A Shock to the System: How can Land Value Taxation change the Face of Cities?

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Abstract

This paper deals with implementing land value taxation in a city. The System Dynamics method is used to gain insights regarding the consequences such a policy would have on the city's growth. The hypothesis that when all taxes except for the land-value tax are suddenly eliminated the construction of new houses and new businesses will be reinforced is tested under different scenarios. The model used is a simplified version of the Urban Dynamics model by J. Forrester (Forrester, 1969), with the urban area being divided in 4 zones. The results showed that the implementation of a land value tax and the nullifying of all the other taxes generates results and behaviors, which are almost the same as in the case where all the taxes existed. On the other hand, if the land value tax is introduced from the beginning- with no other tax present- the city gets the most beneficiary results. Finally, the time of the implementation, but also the level of the land value tax are two crucial factors, which could generate unwanted results.

Keywords: Land value taxation, urban dynamics

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1. INTRODUCTION

Urban development is a growth process of urban areas that result in cities. An urban area is defined as a system of interacting industries, housing and people (Forrester, 1969). The interconnections between the various parts of the system cause a city to develop. As the area develops, new houses are being built, the land area is being filled and new businesses are being developed to provide for the need for consumption goods.

However, the depletion of available land slows down growth, and the aging process causes stagnation. In this phase, without some kind of renewal, the area which was previously characterized by growth, becomes one of aging houses and declining industries.

One policy that could cause the renewal of an area's growth could be the Land Value Taxation. The efficiency of land value taxation was established knowledge since Adam Smith (Adam, 1776), but its most prominent supporter was Henry George. He described his first book "*Progress and Poverty*" as *An inquiry into the cause of depression and of the increase of want with the increase of wealth; The Remedy* (George, 1879). After a description of the socio-economic situation, he states his remedy as: *"We must make land common property"* (George, Progress and Poverty, 1879, p. 238)

The notion behind that idea is that every community has a right to the land on which it exists:

To this land in its natural state, undrained, unfenced, unfertilized and unoccupied […], every individual in the community has an equal right, while all the individuals together have a joint right to the value for use which society has conferred upon these natural advantages. This value for use is known as "Land Value" (Root, 1975)

By taxing the value of the land and not the buildings or the improvements upon it, the landowner has an incentive to improve it in order to gain from what would otherwise be a lot of land that would cost money without returning any revenues. Taxation on production of wealth decreases the amount of wealth, but taxation on the land value does not decrease the amount of land. Therefore, the taxation could be as high as the community wishes "*without lessening the amount of land, or the capabilities of land, or the inducement to use land*" (George, 1881).

The tax on land value should be also borne by the landowner and not the tenant. If a landowner tries to pass on the tax to the rent he is charging, he would face vacancies (Falvary, January 2006). It has also a number of other benefits: it stops speculation that prevents land from being built, it ensures that the most valuable sites are developed first and discourages urban sprawl (Monbiot, 22 January 2013).

Mirrlees et al. (2011) state that the challenge of economic tax design is to achieve social-economic objectives. But tax reforms could achieve more than that. Contrary to current tax systems, which reinforce the status quo, the dynamic nature of land value taxation could be used as a lever to change both individual and system behavior.

However, a city is a complex system and an action like the implementation of land value taxation- though beneficiary in theory- may have unforeseen consequences. That phenomenon was described by Forrester as "counterintuitive behavior of social systems" (Forrester, Counterintuitive Behavior of Social Systems, 1971). With *Urban Dynamics* in 1969, Forrester introduced a new method of analyzing such complex issues, which became known as System Dynamics.

In section 2 the method used in this paper and a short description of the literature that influenced the present model are presented. In section 3 the model and the modeling choices are developed. The results and the different scenarios are analyzed in section 4, while conclusions, a reflection on the modeling process and suggestions for further research are described in section 5.

2. METHOD

This paper uses the System Dynamics approach to gain insights regarding the consequences of land value taxation on the growth of a city. Many System Dynamics models regarding urban dynamics exist: Alfeld (1976), (1995), Alfeld and Meadows (1970), Schroeder (1975) and others. This paper builds on the original Urban Dynamics work of Forrester (1969).

The traditional Urban Dynamics model, represents the city as a system set in an environment with which it communicates. People can move in and out of the area based on the relative attractiveness of the city, when compared to its environment. Figure 1 illustrates the above-described system.
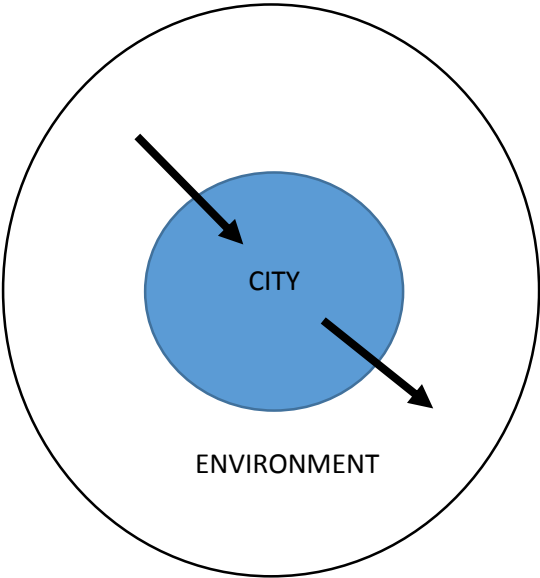

