LAND VALUE CAPTURE POTENTIAL OF THE LISBON SUBWAY: ESTIMATION AND INTEGRATION WITH THE CURRENT FISCAL SYSTEM

L. Miguel Martínez, CESUR, Department of Civil Engineering, Instituto Superior Técnico, Technical University of Lisbon (martinez@civil.ist.utl.pt)

José Manuel Viegas, CESUR, Department of Civil Engineering, Instituto Superior Técnico, Technical University of Lisbon (viegas@civil.ist.utl.pt)

ABSTRACT

The aim of this paper is to estimate the value capture potential of the Lisbon subway (Metro) and examine its integration with the current fiscal system in order to develop a new financing scheme for the infrastructure development. This study was developed for the Lisbon Metropolitan Area (LMA) as part of a broader study that intends to develop new land value capture financing schemes for public transportation in the LMA. The paper focuses on the municipality of Lisbon where the subway system mainly operates, although new developments of the system reach other municipalities (Amadora and Odivelas).

The paper tries to measure, using spatial hedonic pricing models developed in previous stages of the study, the extent to which access to transportation infrastructure currently is capitalized into house prices market and into the commercial and offices market.

A Monte Carlo simulation procedure is used to estimate the market composition of the residential, commercial and office sectors from the census aggregated statistical data available at city block level, leading to an estimate of the value capture potential of the subway in the Lisbon municipality. The potential value capture estimate is then used to estimate an annual tax that could be charged, which is compared with the annual financial cost of the Subway infrastructure. Finally, the estimated tax is compared with the existing municipal land value tax in order to analyze the viability of its integration with the current fiscal system.

The results suggest that there is a significant potential of the use of this instrument to finance the Subway infrastructure.

Keywords: Value Capture, Transport Financing, Fiscal Simulation, real estate, hedonic price models, Lisbon' subway.

INTRODUCTION

Most of the cities across the world are facing today the challenge of financing public transport. For several decades now, Urban Public Transport (UPT) has been unable to collect from its clients revenues enough to cover its production costs. The fact that this is seen as an indispensable service in all medium and large cities, accompanied by the operating constraints and the multiple, partially conflicting, objectives under which it performs, have largely prevented radical political moves to force the sector to operate at levels of cost coverage more in line with the normal market economy (Viegas, 2005).

In parallel with these financial difficulties, the service provided by UPT, even with younger fleets and more comfortable vehicles, has not been attractive enough to resist to the higher availability and comfort provided by the private car, and the long term market share of UPT has been declining in all cities, with only a few recent short term exceptions. So, the financing problem of UPT, partly explained by this loss of competitiveness and patronage, is accompanied by a problem of generally low quality and sustainability of Urban Mobility (Viegas, 2005).

Simultaneously, accessibility to desired destinations tends to play a major role in location decisions of activities as well as in households residential location, which uplifts value of land in highly accessible locations. The monetary value of this accessibility is reflected in the value of a home or a business, in addition to the value of other features such as the specific physical attributes of the building and neighbourhood characteristics (Lari, Levinson et al., 2009).

Value capture then arises as the process whereby a funding agency (e.g. the city, the region or the state) attempts to recover a share of the value added to property resulting from any infrastructure development (Hass-Klau, 2006).

This paper examines the value capture potential of the Lisbon's Subway and looks at its integration with the current fiscal system in order to develop a new financing scheme for the infrastructure development. The paper focuses on the municipality of Lisbon were the subway system mainly operates, although new developments of the system reach other municipalities (Amadora and Odivelas).

This study uses a Monte Carlo simulation procedure in order to estimate the market composition of the residential, commercial and offices sectors from the aggregated statistical data available at city block level, leading to an estimate of the value capture potential of the subway in the Lisbon municipality. The potential value capture estimate is then analyzed in order to extract an annual tax for dwellings and commercial areas that could be charged as a Special Assessment (SA) tax. This annual potential revenue is compared with the annual financial cost of the subway infrastructure development, allowing a first insight on the value capture impact on the financial infrastructure development. Finally, the estimated tax is compared with the existing municipal Land Value Tax (LVT) in order to analyze the viability of its integration with the current fiscal system.

LITERATURE REVIEW

The funding of transport projects in most developed countries has become increasingly complex since the Second World War. In the early post-war period transport infrastructure projects were primarily funded through national government, with contributions sought by users either directly or indirectly (e.g. fares, petrol taxes, vehicle registration duty etc). The focus of such investment was more inclined to road and airport schemes, rather than railway and non-mechanized forms of transport (GVA Grimley, 2004).

Over the last 20 years there has been an increasing shift towards deregulation of public transport, allied with encouragement of private sector involvement in transport project funding, and indeed, even design, construction and operation (Vivier, 1999; Worsey, 2000).

The main forms of direct private sector involvement in terms of funding transport schemes has been through PFI/PPP contracts, Design, Build, Finance and Operate (DBFO) contracts, and direct equity funding. In addition, support can be gained from government for the promoters of schemes through grants, as well as from the European Union, as well as other funding streams set up by the European Commission (Faber, 2000).

In addition, the private sector can be involved in funding transport measures through various indirect methods (Lichfield and Connellan, 2000; Hack, 2002). This includes:

- Statutory undertakers providing infrastructure (e.g. water and sewerage) and passing these costs on to the developer, who in turn may pass them on to the eventual consumer of the property or to the selling landlord.
- Environmental and public health factors can require infrastructure to be funded on the basis of the polluter pays principle. In other words, developers may be required to provide new infrastructure to ameliorate adverse impacts of a development.
- Related to this is the imposition, as part of planning permission approval, to seek new, but related, infrastructure, such as road improvements.

Public investment in transportation infrastructure is under pressure due to the increasing financial needs for other social obligations of Governments, which have looked to various alternative sources of funding to supplement government financing for transport, or even replace it (Berry and Sims, 1999; Simon, 1999; Godier, 2002; Ubbels and Nijkamp, 2002).

Under this context, some public transport alternative funding methods that have been introduced in some countries. Some of the alternative methods are focused on the implementation of a land value capture mechanism, which can be addressed with different approaches.

A number of published studies have investigated the concept of value capture to fund transit considering that property values enhancements were only within public transport corridors (i.e. within about 500 meters of a public transport stop or station, that is, the distance that people are typically willing to walk). Borhart (1994) states that this perspective underestimates the full impact. A greater capital improvements revenue base would be available to transit agencies if rising land values within an entire region were appropriated through a general land-based property tax.

There are many examples of potential or successful land value capture to fund transit like Hong Kong's land leasing mechanism (Hong, 1996). Rybeck (2004) has also estimated the added land values sequential to the development of Washington D.C.'s Metro, and found a surplus of incremental value that could be charged. Riley (2001) found that the Jubilee Line extension of the London tube had generated surplus values enough to finance all the infrastructure costs.

A substantial portion of the capital costs associated with constructing public transit facilities is land acquisition. This cost could be effectively reduced if ground rents were collected. That is, when the public sector captures incremental land values through the general property tax and through special levies on land holdings in transit corridors, less value remains for private owners to capitalize into price. This dampening of land prices helps to reduce land acquisition costs (Smith and Gihring, 2006).

