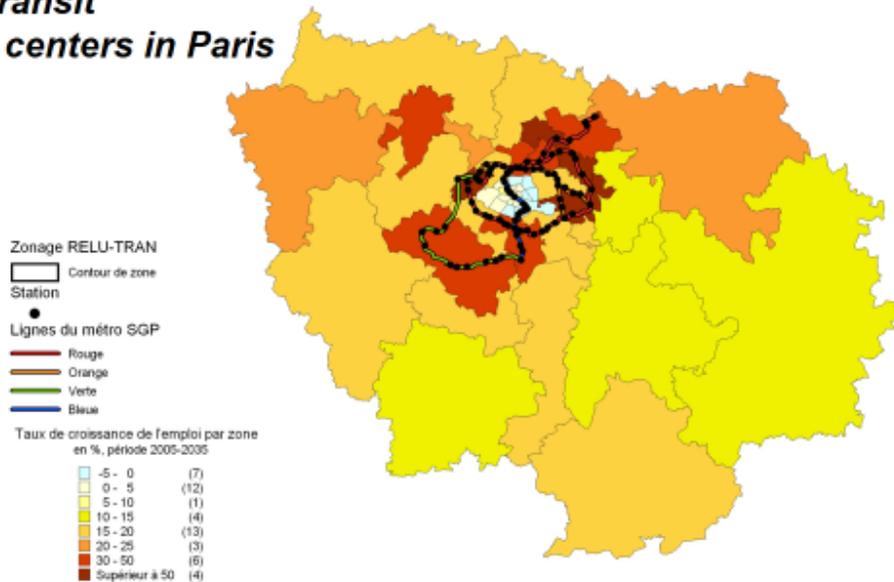


FIGURE 6
Public transit and job centers in Paris

Presentation on YouTube: <http://www.youtube.com/watch?v=8gusipxlliu>
 Slideshare: <http://www.slideshare.net/NewEconomicSchool/what-do-chicago-paris-and-los-angeles-have-in-common>

RELU – TRAN Versions	Public transit share in commuting	Employment dispersion
Chicago, MSA	13%	About 30% of jobs in the 4 largest job centers
Ile-de-France (Greater Paris)	50%	About 50% of jobs in the City of Paris and 10 surrounding suburban centers
Los Angeles, MSA	2%	About 30% of jobs in the 30 largest job centers

TABLE 1
Comparison of job dispersion in Chicago, LA and Paris

4. Land value imputation, taxation and social welfare in RELU-TRAN

We need to start with some basic definitions. *Property value* refers to the total market asset value of the building and its land lot; *structure value* refers to the cost of constructing the structure on the lot, adjusted for depreciation; *land value* refers to the market asset value imputed to the lot under the building. In the case of vacant land, land value refers to the total market asset value of the lot. Property and structure values will be normalized by floor space to convert them to unit prices per square foot. Land values (imputed or otherwise) will be normalized by lot area and will be per square foot of *land*.

Imputation of land value

Since the value of the land under a building cannot be observed, it needs to be imputed. As explained by Mills (1998) and Anas (2003), doing so is subject to possible errors. It must be done carefully. We have considered and tested two imputation methods which are both possible in the context of our CGE model.

Method 1 (imputation from vacant land): The model produces a market equilibrium price of the vacant developable land in each zone. A simple approach would impute this to the land in all built plots in the same zone regardless of building type, but usually the vacant land in the zone is not randomly distributed and the imputation to lots occupied by buildings may be biased. In addition, land under different types of buildings may be valued differently in the same zone, due to zoning and other regulations and externalities. We have tried this approach and observed that the results are not realistic. We have, therefore, not used this approach.

Method 2 (land value as residual): In this case, we subtract the construction cost (or better the depreciated construction cost) from the property's total asset price and then attribute the difference to the land. We use that land imputed price as the tax basis for a land tax. Thus, under this method which we implemented, land under different buildings in the same zone is valued differently reflecting externalities, regulations and other imperfections. The method, overall gives reasonable results.