Figure 1 the city and its environment

In this paper, a simplified version of the *Urban Dynamics* model is used, but the city is divided in 4 different zones. Each zone has a housing sector, a business sector and a population. Besides the movement in and out of the city limits, movement from one zone to the next one is also included. The notion of dividing the urban area is not new and was previously analyzed by Schroeder (1975), Burdekin (1979) and others, the work of which influenced the present paper.
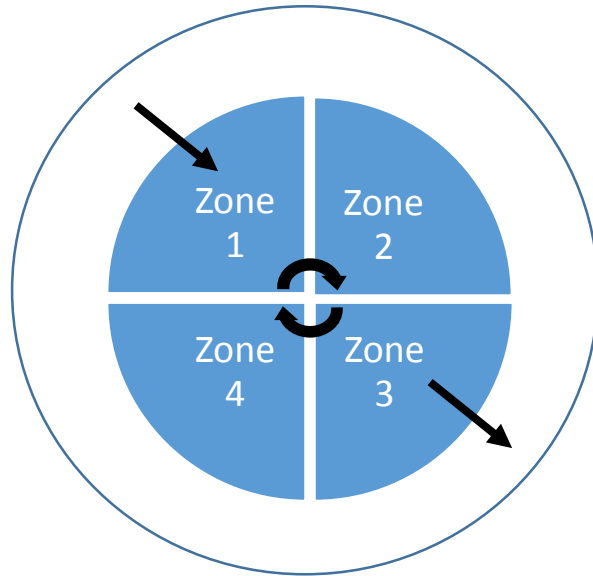
Figure 2 the city and its environment

Halfway through the simulation a shock will be implemented in the model: the taxes will be nullified and the land value tax, which was added on the taxes of the original model, will be increased. Hence, the hypothesis is that when all taxes except for the land-value tax are suddenly eliminated, the construction of new houses and new businesses will be reinforced. The purpose of the paper is to investigate this shock and its consequences under different scenarios .

3. THE MODEL

The basic concept behind the model remains the same: each zone has a housing sector, a business sector and a population, which interact with each other. Furthermore, it is assumed that the land is owned by landowners, who neither they nor their behavior is present in the model.
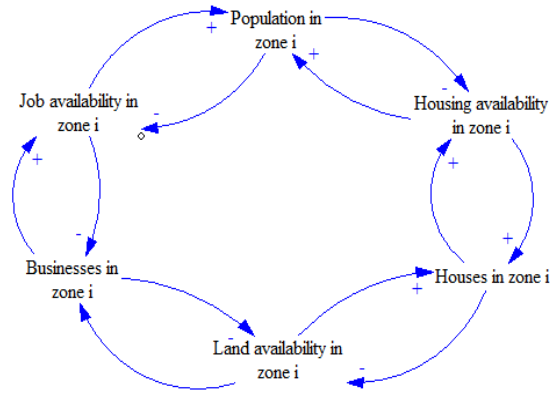

Figure 3 Causal Loop Diagram

3.1 The Population

The population consists of Workers and Unemployed, but not of Managers as in the original one. The basic elements of that part of the model are taken from Sanders (Sanders & Sanders, 2004). In figure 3, the two groups of persons are displayed and how they interact with each other.
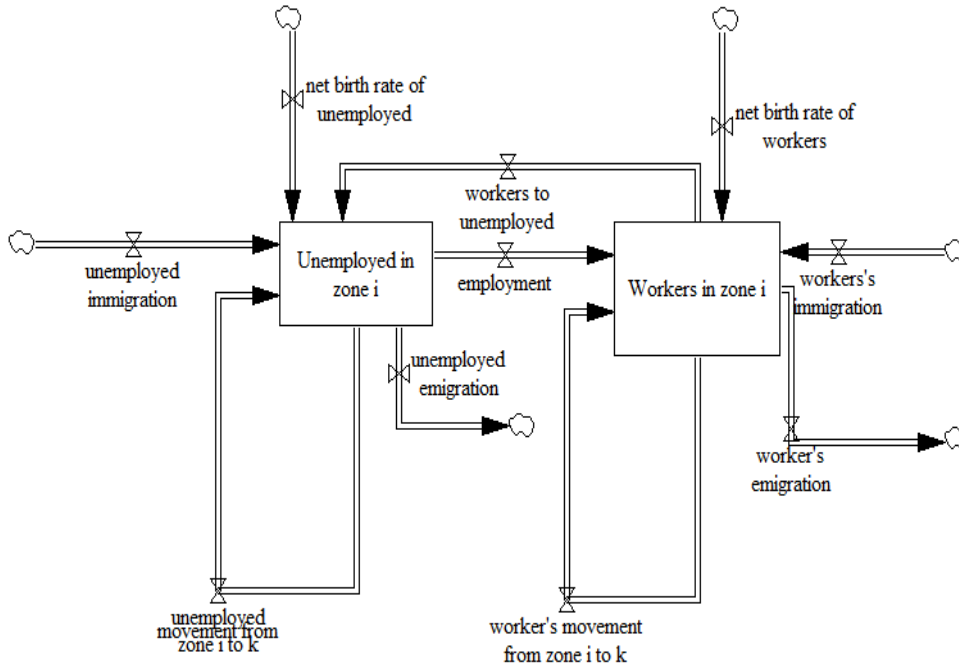

Figure 4 Population in zone i

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The principle of *attractiveness* remains. Both the inner- and outer-city movements, for the unemployed part of the population, depend on:

- Housing availability
- Job availability

For the *Workers* one more element is added to the notion of *attractiveness* and that is:

- The social mixture of zone i

3.2 The Housing Sector

The construction of *Houses* follows the original model and it depends on:

- Land availability
- Taxation Satisfaction
- Demand for housing
- Job availability
- New businesses growth rate

The new element added is the attractiveness because of:

- Land value in zone i

3.3 The Business Sector

The same applies to the *Business Sector*, which consists of *New Businesses, Mature Businesses and Declining Businesses*. The construction of *New Businesses* depends on:

- Land availability
- Taxation Satisfaction
- Labor availability
- New businesses growth rate
- Mixture of businesses and
- New Business Value

3.4 The Financial Sector

A new addition is the *value* of every kind of building in the model and of course the *Land Value*. It is a common rule in the real estate sector that everything depends on location. The notion of location in the model is expressed as the number of *Houses, New Business and Mature Businesses* divided by all the buildings in the zone.