Other possible revenue sources include joint-development, and the leasing of sites near stations (Urban Land Institute and Associates, 1979; Roeseler and Vondosky, 1991; Scheurer, Newman et al., 2000). This can provide a direct source of income towards the installation of the service while guaranteeing superior accessibility and a certain volume of potential customers frequenting the site (Scheurer, Newman et al., 2000). It also assures some degree of ridership for the transport project.

In the past, private developers often built transit systems to urban fringe neighborhoods and recouped the capital costs from the sales of developed sites (i.e. Japan) (Tsukada and Kuranami, 1990). Such profits from land residuals are commonplace in the private sector, but could reasonably be extended to the public domain, where local government covers the financial risk and the cost of building transit systems.

Cervero, et. al. (2004) conclude that a central element of joint-development is the profit sharing between private developers, benefiting from transit accessibility capitalized into higher rents and occupancy rates, and transit agencies, whose capital funding is enhanced through cost sharing mechanisms.

Localities can also adopt other forms of green taxation such as congestion pricing and vehicle emission permit fees to help fund transit systems. For example, London recently introduced a congestion charge for driving downtown, and many cities use parking revenue to help fund local transportation services (Glaister and Graham, 2005).

To date, most studies of value capture financing for transit focus on cities in developed countries, where low density development and auto-dependency predominate. Studies have begun to emerge from developing countries, where denser cities and a more even modal split can be found, like Jakarta (Cervero and Susantono, 1999), Bogota (Rodriguez and Targa, 2004), Uruguay (Prest, 1969), and studies for several developing countries at once (Tsukada and Kuranami, 1990; Nakagawa and Matsunaka, 1997). Some of these authors have noted that while progressive legislation may exist, the practical means of capturing site values for transit projects is hampered by inadequate land registration records and lagging assessments.

Table I presents a summary of value capture techniques that have been applied in some countries, were the main advantages and disadvantages of each mechanism is analyzed based on a RICS report about London's transport funding (GVA Grimley, 2004) among other studies.

Table I – Innovative funding methods for transport infrastructure

<table>
<tr><th>Funding Method</th><th>Focus</th><th>Funding Source</th><th>Advantaged</th><th>Disadvantages</th></tr>
<tr><td rowspan="2">Land Value Taxation (LVT)/Site Value Rating</td><td>Beneficiary pays</td><td>Land/Property Property-related taxes</td><td>Encourages appropriate development. Landowners who see a fall in value are compensated</td><td>Regular valuations required. Initial data collection. Requires primary legislation</td></tr>
<tr><td colspan="4">Case Studies: Most general type of value capture policy applied widely around the world for general public goods provision (variations: split rate property tax) (Lari, Levinson et al., 2009)</td></tr>
<tr><td rowspan="2">Tax Incremental Financing (TIF)/LRTP</td><td>Development based Beneficiary pays</td><td>Land/Property Property-related taxes</td><td>Defers payment from businesses. Can stimulate new development. Does not require primary legislation</td><td>Cannot guarantee development. Funding can also be slow to come forward</td></tr>
<tr><td colspan="4">Case Studies: Widespread adoption in many US states. In Chicago, TIF districts have been established to support the construction of subway/elevated stations near the CBD (McGreal, Berry et al., 2002). Portland, Oregon has also promoted TIF districts to support the streetcar and light rail development (Dueker and Bianco, 1999). Adoption in other cities for urban regeneration processes not related to transport (e.g. Dublin) (McGreal, Berry et al., 2002)</td></tr>
<tr><td rowspan="2">Special Assessments (SA)/Business Improvement Districts (BIDs)</td><td>Development based Beneficiary Pays</td><td>Land/Property Property-related taxes</td><td>Does not require primary legislation. Can increase public-private cooperation</td><td>Difficult boundary definition and business inclusion. Payment levels can be difficult to structure. Seen as an extra tax</td></tr>
<tr><td colspan="4">Case Studies: Created in the United States and Canada (Hass-Klau, 2006). In Los Angeles a variation of this tax knows as 'Special Assessment Districts' was introduced. This tax feeds a share of the increase in property values associated with a newly established rail line on sites typically within 400-800 m of the stations back into funding the transit system (Doherty, 2004)</td></tr>
<tr><td rowspan="2">Transportation Utility Fees</td><td>Beneficiary Pays</td><td>Transportation seen as a utility/Transport demand related</td><td>Potentially efficient to finance local transport by shifting cost burden to residents and commercial and industrial properties. Stable source of funding</td><td>Regular valuations required based on trip generation rates for different properties (e.g. Trip Generation Handbook). Initial data collection. Requires primary legislation</td></tr>
<tr><td colspan="4">Case Studies: US examples in Colorado, Oregon, and Texas (Lari, Levinson et al., 2009)</td></tr>
<tr><td rowspan="2">Development Impact Fees</td><td>Beneficiary Pays</td><td>One time charges</td><td>Improve efficiency in resource allocation in local governments</td><td>Narrow revenue capabilities. Problems with the ability-to-pay in low income locations</td></tr>
<tr><td colspan="4">Case Studies: There are several examples throughout the US, especially in fast growing areas such as California, Florida and Texas (Doherty, 2004)</td></tr>
</table>

<table>
<tr><th>Funding Method</th><th>Focus</th><th>Funding Source</th><th>Advantaged</th><th>Disadvantages</th></tr>
<tr><td rowspan="2">Joined Development</td><td>Beneficiary Pays</td><td>Land/Property Development land charges</td><td>Seen as a ‘proactive’ tool in which those who are prepared to invest see increased opportunity to obtain benefits</td><td>May only secure relatively small levels of revenue. Would require changes to Local Plans/UDPs</td></tr>
<tr><td colspan="4">Case Studies: Applied in the spatially coincidental developments of transport facilities and private real estate development (Lari, Levinson et al., 2009)</td></tr>
<tr><td rowspan="2">Business rate levy</td><td>Beneficiary Pays</td><td>Land/Property Property-related taxes</td><td>Difficult to avoid, and business rating list is regularly updated. Value changes are self-adjusted changes</td><td>Tenants charged twice effectively. Payers do not see any direct benefit in land values, unless an owner occupier</td></tr>
<tr><td colspan="4">Case Studies: Applied in London Crossrail to fund the operation (Lari, Levinson et al., 2009)</td></tr>
<tr><td rowspan="2">Greenfield Development Tax</td><td>Beneficiary Pays</td><td>Land/Property Property-related taxes</td><td>Encourages development in more sustainable locations. The tax-service the development link</td><td>May be difficult to define ‘Greenfield’ sites. May encourage development activity to other areas/regions. Would require legislation in some form</td></tr>
<tr><td colspan="4">Case Studies: Several US cities have applied this tax to control urban sprawl (GVA Grimley, 2003)</td></tr>
<tr><td rowspan="2">Betterment Levy/Freehold Levy</td><td>Beneficiary Pays</td><td>Land/Property Development land charges</td><td>Charges based on sale price are easy to collect. Concept simple to understand</td><td>Would penalize those who lost value as a result of the scheme. Would require legislation</td></tr>
<tr><td colspan="4">Case Studies: A levy on freehold property in a specific area. The levy is applied to the uplift in property values as a one-off charge. Applied in UK cities (GVA Grimley, 2003; Lari, Levinson et al., 2009)</td></tr>
<tr><td rowspan="2">Planning Gain/Tariffs</td><td>Beneficiary Pays</td><td>Land/Property Development land charges</td><td>Difficult to avoid as development requires planning consent. Relatively straightforward and understood</td><td>Section 106 agreements would happen anyway. Restricting use of funds to transport schemes</td></tr>
<tr><td colspan="4">Case Studies: This mechanism was introduced due to the lack of funds in German cities at the end of the 1980s to pay infrastructure costs generated by the designation of urban land use (Hold, 2004). Other examples are Section 106 in the UK and the Section 94 in Australia (Hass-Klau, Crampton et al., 2004; Glaister and Graham, 2005)</td></tr>
<tr><td rowspan="2">Employer tax (Versement Transport)</td><td>General Taxation</td><td>Employers (value capture)</td><td>Very successful in France. Large revenues generated, and funds easily related to transport improvements</td><td>Increases overall tax burden. Could lead to loss of employment or activities re-location</td></tr>
<tr><td colspan="4">Case Studies: In France, every employer (private or public) with more than 9 employees who is located within the area managed by a transport authority may be asked to pay between 0.15-1.80% of its total payroll as a transport tax to the authority (Hass-Klau, 2006). This financing mechanism has been only copied in Portland (Hass-Klau, 2006)</td></tr>
</table>