Real estate valuation in RELU-TRAN

To understand better how land taxation works in RELU-TRAN we need to understand in better detail how real estate valuation and conversion are modeled. In the LA version construction and demolition are the two types of conversion activities modeled. The former depletes developable vacant land, the latter replenishes it. The model works in discrete annual time periods. In the beginning of such a year, all owners of real estate observe the total market asset price of their real estate and can buy or sell in a competitive market ignoring market frictions. During the year, rent is collected from the use of the real estate including an endogenously determined vacancy probability. At beginning of the year, forward-looking owners expect rationally and know the endogenously determined probability that they will either convert their real estate (by demolishing a building or by building on a vacant lot) or that they will keep it in its current state. This decision of whether to convert or not happens later in the year when new information about the profitability of the conversion appears idiosyncratically to each agent.

Based on the above assumptions of how the market works, the asset pricing equation for building type k located in zone i is a zero-expected-profit equation, as follows:

$$\underbrace{V_{ik}}_{\text{Property value}} = \underbrace{\varpi_{ik}(R_{ik})}_{\text{Expected rent during year}} + \frac{1}{\Phi_{ik}} \log \left[\underbrace{\exp \Phi_{ik} \left(\frac{1}{1+\rho} V_{ik} - \square_{ikk} \right) + \exp \Phi_{ik} \left(\frac{1}{1+\rho} \left(\frac{V_{i0}}{m_{ik}} - p_{Dk,i} \right) - \square_{ik0} \right)}_{\text{Expected net revenue from conversions during year}} \right] - \underbrace{\frac{\tau_{ik}}{1+\rho} V_{ik}}_{\text{CPT discounted}}$$

V_{ik} is the property value per square foot of floor space, that is the price of type- k floor space ($k > 0$), while V_{i0} is the price of the vacant land created if the building is demolished. Both are endogenously determined by the model. ρ is the owner's interest rate, and \square_{ikk} , \square_{ik0} are fixed effects estimated econometrically or calibrated to reflect non-financial costs associated with keeping the building in its current state ($k \rightarrow k$) or demolishing it ($k \rightarrow 0$). Φ_{ik} is a calibrated parameter that measures the dispersion of the idiosyncratic shocks on the two states (keep as is or demolish) and $p_{Dk,i}$ is demolition cost per square foot. m_{ik} is the structural density in units of type- k floor space per unit of land in the lot. The conventional property tax rate for type- k floor space value is τ_{ik} . The tax is assumed paid at the end of the year, based on the building that existed in the beginning of the year, hence the discounting of the ad-valorem tax in the last term.

The corresponding equation for vacant land is similar (case of $k = 0$). In this case, $p_{Ck,i}$ is the cost of construction per square foot of floor space:

$$\underbrace{V_{i0}}_{\text{Property value}} = \underbrace{R_{i0}}_{\text{Expected rent during year}} + \frac{1}{\Phi_{i0}} \log \left[\underbrace{\exp \Phi_{i0} \left(\frac{m_{ik}(V_{ik} - p_{Ck,i})}{1+\rho} - \square_{ikk} \right) + \exp \Phi_{i0} \left(\frac{1}{1+\rho} V_{i0} - \square_{ik0} \right)}_{\text{Expected net revenue from conversions during year}} \right] - \underbrace{\frac{\tau_{i0}}{1+\rho} V_{i0}}_{\text{CPT discounted}}$$

Next consider how these equations are modified if the tax on type- k ($k > 0$) floor space is levied as a rate on the imputed land value using the residual method. The tax would be $\tau_{ULT}(V_{ik} - p_{Ck,i})$ where τ_{ULT} is the ULT rate.

$$\underbrace{V_{ik}}_{\text{Property value}} = \underbrace{\varpi_{ik}(R_{ik})}_{\text{Expected rent during year}} + \frac{1}{\Phi_{ik}} \log \left[\underbrace{\exp \Phi_{ik} \left(\frac{1}{1+\rho} V_{ik} - \square_{ikk} \right) + \exp \Phi_{ik} \left(\frac{1}{1+\rho} \left(\frac{V_{i0}}{m_{ik}} - p_{Dk,i} \right) - \square_{ik0} \right)}_{\text{Expected net revenue from conversions during year}} \right] - \underbrace{\frac{\tau_{ULT}(V_{ik} - p_{Ck,i})}{1+\rho}}_{\text{ULT discounted}}$$

In the case of vacant land the same ULT rate applies but in this case there is no construction cost so τ_{ULT} just replaces τ_{i0} .