That fraction influences the *Land Value* over an adjustment time. On the other hand, the value is depreciated by a depreciation rate.
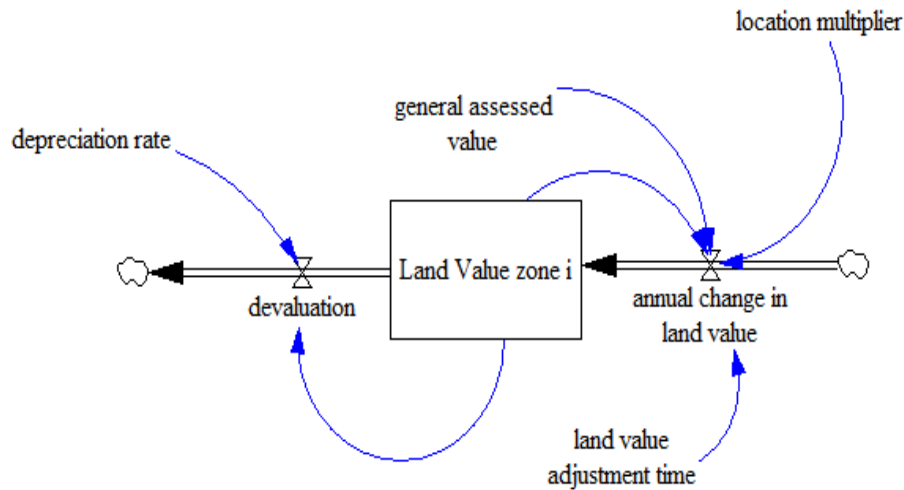
Figure 5 Land Value in zone i

The same logic applies to the Value of the different kinds of buildings in each zone.

In addition, the financial sector contains a simplified version of a taxation system. In this paper, the Housing Sector is taxed by a *property tax*, the Business Sector by a *business tax* and there is also the *land value tax*. The different taxes are the same for all the city zones, but the Revenues that the community receives depend on the different *value* of the buildings in the different zones. The expenditures are calculated by multiplying a fixed amount of money the city spends for the different kinds of persons and buildings and the number of persons and buildings. The taxation system is static, meaning that there is no forecast for the tax ratio that might be needed, and it serves only as an indicator of how the model works.

During the simulation, *the property and business taxes* will be nullified and the *tax on land value* will be increased.

4. RESULTS

The simulation of the model during 100 years is used first to examine the hypothesis and then to test the consequences of different shocks in the taxes under uncertainty. The model was simulated on *Vensim* (integration method:RK4, Time Step: 0.0625), while for the uncertainty testing the simulation was performed with the help of the tool developed by E. Pruyt and J.H. Kwakkel at TUDelft (2013).

4.1 Base Model Behavior

To gain a better understanding of the results, two more extreme simulations were used as reference. One where the taxes have a fixed value for the entire period of the simulation- named all_taxes (*property tax=business tax*=0.1, *land value tax*=0.1)- and one where the *property tax* and the *business tax* are zero and the *land value tax* has a higher value-named land_value_tax (*property tax=business tax*=0, *land value tax*=0.5).

As it can be seen in the graph below, the land is occupied slightly faster when land value taxation is implemented.
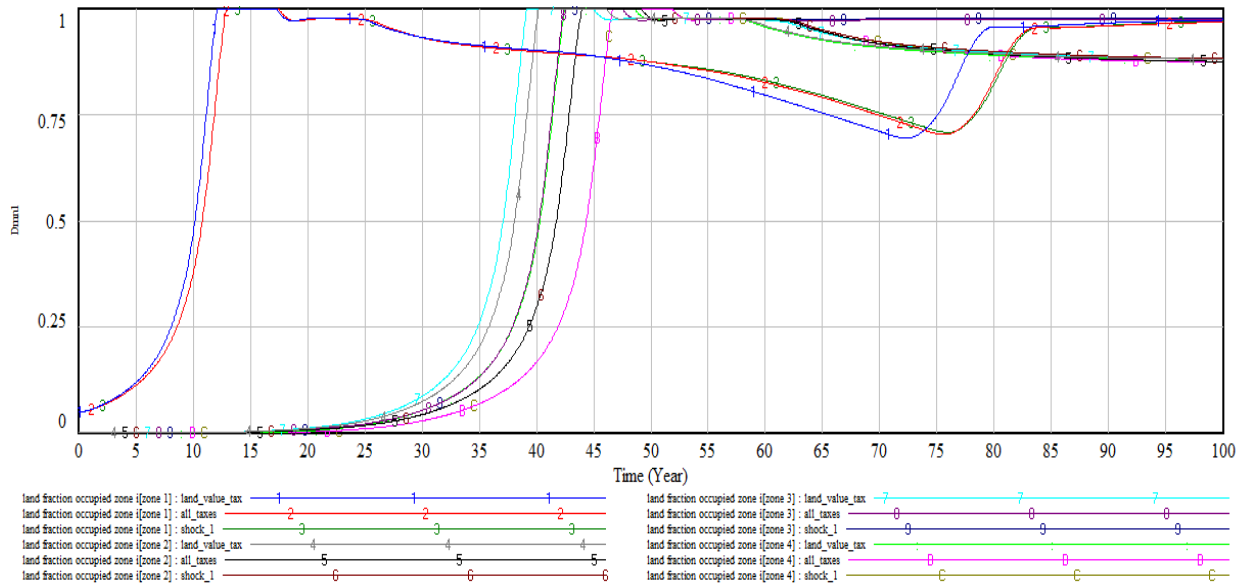
Figure 6 Land fraction occupied for the different zones and the different simulations

After zone 1 has been fully occupied and it starts to stagnate, the development of the other three zones begins. The shock of nullifying the property and business tax and increasing the land value tax, has almost identical results as the one where the taxes remain constant during the entire simulation period. On the other hand, when the land value tax was the only one from the beginning, the development begins sooner, it reaches the peak faster and after the stagnation of the other zones is achieved, the re-development of the previous zones begins faster and at a higher rate.