DATA DESCRIPTION

In order to develop a simulation on the value capture potential for the Lisbon municipality a large set of data was collected. The data requirements resulted from the spatial hedonic pricing models developed in previous stages of the study that are used in this study to estimate individual property value. The variables required for each property are classified into three types: structural attributes of the properties (e.g. number of bedrooms, age and existence of off-street parking facilities inside the property), neighbourhood attributes, which include some indicators that characterise the vicinity of the property and measures their influence in the property price (e.g. education level indicator, or land use mixture indicator), and accessibility attributes that measure the influence of the proximity of different types of transport infrastructures in property prices. These models use a semi logarithmic specification with a spatial lag term as presented in (1). The specification of the attributes of the models and their resulting coefficients are presented in Table II.

$$Ln(P_i) = \rho W_{Ln(P_i)} + \beta_0 + \beta_1' X_{i1} + \beta_2' X_{i2} + ... + \beta_n' X_{in} + \varepsilon_i \qquad (1)$$
$$\varepsilon \sim N(0, \sigma^2 I)$$

Table II – Summary of the hedonic price models used for property value estimation

Summary of the residential hedonic price model used for the LMA (Martínez and Viegas, 2009)

Variables	Coef.		Std. Error
SP_LAG_LOGPRICE	0.3561	***	0.0085
Constant	6.9089	***	0.0999
Structural attributes			
Bedrooms	0.0427	***	0.0030
House	0.1685	***	0.0154
Floor	0.0155	***	0.0009
Area	0.0064	***	0.0001
Age2	-0.1034	***	0.0063
Age3	-0.0729	***	0.0068
Garage	0.1126	***	0.0059
Neighbourhood attributes			
Educational Index[1]	0.4160	***	0.0225
Entropy Index[2]	0.2312	***	0.0234
Accessibility Attributes			
2MAccess	0.0916	***	0.0133
1Maccess	0.0652	***	0.0084
Network1	-0.0732	***	0.0069
Network2	0.0458	***	0.0064
Network3	-0.0380	***	0.0060
Sintra	-0.0614	***	0.0134
Cascais	0.1517	***	0.0259
Pseudo R^2	0.795		
LM statistic	1154.496 ***		
Log likelihood	236.608		

Summary of the commercial and offices hedonic price model used for the LMA (Martínez, 2009)

Variables	Coef.		Std. Error
SP_LAG_LOGPRICE	0.0394	***	0.0088
Constant	10.2640	***	0.1143
Structural attributes			
Store	0.4147	***	0.0446
Office	0.3892	***	0.0530
Floor	0.0227	**	0.0108
Area1	0.0079	***	0.0002
Area2	0.0018	***	0.0001
Area3	0.0005	***	0.0001
Age2	-0.1775	***	0.0281
Age3	-0.1560	***	0.0263
Garage	0.1316	***	0.0344
Neighbourhood attributes			
Educational Index	0.9892	***	0.0939
Shopping Centre	0.2308		0.1518
Accessibility Attributes			
2MAccess	0.2163	***	0.0466
1Maccess	0.0918	**	0.0357
Network1	-0.1270	***	0.0360
Network2	0.1029	***	0.0302
Pseudo R^2	0.760		
LM statistic	19.940 ***		
Log likelihood	-693.486		

***, **, and * denote coefficient significantly different from zero at the 1%, 5%, and 10% level of significance, respectively.

[1] Household income proxy indicator measured by the number of undergraduate persons/Population over 20 years old (500 meters radius).

[2] Land use mixture indicator based on Cervero, R. and K. Kockelman (1997). Travel demand and the 3Ds: Density, diversity, and design. Transportation Research Part D-Transport and Environment Vol.2, No.3, pp. 199-219. and Potoglou, D. and P. S. Kanaroglou (2008). Modelling car ownership in urban areas: a case study of Hamilton, Canada. *Journal of Transport Geography* Vol.16, No.1, pp. 42-54.

The data required was then collected from three data sources available:

- Census data on building and dwelling characteristics at city census block level for the characterization of the residential market.
- Land use data on activities (offices, retail and warehouses) for Lisbon municipality collected from the Portuguese Yellow Pages (http://www.pai.pt). This database contains all the activities that present affixed phone number registered, which might exclude some activities that rely only on mobile phone services. Nevertheless, this sample was used to characterize the commercial, offices and warehouses market due to the lack of better data.
- A real estate cross-sectional database of 2007 from an online realtor's database (Imokapa Vector) for Lisbon, Portugal. This database presents the asking price of residential properties on sale during February of 2007 with a total of 8,742 complete records and 1,165 complete records on commercial, offices and warehouses properties. The real estate data contained information on their asking sale price, structural attributes and address.

Residential Market

The census data allowed the definition of statistical distributions for the different structural property attributes of properties inside a census block and at the same time control the total number of properties that exist at each census block. The neighbourhood properties and the local accessibility attributes were computed considering as reference the centroid of each census block (normally smaller than 1 ha). In order to compute the spatial lag term it was used the real estate data available for Lisbon city considering a 500 threshold distance as in the model previously defined.

Commercial, Offices and Warehouses Market

The land use data available was considered as a census of all existent activities in the city, and was used for the definition of statistical distributions for the different structural property attributes of properties inside a census block and to control the total number of properties that exist at each census block. The neighbourhood properties and the local accessibility attributes were computed for each property available from the database. In order to compute the spatial lag term it was used the real estate data available for Lisbon city considering a 500 threshold distance as in the model previously defined.

VALUE CAPTURE POTENTIAL SIMULATION MODELS

In order to estimate the value capture potential of the Lisbon's Subway it were developed two simulation procedures (one for residential market and other for commerce, offices and warehouses). Figure I presents a flowchart of the simulation model for the residential market, presenting the similar structure for the non-residential market simulation model.

For each iteration, the model generates a synthetic population of residential properties for the city of Lisbon based on the statistical distributions available of the census block. All the structural attributes that generated from the statistical census data are considered as independent variables with the exception of the Area, which depends of the number of bedrooms generated. This simplification assumption reduces significantly the complexity on the interrelation between the different attributes; however it might lead in some low probability cases to some unreliable configurations (i.e. a dwelling in the 20^{th} floor of a XIX century building with parking lot inside the building).