Skipping the math, it can be shown that the both the CPT and the ULT are not perfectly neutral. For example, in the case of the CPT, we can show that the elasticity of the prices to their respective tax rates are:

$$\frac{dV_{ik}/d\tau_{ik}}{V_{ik}/\tau_{ik}} = -\frac{\tau_{ik}}{\tau_{ik} + Q_{k0}^{CPT} + \rho} \text{ for } k > 0 \text{ and } \frac{dV_{i0}/d\tau_{i0}}{V_{i0}/\tau_{i0}} = -\frac{\tau_{i0}}{\tau_{i0} + Q_{0k}^{CPT} + \rho},$$

where Q_{0k}^{CPT} , Q_{k0}^{CPT} are the model's construction and demolition probabilities respectively, under the CPT. So the prices respond to the tax rate increases by rising inelastically (less than one elasticity) and floor space values and land values respond with different elasticity as the model's construction and demolition probabilities differ, even if the tax rate were not to differ by building type. The elasticities are very similar under the ULT. However, intuitively, the ULT should be a more neutral tax since it is not levied on all of the property value but just on the imputed land value.

One question which arises is what would be a perfectly neutral tax on land and why not use such a tax. Such a tax would be a lump sum tax on each lot of land or each square foot of floor space. Suppose that the tax is T_i per unit of vacant land in some location i . The tax would be the same no matter what structural density were to be built on the lot. In the case of an existing building again the lump sum tax would not change whether the building is demolished or not. It can be shown that such a tax would not affect the construction and demolition intensity in the RELU-TRAN model and would, therefore, be perfectly neutral, not causing any distortion. The problem arises when we are forced to consider how such a tax should vary from lot to lot. Since values of land vary quite enormously within a metropolitan area, setting the lump-sum tax as uniform over all lots would be extremely inequitable. Any fair administration of such a tax that seeks acceptability would have to vary the level of the lump sum tax making it higher where values are higher and lower where values are lower. In effect then, if the variation follows land values, the tax would be perceived as a percentage of land value, hence ad-valorem.

Other taxes in RELU-TRAN

The other taxes included in the RELU-TRAN model for LA are the income tax (as the combined sum of the Federal and State income tax) and the sales tax. In the model, the income tax varies by County in the modeled region and by income quartile. The combined sum is estimated as the total taxes received divided by the total income. The sales tax rates also vary by county and we use the known tax rates. We also include the mark up between the producer-wage and the worker-wage. Included in the markup are the FICA tax, the Medicaid tax and non-wage compensation. We cannot separate these due to data unavailability. But we include a wedge between the producer and worker wage should make the model more realistic and the results more reliable.

Welfare measurement in RELU-TRAN

The aggregate benefits of a tax switch is measured by adding up: a) the consumer surplus change per year across all consumers; b) the aggregate change in tax revenue from the property tax (CPT or UPT), the income tax and the sales tax; c) the aggregate change in the gap between producer and consumer wages; d) and the annualized change in the value of all real estate. In the model, producers are modeled as making zero economic profit, hence there is no producer surplus to include other than the windfall change in real estate values in (d). As we know from the simple textbook diagram in Figure 8, a deadweight loss (DWL) is generated by taxes that are not perfectly neutral. Of course the diagram does not do justice to the model where multiple

types of real estate markets, labor markets and markets for other goods exist in each model zone and are interacting with each other.

A couple of caveats are in order here. First, in RELU-TRAN consumer choices are subject to income effects. We consider this a desirable specification. Hence we have to use a utility function which is not of the Gorman form. Consumer surplus changes therefore are not exact. We estimate these by calculating the utility changes of consumers and then dividing by the marginal utility of income evaluated at equilibrium after the change or by calculating the compensating variation. We have done both and have settled on the latter. A second caveat is that we are using a stationary equilibrium model. Hence when we calculate the change in real estate values we are doing it by subtracting the aggregate real estate values in the state before the tax switch from the aggregate values in the state after the tax switch. As explained in Anas (2003), this procedure ignores the path of adjustment and could give biased results of real estate value changes.