In terms of Houses and New businesses, the same effect can be observed.
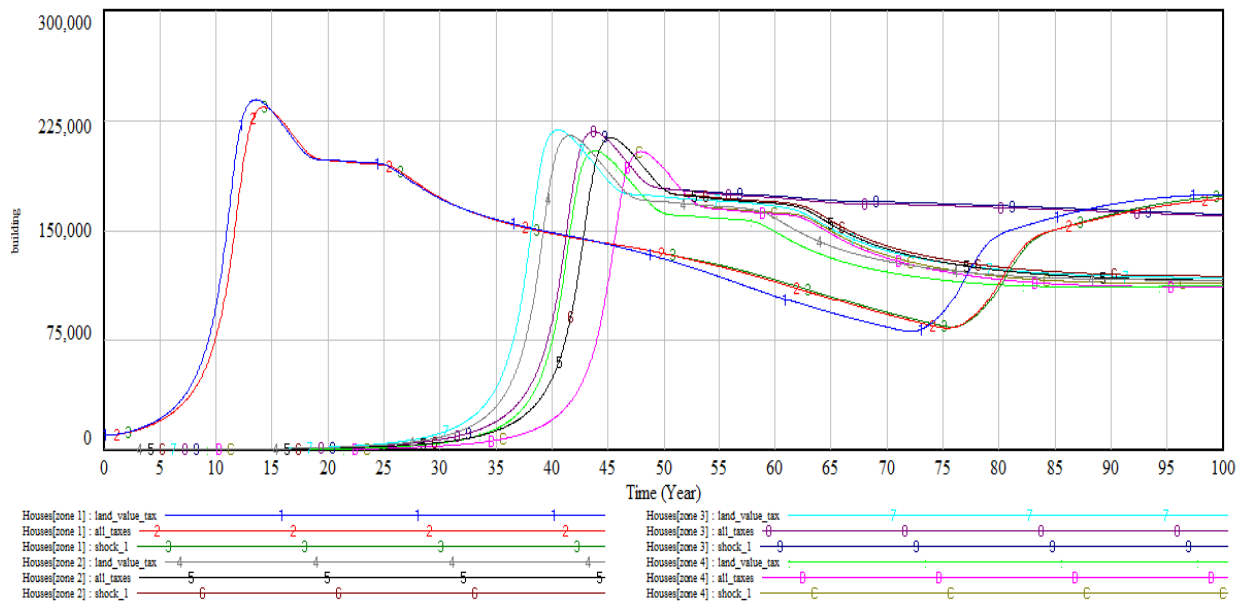

Figure 7 Houses for the different zones and the different simulations

With the land value tax as the only tax from the beginning, the construction of new houses begins sooner and it goes a little higher. Once again, the implementation of a different taxation system halfway

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through the simulation does not seem to affect the construction of new houses any different than in the case where all three taxes exist from the beginning.

The same can be also said about the construction of new businesses, as it can be seen in the graph below.
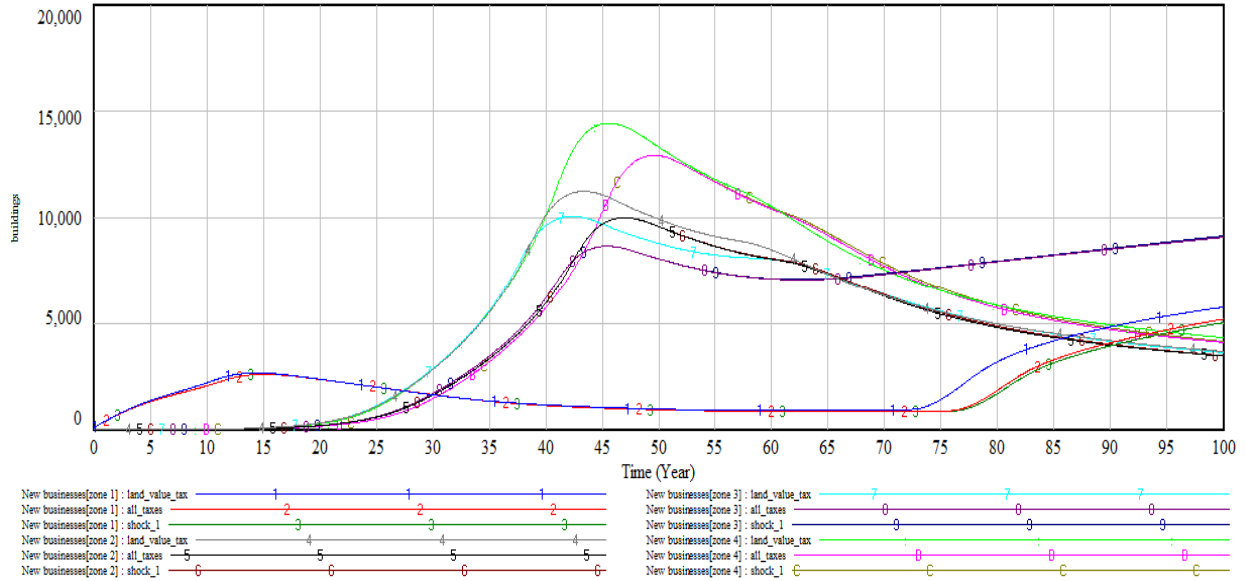