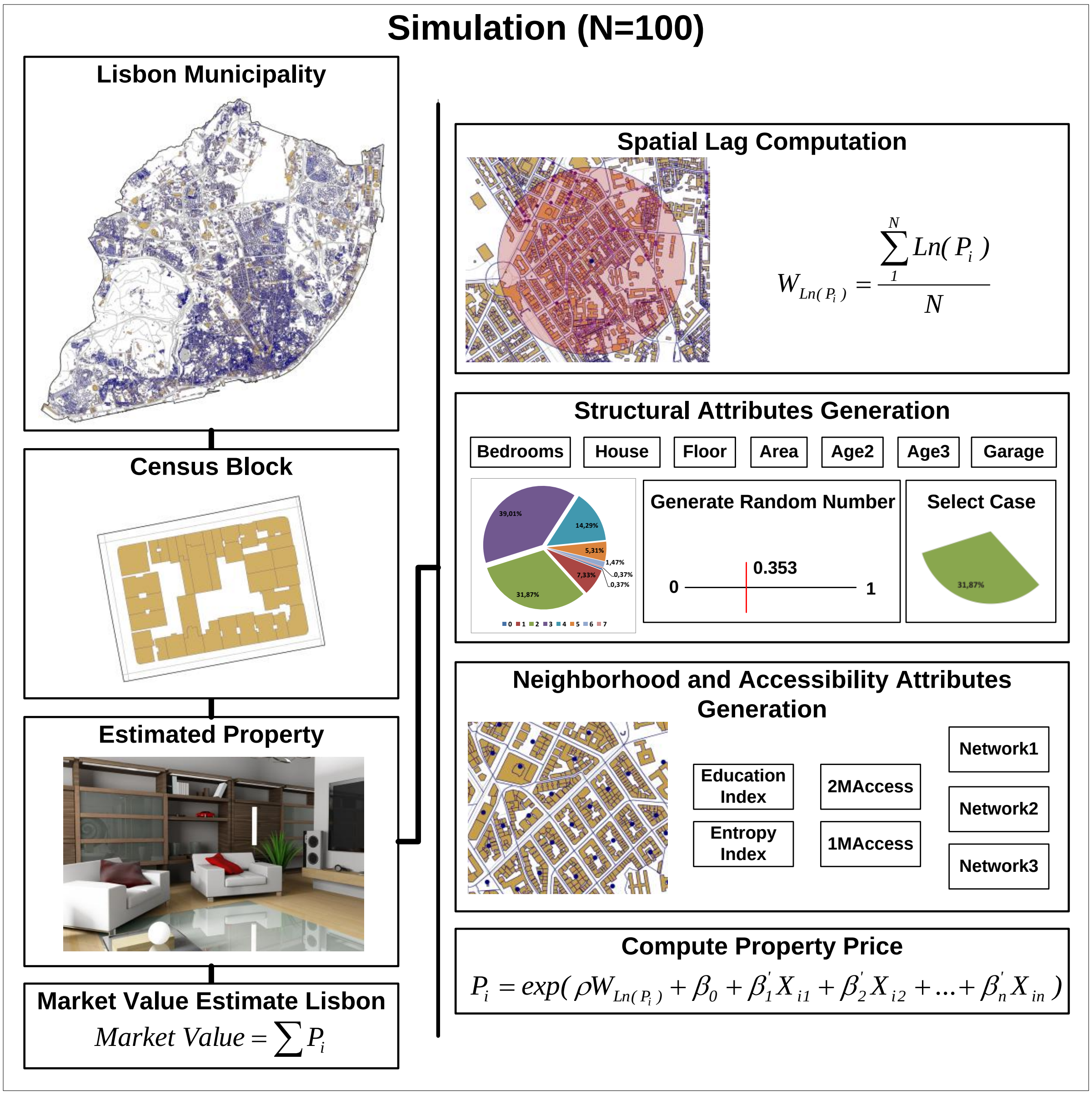

Figure I – Flowchart of Value Capture Simulation Model

For the current study, 100 iterations for the residential and the non-residential simulation models were used. The summary of the average values obtained from the simulation are presented in Table III. The resulting values show that approximately 2.5% of the total residential market value is derived from subway valuation, which is quite significant considering that not all the Lisbon municipality is covered by subway.

The results for the non-residential market show a higher valuation (approximately 9% of the total non-residential market value) which is derived from a higher coefficient for the subway service in the hedonic price model, but also from the higher concentration of activities on the city centre where the subway present a higher concentration of stops.

The total subway valuation obtained for the Lisbon municipality is approximately 2.9 B€, which would be sufficient at current prices of Lisbon's Subway construction prices to build 40-48 km of line (see Table III). This initial assessment shows the huge potential of value capture from subway that is available for the Lisbon municipality.

Table III – Summary of the results of the value capture potential simulation

Total Residential Market Value	61.431 B€
Total Subway Valuation	1.512 B€
Total Network1 Valuation	-1.183 B€
Total Network2 Valuation	1.124 B€
Total Network3 Valuation	-701M€
Total Sintra Valuation	-65 M€
Total Cascais Valuation	46 M€

Total Commercial, Offices and Warehouses Market Value	14.824 B€
Total Subway Valuation	1.350 B€
Total Network1 Valuation	-322 M€
Total Network2 Valuation	712 M€

MODELING A SPECIAL ASSESSMENT ANNUAL TAX

In order to model a possible impact of a special assessment annual tax around the Lisbon's subway for residential and non-residential properties, it was initially spatialised the coverage of the value capture potential resulting from the simulation model, The results are presented in Figure II for the residential market and Figure III for the non-residential market. These figures identify the potential areas of a special assessment of subway accessibility, considering a minimum direct effect of 1% of the total market value for each census block.

The special assessment district is formed by all the areas in the city identified in Figure II and Figure III, where the set value to charge is not obtained by a fixed charge, but is obtained by the hedonic price model market value estimates. From the total value identified as being derived from the subway proximity, the subway should recoup only 2/3 of the total amount, in order distribute part of the property values uplift with the private sector, as in other planning gain tariffs policies (e.g Socially Justified Land Use tariff in Munich) (Hass-Klau, 2006).