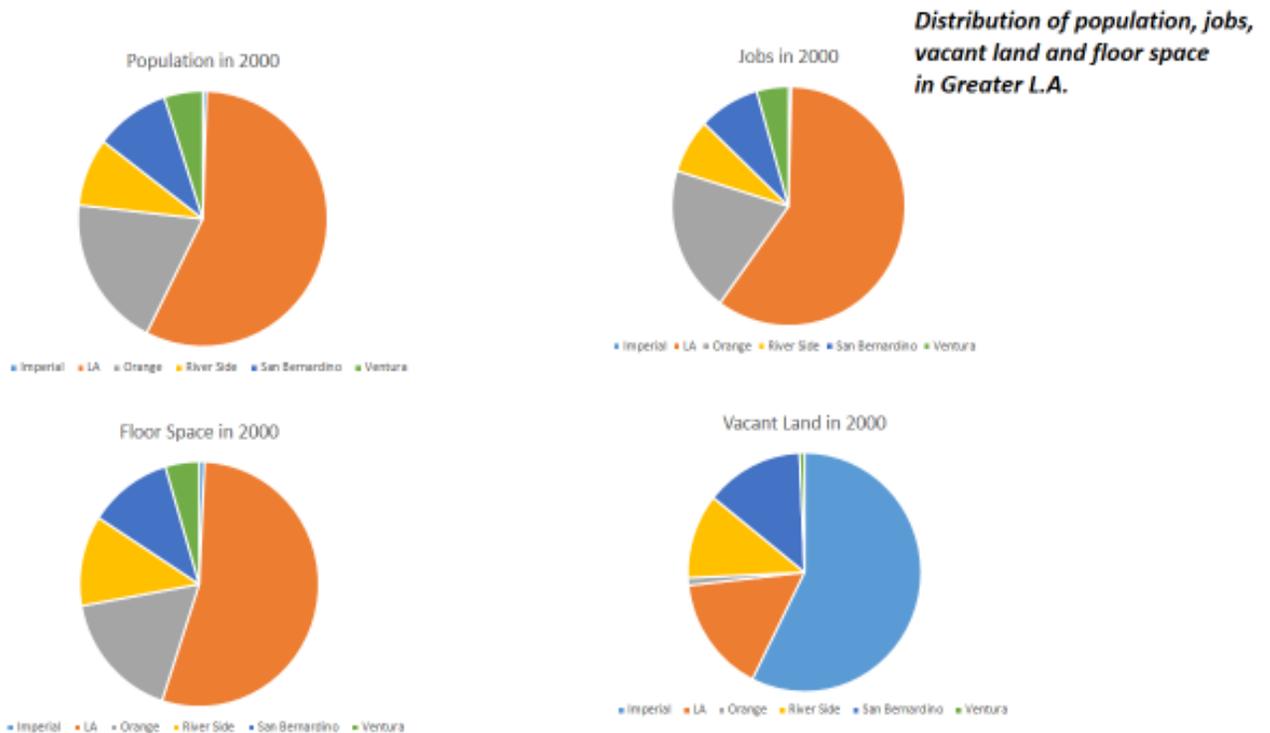
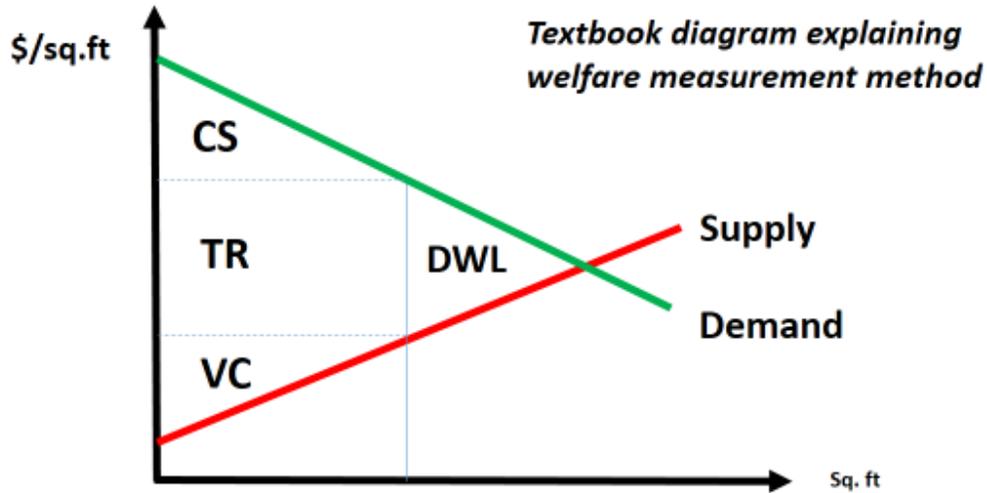