Figure 8 New businesses for the different zones and the different simulations

Another two indicators that confirm the above results, are the job availability, the population and the surplus of the city.
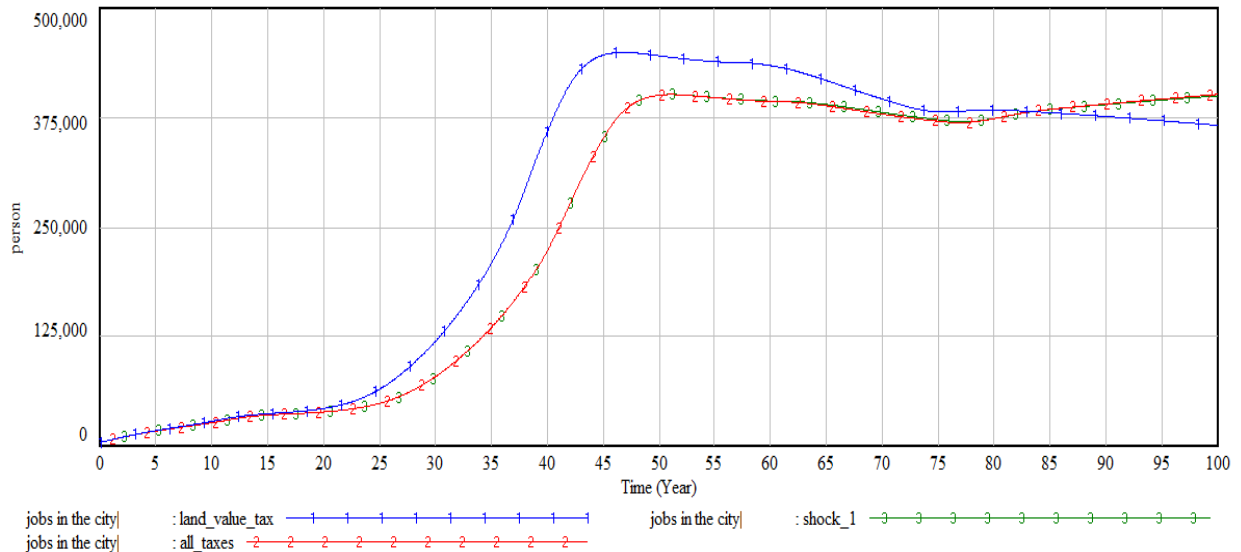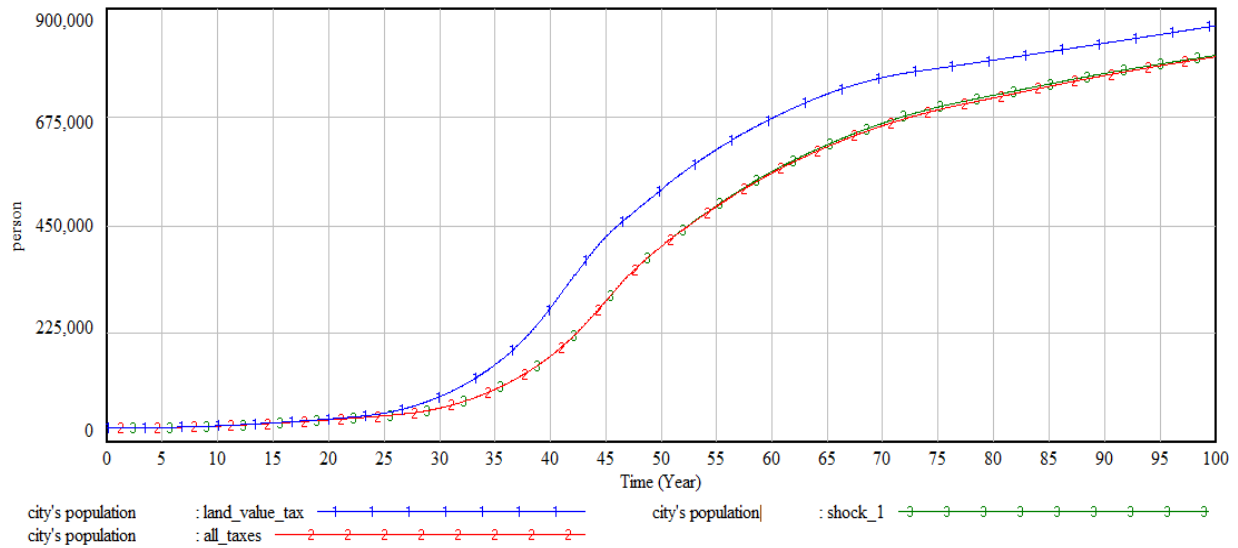

Figure 9 job availability in the entire city
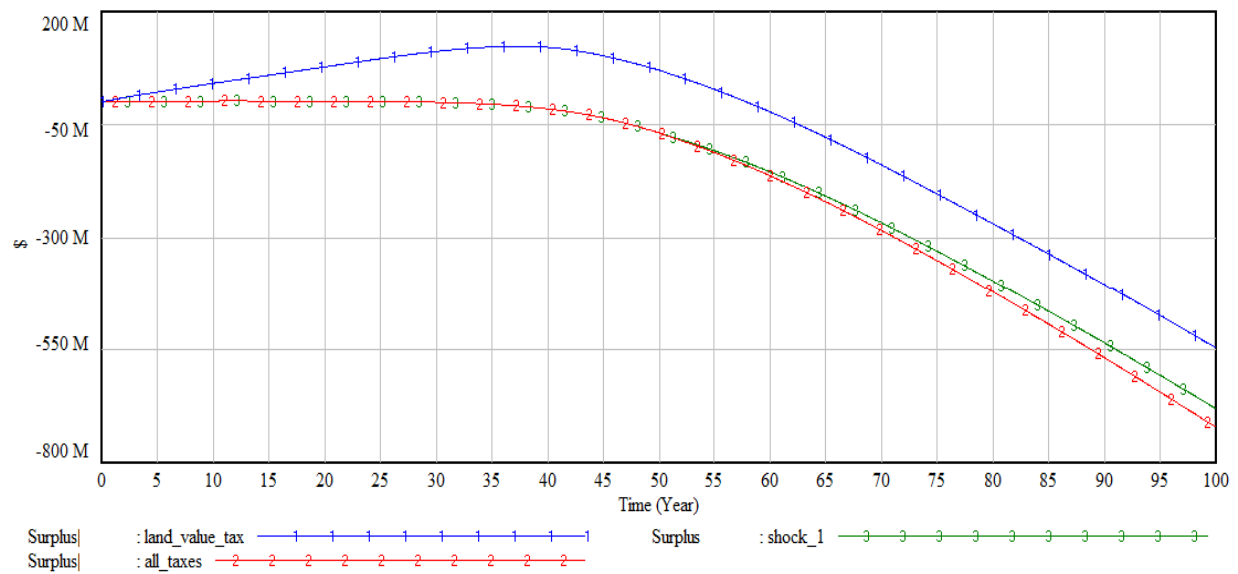
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Figure 10 The city's population

Figure 11 Surplus

The sudden taxation shock has almost identical results like the one where all taxes are existent. On the other hand, a taxation system where only the land value tax exists from the beginning seems to be the most beneficiary for the city.