In order to define a percentage of annual tax from the potential value capture estimated it was consulted and historical real estate price per square meter database to observe the growth tendency of the real estate market relative to the inflation variation. This historical database from the company Confidencial Imobiliário evidences a strong growth rate of the market prices since 1988 to 2004 (189%), which is considerably higher than the inflation rates from the same period. Nonetheless in recent years, this tendency of high growth of the real estate prices in the municipality of Lisbon has been stabilising, presenting average values on the five last years of 3.40% per year. The inflation rate for the same period has been approximately 2.50% accordingly to Statistics of Portugal data, which reveals a net annual growth of the real estate prices of approximately 0.90%

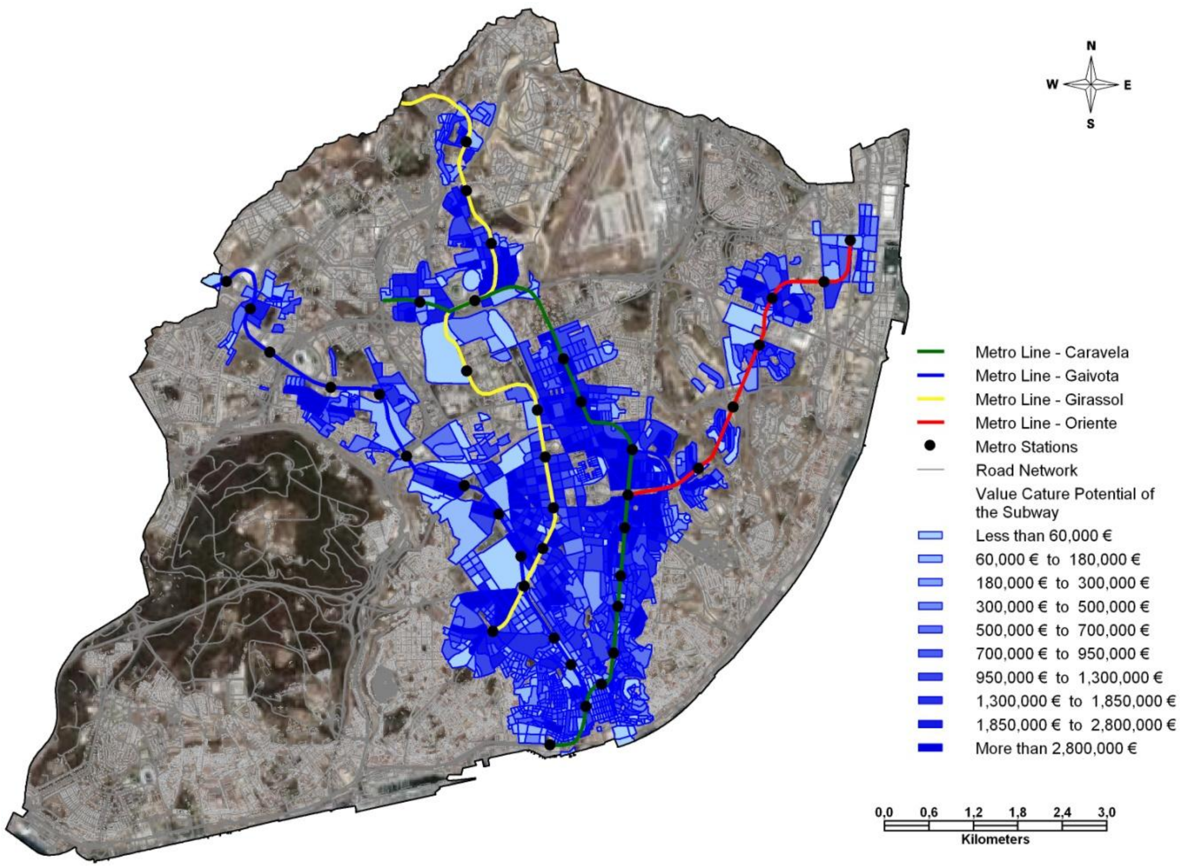

Figure II – Residential market value capture potential map

Using this information, we will consider for our analysis a time horizon of 20 years for property fruition, which will translate the subway valuation for the next owner and a yearly update of 0.90% growth of the real estate market over the inflation rate.

The total annual special assessment tax for the Lisbon municipality resulted in 17.078 M€ (25.617 M€ if instead of 2/3 it would be completely charged). This annual value would be sufficient at current prices of Lisbon's Subway construction prices to build 285 m of subway line per year (approximately 36% of the current average construction pace of the subway) or to pay 24% of the annual operational deficit of the subway (2007 subway operational deficit values).

The estimated tax revenue would have a significant impact on the costs coverage of the subway and enhance the subway network development with this new annual stream of financial resources.

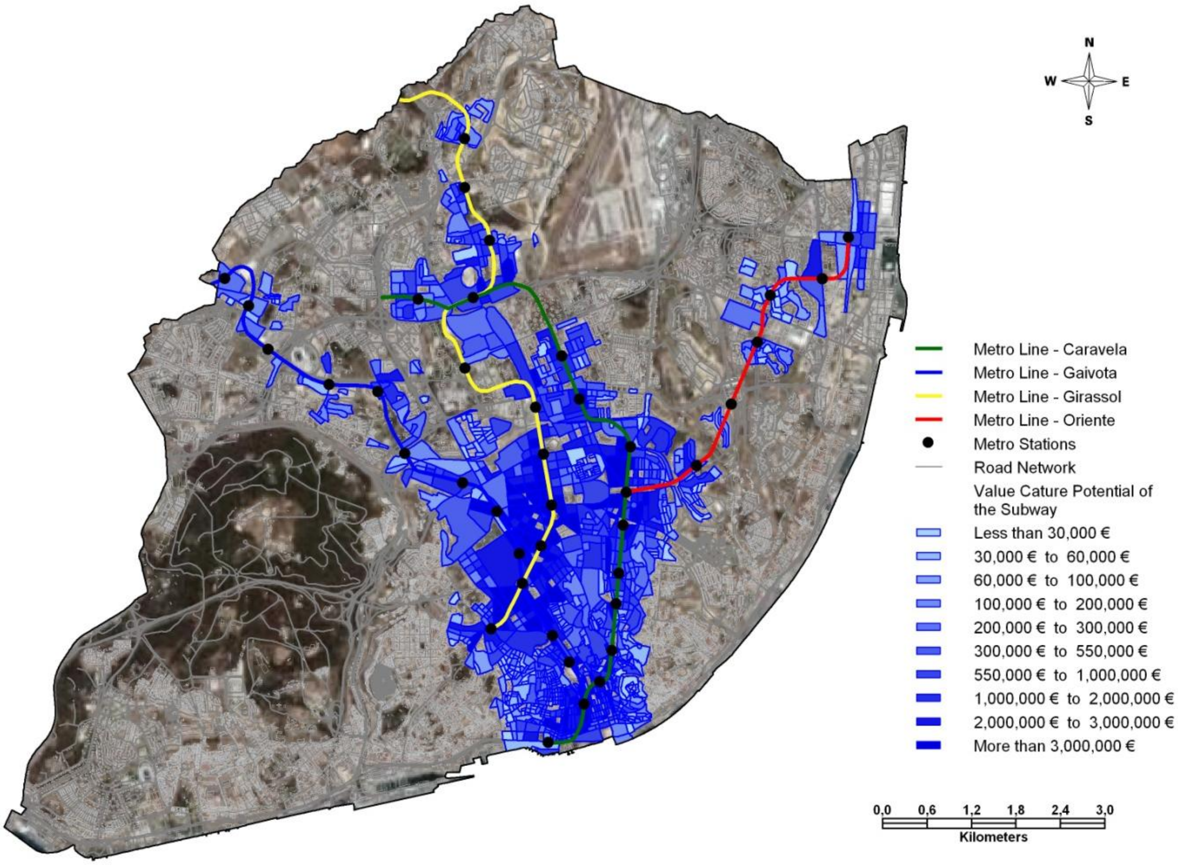

Figure III – Non-residential market value capture potential map

The problem of this taxing policy relies on the increase of the tax burden to property owners without any improvement of the current public transport service or amenities close to the property location easily perceived. Apart from the improvement of the service in other location that may increase the public transport network and improve the general accessibility, is hard for the tax payer to link the service improvement with the significant increase in taxation. There are several studies in the literature that illustrate that a tax burden increased that is not linked with an improvement in urban amenities and services can lead to property values decrease and welfare losses in the medium and long run (Oates, 1969; Oates, 1973).