FIGURE 7
Distributional data in the RELU-TRAN LA Counties



$$\text{WELFARE} = \text{CS} + \text{TR} + \text{VC}$$

FIGURE 8

5. Substitution of a uniform land tax for a conventional property tax

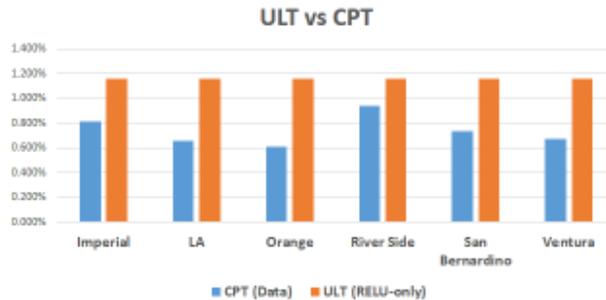
Table 2 shows the CPT rates by County. These have been estimated by dividing total property tax revenue by total property value. In the year 2000 they varied from a low 0.612% of value per year in Orange County to a high of 0.936% in Riverside County. Replacing the aggregate revenue of all these CPTs with a ULT at the same rate in all countries would require a ULT that is 1.161% of value.

Under the CPT, 14.1% of the total property tax revenue was from vacant land, 45.6% from land occupied by buildings and the remaining 40.3% is from building structures.

The first row of Table 3 shows the per person welfare effects of replacing the CPT with the ULT. The welfare changes are small but the welfare gain climbs as the ULT rate is raised.

Revenue neutral switch from the CPT to the ULT (year 2000)

COUNTY	Imperial	LA	Orange	Riverside	San Bernardino	Ventura
CPT (Data)	0.810%	0.655%	0.612%	0.936%	0.735%	0.671%
ULT (RELU)	1.161%	1.161%	1.161%	1.161%	1.161%	1.161%



Under the CPT, 14.1% of the total property tax revenue is from vacant land, 45.6% is from occupied land and the remaining 40.3% is from building structures.

TABLE 2

Welfare effects of increasing the ULT

Uniform Land Tax Rate (% of Land Value)	Per person annual \$ change						Total Welfare Change	
	Consumer Surplus	+	Buildings Value Change	+	Tax Change	=		
1.66	-7		+9.2		+7.2		+9.4	ULT replaces CPT (revenue neutral)
2.31	-56		-872		+2545		+1617	
3.31	-95		-1451		+3854		+2308	
4.31	-128		-1918		+5049		+3003	
5.31	-156		-2303		+6160		+3701	
6.31	-180		-2625		+7207		+4402	
7.31	-201		-2899		+8205		+5104	
8.31	-219		-3135		+9164		+5808	
9.31	-236		-3340		+10091		+6513	

TABLE 3

The effects of the ULT, discussed for an increase from 1.3% to 4.3% of residual land value, are as follows:

- Buildings of higher residual land value become more costly relative to buildings of lower land value.
- Single family houses have higher residual land value, hence house stocks shrink by 3.3% region-wide. This causes house rents to increase.
- Apartment stocks increase by 1.5% and apartment rents fall.
- Similarly, commercial building stocks also increase by 1% and commercial rents fall.
- In summary, a higher ULT makes houses too costly therefore some houses are demolished and higher density buildings are built in their place. This is the well-known effect from the theoretical literature discussed earlier, that a switch towards a land tax would increase structural densities.

Other effects of the ULT beyond the real estate market are:

- The lower commercial rents induce a real output increase of 0.13%. The higher output requires more labor. Hence wages increase by 0.3%.
- The spatial reallocation of jobs and population is small. Population in LA County drops by 20,632 due to the higher rents on houses, and in the more peripheral Orange County population grows by 16,890 because the rent increases of houses there are smaller.
- The higher wages dominate the lower commercial rents, leading to a higher production cost and higher prices for goods and services by 0.2%. With greater real output, aggregate sales also increase.
- Since most people live in houses, the rent increase of houses, together with the higher prices for goods and services dominate the increase of wages. Therefore, consumer surplus suffers falling by \$ 128 per year per person.