As it was mentioned in section 3, the construction of new houses and businesses depends on a number of factors, one of which is the taxation attractiveness. The absence of the property tax and the business tax reinforces the city's development, but the above graphs also show that the time that the land value tax will be implemented plays a crucial role.

4.2 Scenario Analysis

The simulations that were displayed in the previous section can be considered extreme. On one hand, the simulations *land_value_tax* and *all_taxes* include static taxation systems that do not change during the simulation period. On the other hand, *shock_1* introduces an increase in the land value tax and the nullifying of the other taxes on the year 50 of the simulation. To test the consequences of different taxation systems for the city's development, a scenario analysis was performed, with different values for the taxes and a different time of implementation. A list of the different simulation settings can be seen in the table below:.

	Land value tax	Property tax	Business tax
Shock 1	0.1+STEP(0.2, 50)	0.1-STEP(0.1, 50)	0.1-STEP(0.1, 50)
All taxes	0.1	0.1	0.1
Land value tax	0.5	0	0
Shock 2	0.1+STEP(0.2, 25)	0.1-STEP(0.2, 25)	0.1-STEP(0.2, 25)
Shock 3	0.1+STEP(0.2, 25)	0.1	0.1
Shock 4	0.1+STEP(0.4, 25)	0.1+STEP(0.2, 25)	0.1+STEP(0.2, 25
Shock 5	0.1+STEP(0.4, 25)	0.1-STEP(0.1, 25)	0.1-STEP(0.1, 25)
Shock 6	0.1+STEP(0.2, 10)	0.1-STEP(0.1, 10)	0.1-STEP(0.1, 10)
Shock 7	0.1+STEP(0.4, 10)	0.1-STEP(0.1, 10)	0.1-STEP(0.1, 10)
Shock 8	0.1+STEP(0.2, 10)+STEP(0.2, 50)	0.1+STEP(0.2, 10)-STEP(0.3, 50)	0.1+STEP(0.2, 10)-STEP(0.3, 50)

Table 1 Equations of the different taxation regimes

The results confirmed the recurring theme of the model: the implementation of a land value tax does not have a significant effect on the city's development and they are worse than the case where the land value tax exists from the beginning of the simulation. For example, as it can be seen in the graph below, the fraction of the land that is occupied in zone 1 reaches the peak faster with the existence of only the land value tax from the beginning than in the other cases.
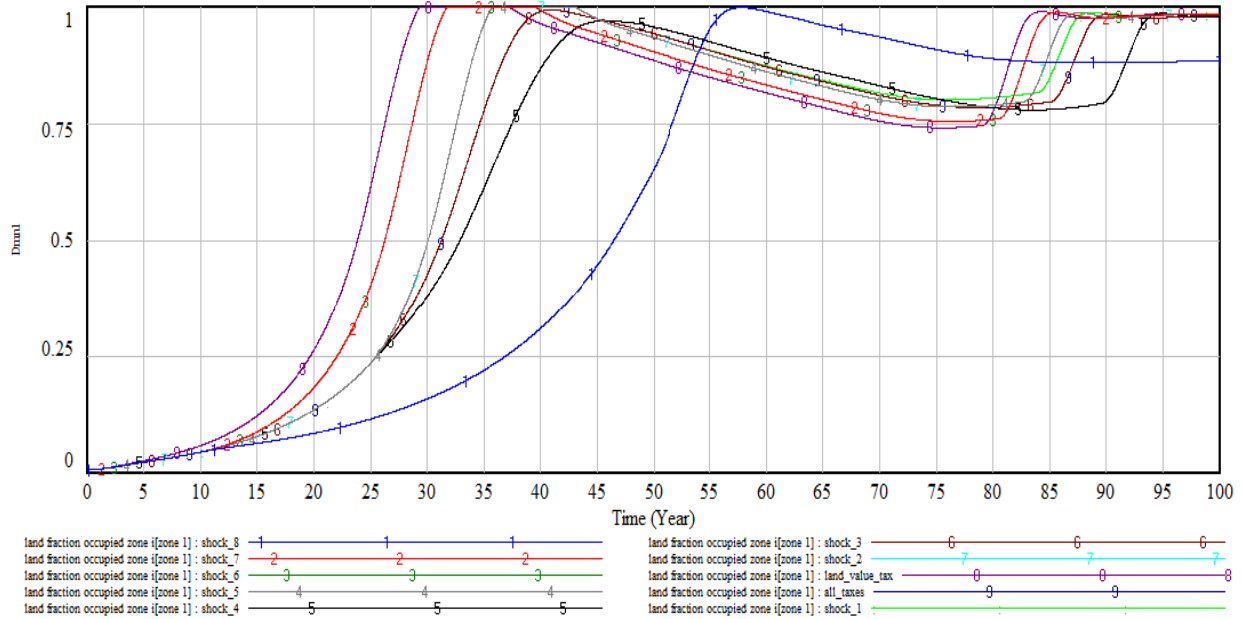
Figure 12 Uncertainty analysis for land fraction occupied of zone 1