This tax increment would lead to an average tax burden increase for residential properties of 16.62% and 22.03% for non-residential properties. This value represents an average tax increment of 18€ for residential properties and 59€ for non-residential properties. The spatial distribution of the combined tax burden increase (residential and non-residential) is presented in Figure VI.

The obtained results suggest that this increase would be more significant for the non-residential sector, mainly for properties located in the city centre and some high activity density poles inside Lisbon (see Figure IV). This fact could generate a considerable number of relocation of activities that want to reduce their cost and may affect the job distribution within the municipality and even the Lisbon Metropolitan Area. From a transport and land use planning perspective, this could generate significant unbalances creating relocations to less accessibility public transport areas affecting the overall region sustainability.

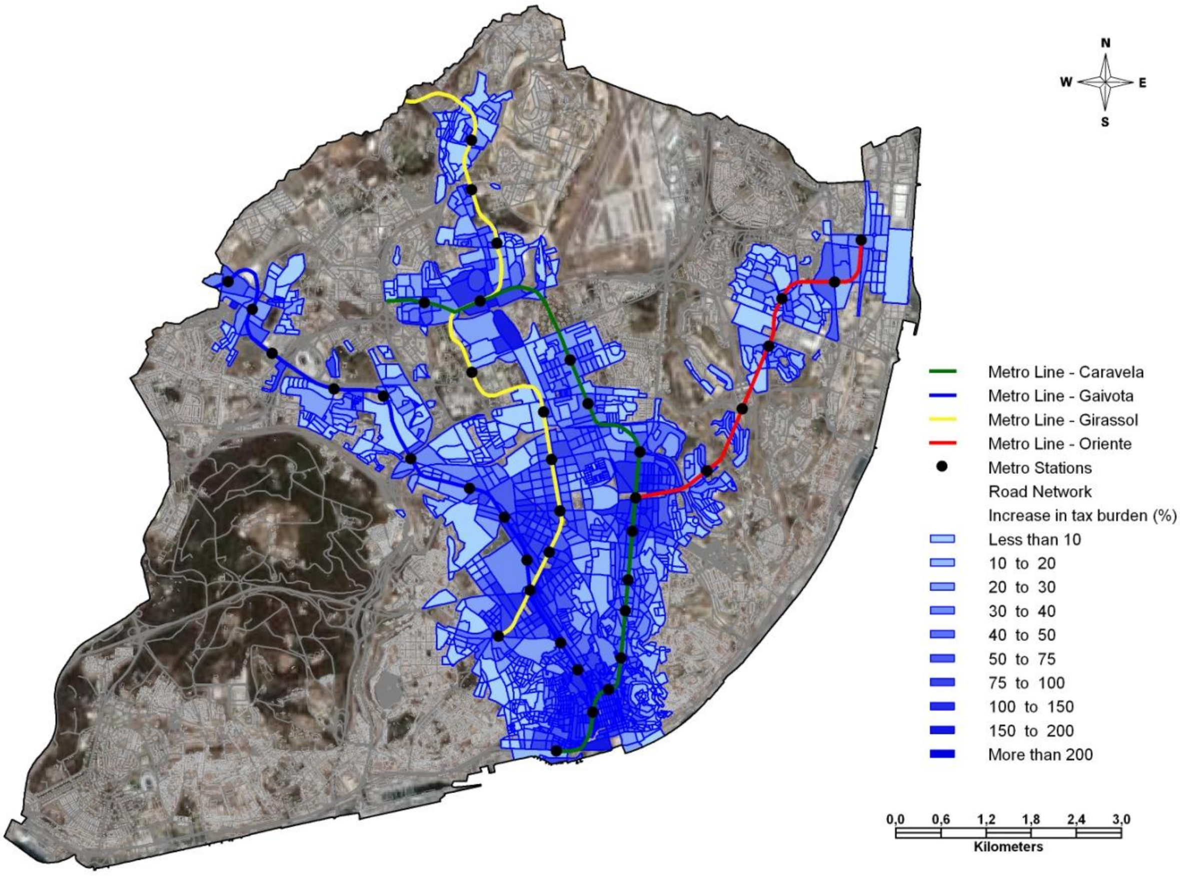

Figure IV – Spatial distribution of the tax burden increase with the Special Assessment tax

LAND VALUE TAX INTEGRATION

Land Value Tax Estimation

The current land value taxation in Portugal was reformed in 2003 with the introduction of a new Code: the Municipal Tax on Immovable Property (IMI). This tax presents a configuration of land and property values taxation merged into a single tax, including buildings, improvements, and personal property rather than land value, being more close to a real estate taxation principle.

Nevertheless, this is the current form of property ownership taxation in Portugal and we will estimate the land value tax for the synthetic population of residential and non-residential properties in the municipality of Lisbon as in the value capture simulation model.

The IMI tax is calculated as a tax rate that is applied to an estimated real estate value of a property. This tax rate must be set by each municipality and should range between 0.2% and

0.5% (0.5% in the case of Lisbon municipality). The real estate value is computed using a reference equation defined as:

$$Vt = Vc \times A \times Ca \times Cl \times Cq \times Cv \tag{2}$$

where *Vt* is the real estate estimated value (Patrimonial value), *Vc* is a base construction value per sq. meter established by each municipality (615 €/sq. m in the case of Lisbon municipality), *A* is the equivalent area of the property in square meters, *Ca* is a area function coefficient, *Cl* a location coefficient, *Cq* is a quality and comfort coefficient, and *Cv* is an age correction coefficient

The equivalent area (*A*) is a new factor in urban property valuation which aggregates building construction area and the exceeding area resulting from constructions implantation (see equation 3).

$$A = (Aa + 0.3\,Ab) \times Caj + 0.025\,Ac + 0.005\,Ad \tag{3}$$

where *Aa* is the private area (area referring to the principal function of the autonomous fraction), *Ab* is the dependent area (e.g. parking space, laundry, animal facility, attic, basement floor), *Caj* is the area adjustment coefficient, *Ac* is the proximity area (vacant land area: limited to two times the constructions implantation area), and *Ad* is the distant area (vacant land area: the exceeding area of two times the constructions implantation area).

The area adjustment coefficient is defined by a table in the Code, function of the $Aa + 0.3\,Ab$ value and the type of use of the property (residential, commercial or services or industrial).

The area function coefficient (*Ca*) depends on the type of activity developed in the property or that is intended to the property following the value presented in Table IV.

Table IV – Area function coefficients for IMI calculation (adapted from Taxation Code 2003)

Area function	**Ca**
Commerce	1.20
Office building	1.10
Dwelling	1.00
Controlled cost dwelling	0.70
Industry and warehouse	0.60
Commerce and offices in warehouse buildings	0.80
Covered and enclosed parking lots	0.40
Covered and opened parking lots	0.15
Opened parking lots 0,08	0.08
Buildings without construction permit 0,45	0.45
Storage facilities 0,35	0.35

The location coefficient (*Cl*) depends on the type of activity developed (housing, commerce, industry or services) and on the kind of urban property (construction or land for construction) subject to this valuation procedure. The range of values for this coefficient varies between

0.35 and 3.00, whether is a dispersed building in rural area or in a raised real estate market value zone. The factors influencing this coefficient are accessibility (quality and variety), proximity to public equipments (e.g. schools, hospital, and commerce), public transportation systems and real estate market value.