The decomposition of the aggregate welfare effects are as follows:

- Property values decrease by \$ 1,918/person/year because of the higher ULT rate.
- The property tax increases because the ULT rate has increased.
- Income tax and the wage gap increase because wages are higher.
- The sales taxes are higher, since given the higher sales tax rate, the tax base is now bigger.
- Overall welfare per person improves by \$ 3,003.

6. Substitution of a uniform land tax for the income tax or the sales tax

Tables 4 and 5 show the effects of substituting the income tax (Table 4) or the sales tax (Table 5) with a higher ULT.

A ULT tax rate increase from 1.1% to 4.1% replaces a 10% reduction in the aggregate income tax revenue, and a ULT tax rate increase from 1.1% to 1.9% replaces a 10% decrease in aggregate sales tax revenue. In each case, the ULT plus the other tax revenue is kept unchanged.

Substitution of the ULT for the income tax

The effects under the ULT substituting for the income tax are as follows:

- House rents increase because the ULT rate rises to 4.1% (from 1.1%). This leads to a 2.6% decrease in house stocks and a 1.5% in multifamily housing stocks.
- The consumer surplus of the employed improves because the lower income tax raises disposable income and consumer demand for goods and services. This in turn drives up labor demand and hence wages go up too.
- The consumer surplus of the unemployed decreases because of higher house rents, driven up by the employed who benefit from a higher income caused by the higher wages.
- Overall, consumer surplus improves by \$234 per person because the higher consumption and wages dominate the increase in housing costs.

Substitution of land tax for the income tax

Per person annual \$ change							
Consumer Surplus	+	Building Value Change	+	Tax Changes	=	Total Welfare Change	A Uniform land tax increase from 1.1% to 4.1% replaces revenue loss from a 10% decrease in the income tax for all quartiles. Income tax plus property tax revenue is unchanged.
+234		-1652		+1768		+351	
				+1935	Property tax change		
				-268	Income tax change		
				+101	Sales tax change		
				0	Wage tax change		

TABLE 4

- Building values per person decrease by \$1,652 because of the higher ULT.
- Tax revenue from all sources increase by \$1,768 per person.
- The property tax increases because of the higher ULT, the sales tax increases because of higher price of goods and services and the higher demand, while the income tax revenue drops due to the lower income tax rate.
- Higher wages, and higher commercial rents caused by increased consumer demand push up production cost and therefore prices are higher by 1%. Real output, driven by demand, is also greater than before by 0.6%, despite the higher production cost.
- Regional gross product increases by 1.6%.

Substitution of the ULT for the sales tax

In the case of the sales tax the results are as follows:

- The sales tax revenue drops by \$ 630 per person because of the lower sales tax rate. This is due to the relative inelasticity of the demand for most goods and services. That is because the ULT is not a perfectly neutral tax it is in fact possible that the sales tax is relatively more efficient than the ULT and that is what happens here.
- The sales tax base (or aggregate output value) increases by a small amount, because: 1) Although wages increase, commercial rents decrease due to more commercial buildings as a result of the higher ULT rate. These opposite wage and rent changes cancel the effect on producer price, leading to small increases in after-tax price. 2) Since the after-tax price increase is small, real output change is also small.

Substitution of land tax for the sales tax

Per person annual \$ change						
Consumer Surplus	+	Building Value Change	+	Tax Changes	=	Total Welfare Change
+59		-617		+5.13		-553
				+627	Property tax change	
				+7	Income tax change	
				-629	Sales tax change	
				0.15	Wage tax change	

A uniform land tax increase from 1.1% to 1.9% replaces revenue loss from a 10% decrease in the sales tax revenue. Sales tax plus property tax revenue is unchanged.

TABLE 5

7. Conclusions

We saw that the ULT (a uniform ad-valorem tax on residual lot values) has positive overall welfare effects when it is substituted for the conventional property tax or for the income tax. But it has a negative overall welfare effect when it is substituted for the sales tax.

The ULT does induce a shift from low density SF houses to higher density apartment and commercial buildings as is predicted by the theoretical spatial equilibrium models which were reviewed in section 2.

In the simulations done so far, the ULT had small effects on traffic congestion.

In the simulations done so far, the ULT had spatially varying effects increasing jobs, population and urban sprawl in some outlying areas while decreasing it in others. This results is different from that predicted by the simple theoretical spatial equilibrium models which employed the assumption of monocentric cities.

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