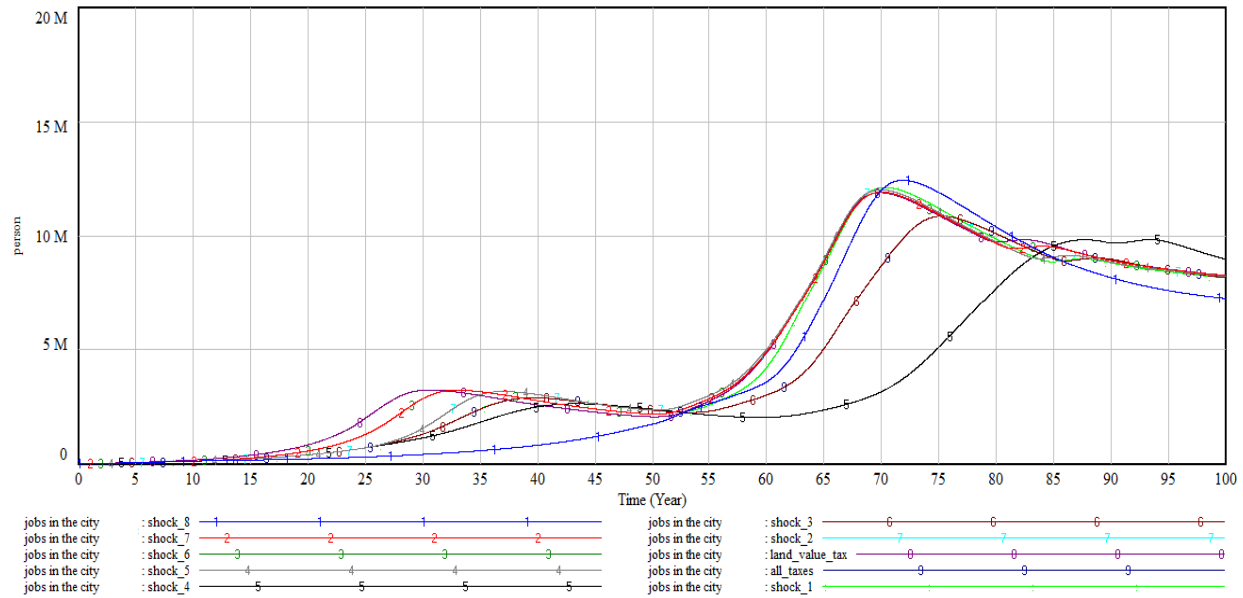The same can be observed on the job availability in the city.

Figure 13 Uncertainty analysis for job availability in the city

The different curves show similar behavior. The peak and how fast it is reached depend on the level of the land value tax and the time of its implementation. These two factors seem to create an interesting effect on the construction of new businesses in the different zones.
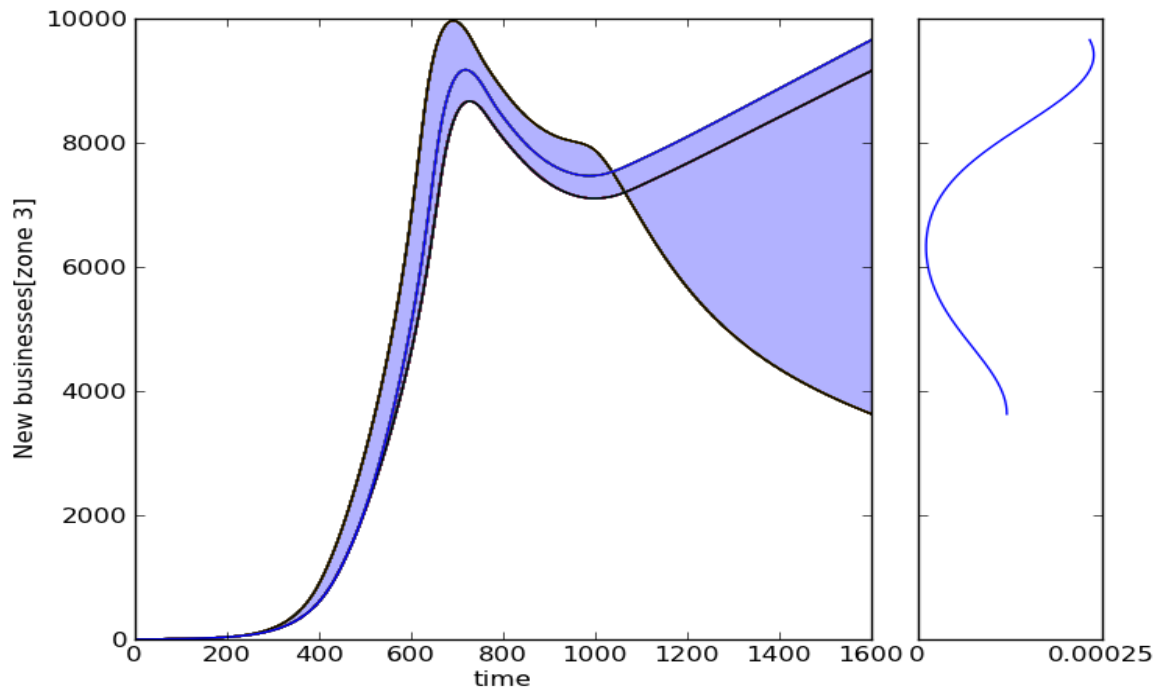
Figure 14 Uncertainty analysis for new businesses in zone 3