This coefficient should be in theory highly correlated with the value capture estimation for each city block previously estimated due to the inclusion of public transport proximity as one of the main factors that determines this coefficient.

The quality and comfort coefficient (*Cq*) is a correction factor to the *Vc* value in order to incorporate the value of improvements and specific quality attributes of a property or the decrease o0f value by lack of some ordinary services (e.g. water and gas supply and availability of kitchen and bathroom in the property), as presenting parking facilities inside the property or a swimming pool. The coefficient should present a minimum value of 0.5 and a maximum value of 1.7.

The age correction coefficient (*Cv*) is a function of the number of year since the issuing of the municipal license of use, presenting the following values:

Number of year of the license of use issuing	**Cv**
Less than 2 years	1.00
2 to 8 years	0.90
9 to 15 years	0.85
16 to 25 years	0.80
26 to 40 years	0.75
41 to 50 years	0.65
51 to 60 years	0.55
More than 60 years	0.40

In order to estimate the land value tax of the Lisbon municipality it were developed two simulation procedures (one for residential market and other for commerce, offices and warehouses) following the same simulation principles than in the value capture simulation using Monte Carlo simulation and the statistical data available at the census block level. Figure V presents a flowchart of the simulation model for the residential estimation, presenting the similar structure for the non-residential.

The simulation was computed with 200 iterations for the residential and the non-residential simulation models. The summary of the average values obtained from the simulation are presented in Table V. The resulting values show that approximately 55% of the total patrimonial value (for residential and for non-residential real estate stock) is derived from the location coefficient, which in theory is linked to the proximity to public transport services and equipments.

The observed total patrimonial value of the real estate stock of Lisbon (approximately 23 B€) is considerable smaller than the market value of the stock estimated by the value capture simulation model (approximately 76 B€). This considerable difference (approximately just

30% of the estimated market value) can be explained by the considerable penalty introduced by the age correction coefficient (*Cv*), that in a considerable part of the building stock of the city with more than 60 years reduces the property values to 40% of the original value.

This degradation of value with the age of the property (see Table II), although also observed in the market, does not present a so significant elasticity as in the fiscal estimation of the market value. The reason behind this considerable difference is the "political" choice of reduce the tax burden to old building owners, that due to the rent control legislation that allowed until recently very low rent prices for old tenants, might not have enough financial resources to maintain their buildings and pay the property ownership taxes.

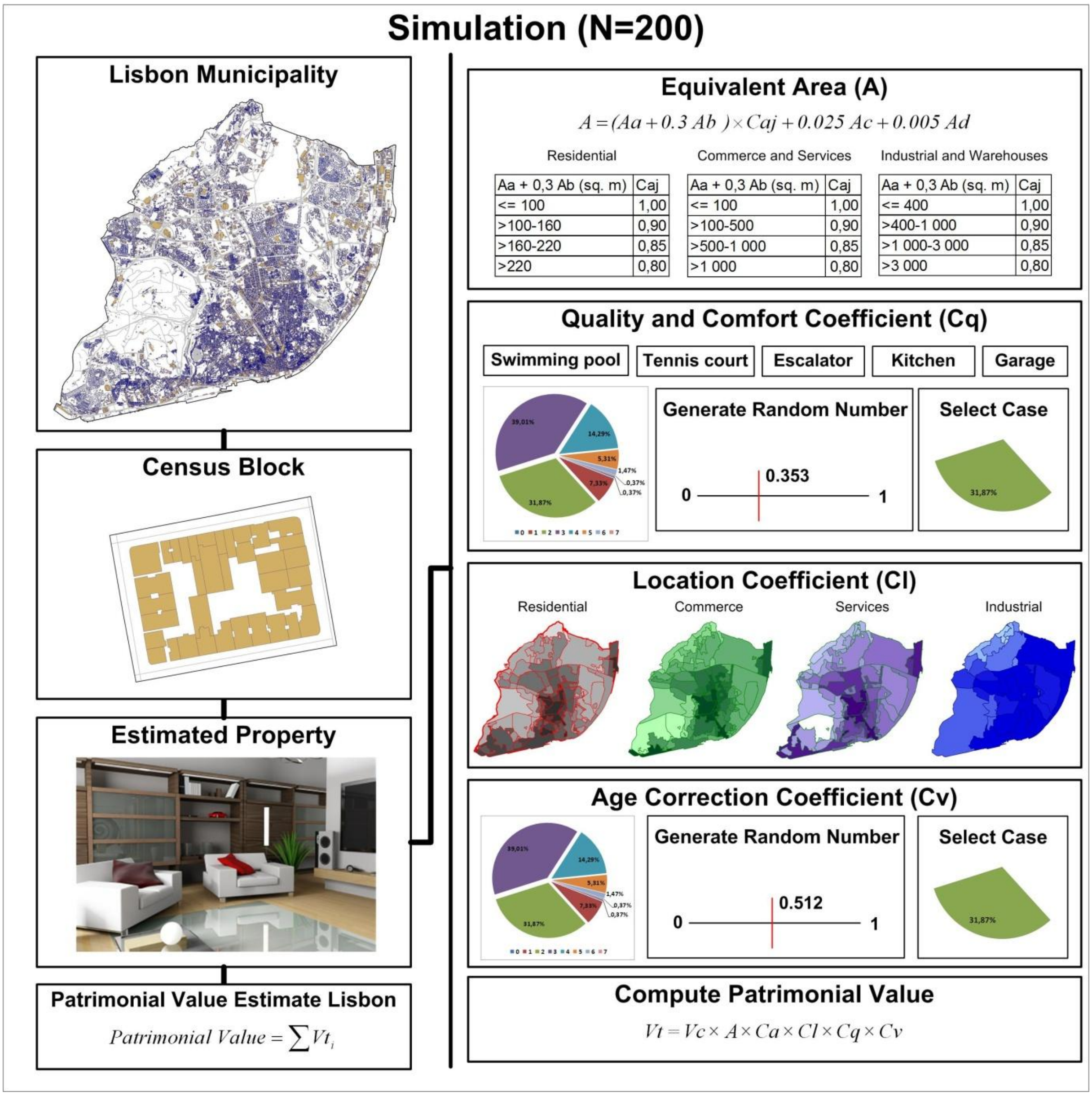

Figure V – Flowchart of Land Value Tax Simulation Model

The total annual tax collection estimated would be of approximately 113 M€. The amount of tax collected in 2009 by the municipality of Lisbon was 88 M€ that is considerably close to the obtained value, and it was charged with the 2009 tax rate of 0.4%, which would lead in the simulation model to an annual tax collection of 91 M€ (less than 3% difference). The estimated average tax value per property is 296 € for residential properties and 600 € for non-residential properties.

From the total patrimonial value estimated we can see that approximately 55% of the total value of the properties is derived from the location coefficient (*Cl*) valuation. This fact can indicate that a significant percentage of the property value is explained by neighbourhood attributes surrounding it, and specially, considering the stated definition in the Code of this coefficient, highly influenced by the proximity to the subway stations.

After this initial assessment and estimation of the current land value tax system, we can conclude that it might be possible to integrate this tax with the value capture of the subway windfalls, and try to recoup part of the property value enhancement to finance the subway construction and operation.