From the graph above it can be seen that the time of the shock implementation and the level of the land value tax can have different effects on the different zones. The new businesses in zone 3 reach a high level when the land value tax is implemented early in the simulation, but their number reaches the lowest point also during the same simulation. A PRIM analysis (Chong & Jun, 2008)confirmed that the start time of the policy makes the difference. Although the time of the implementation is at an early stage, after almost 80 years the number of new businesses is decreased by more than half.
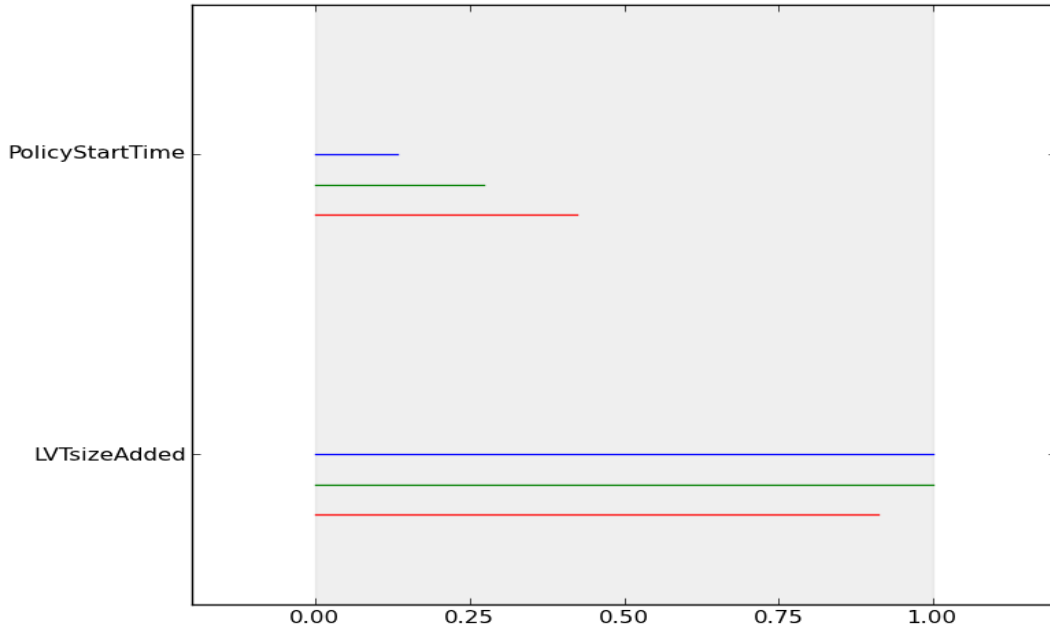
Figure 15 PRIM Analysis for the new businesses in zone 3

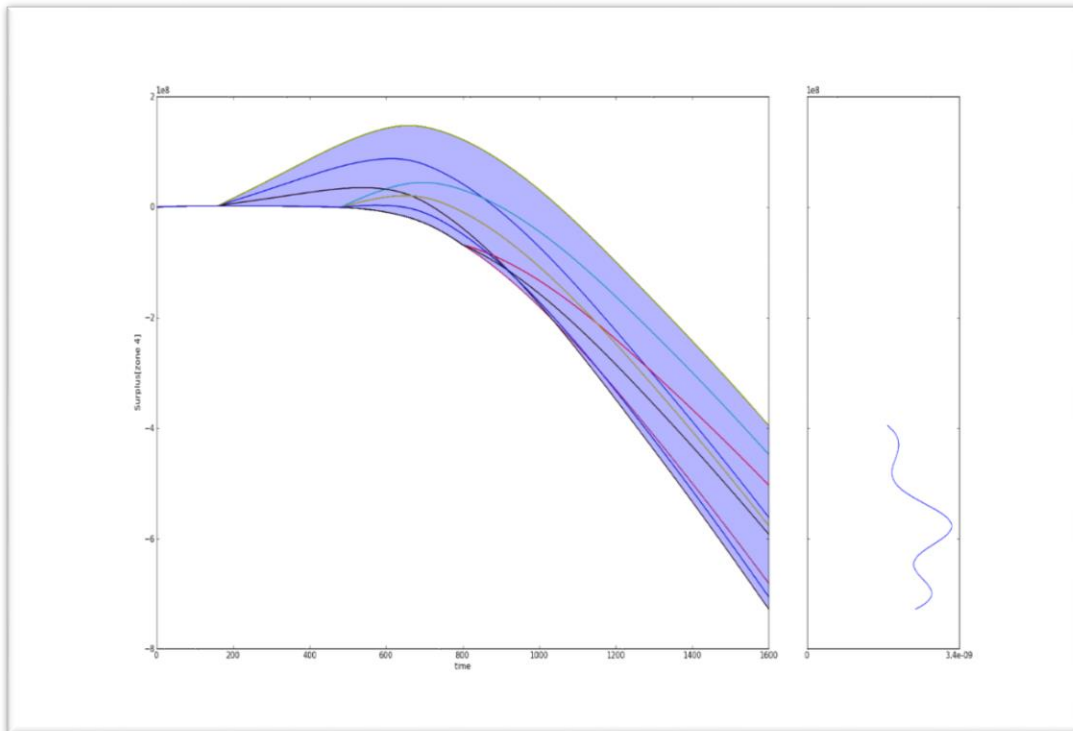The same effect can be observed with the city's surplus.

Figure 16 Uncertainty analysis for the city's surplus

An earlier implementation of a land-value-tax shock can lead to the lowest surplus if the level of the land value tax is not high enough. This happens partially, because the level of the land value tax was

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lower than the sum of the absolute values of the original taxes. On the other hand, with the same implementation time and the appropriate tax level-meaning that the tax level is high enough to compensate for the loss of the other taxes- the city's surplus is the highest.

5. CONCLUSIONS

In theory, the land value taxation creates incentives to use the land and construct new buildings, which would cause a city to develop. However, as Forrester pointed out, in complex systems any action can have unforeseen consequences (Forrester, Counterintuitive Behavior of Social Systems, 1971).

In this model, the implementation of a land value tax and the nullifying of all the other taxes generates results and behaviors, which are almost the same as in the case where all the taxes existed. On the other hand, if the land value tax is introduced from the beginning- with no other tax present- the city gets the most beneficiary results.

Finally, not only the time of the implementation but also the level of the land value tax are two crucial factors. An earlier implementation could have different effects on the different zones, in terms of new houses and businesses. Furthermore, an earlier implementation but with inappropriate level of tax, could generate unwanted results.

Forrester's Urban dynamics model can serve as a good start for the dynamic analysis of land value taxation. Further efforts could be focused on a more detailed taxation system and a more detailed population sub-model, where the population movements inside the city zones could be better defined and modelled. Additionally, the behavior of the landowners could be introduced to reach a higher level of detail and better understand the dynamics of a land value tax implementation. Moreover, the various factors that affect the construction of new houses and businesses depend heavily on variables that contain LOOKUP functions. An uncertainty analysis on those variables could generate different behaviors that would help understand better what influences and to what extent the construction of new buildings. Finally, different taxation implementations with more extreme values and many different implementation times could be used to show the extent of the robustness of the land value taxation.

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