Table V – Summary of the results of the land value tax simulation

Total Residential Patrimonial Value	17.372 M€	Total Commercial, Offices and Warehouses Patrimonial Value	5.287 M€
Location Coefficient Valuation	9.497 M€	Location Coefficient Valuation	2.989 M€
Annual tax collection (0.5%)	86.861 M€	Annual tax collection (0.5%)	26.437 M€

Subway Value Capture Integration with the Current Land Value Tax

The integration between the existing land value tax and the subway value capture could be performed considering two hypotheses:

- The value capture subway tax would result in an added charge to the current land value tax, using the same tax rate, which would increase the tax burden of all the property owner located close to subway stations;
- or, consider the that the actual land value capture tax already includes the subway property valuation and the value capture to finance the subway should be obtained form the current tax collection.

The first option, although capable of generating larger tax revenues to finance the subway construction and operation, leads to an increase of the tax burden to property owners without any improvement of the current public transport service or amenities close to the property location. This fact, as we previously discussed in the paper reduces significantly the policy acceptance and it may even lead to property values decrease and welfare losses in the medium and long run (Oates, 1969; Oates, 1973).

Nevertheless, we have estimated the value of this tax increment to the current land value tax, considering that only 2/3 of the subway uplift in property prices would be taxed and that the tax rate would be the same that the land value tax. The annual total tax increment for all the municipality of Lisbon would be 9.542 M€ (14.313 M€ if instead of 2/3 it would be completely charged). This annual value would be sufficient at current prices of Lisbon's Subway construction prices to build 159 m of subway line per year (the current average construction pace of the subway is 800 m per year) or to pay 14% of the annual operational deficit of the subway (2007 subway operational deficit values).

Although the value capture revenue estimated might be insufficient to cover all annual costs of the subway, it might help to reduce the gap between operational costs and revenues and boost the enlargement of the subway network within the Lisbon municipality and also to the surrounding municipalities.

This tax increment would lead to an average tax burden increase for residential properties of 6.19% and 12.35% for non-residential properties. This value represents an average tax increment of 48€ for residential properties and 105€ for non-residential properties. The spatial distribution of the combined tax burden increase is presented in Figure VI.

The obtained results suggest that the main increase would be supported by the private sector in non-residential properties, mainly in the city centre and some high activity density poles inside Lisbon (see Figure VI). This fact could lead to activities relocation and the reduction of activity density in those areas and also to jobs relocation to other city areas with less public transport accessibility or even outside city to other neighbour municipalities.

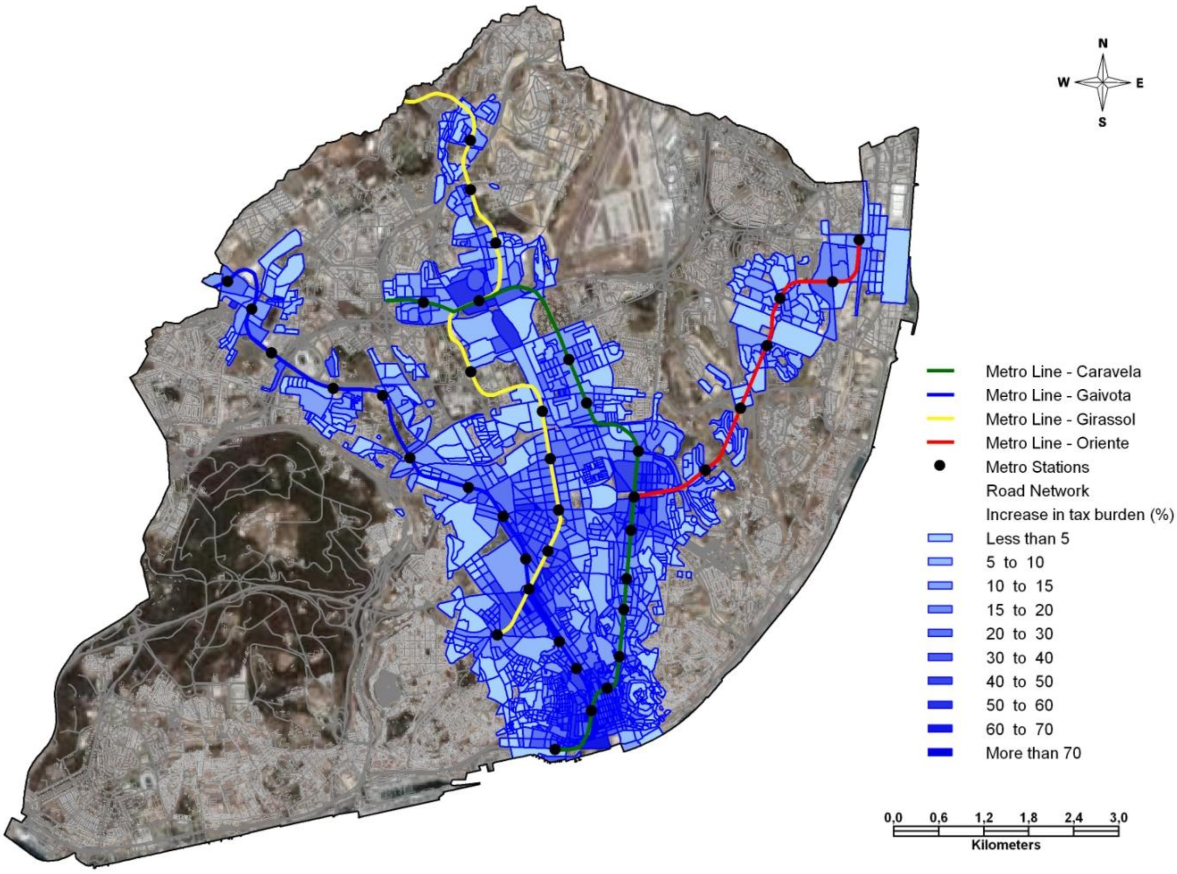

Figure VI – Spatial distribution of the land value tax burden increment

The second option of integration of the subway value capture with the current land value tax is the consideration that the current tax does already contain the premium of proximity to the subway stations. This approach encloses a tax revenue re-assignment of part of the land value tax from the municipality budget to the subway operation company – Metropolitano de Lisboa.

The transfer of part of the land value tax revenues to the subway company would lead in this case to a political blind alley because subway is controlled directly by Central Government and its funds are assigned directly from the general national taxation system. The link between the local authority and this state owned company is negligible, which would complicate its application and raise issues about the local financing system.

Yet, we have estimated the value from the general taxation system that should be transferred to the subway operation company in case of application of this policy. This value is computed considering that the relation between market value of a property and the subway value capture potential remain unaltered with the taxation patrimonial value of a property.

The annual total tax shift from the current land value tax charged by the municipality to the subway operation company would be 3.843 M€ (2.007 M€ from the residential sector and 1.836 M€ from the non-residential sector). This tax revenue would be sufficient at current prices of Lisbon's Subway construction prices to build 64 m of subway line per year (approximately 8% of the current average construction pace of the subway) or to pay 6% of the annual operational deficit of the subway (2007 subway operational deficit values).

The obtained tax revenues to finance the subway for this approach are considerably smaller than for the first approach of an increment to the current tax (approximately 40%). Nevertheless, the application of this policy would lead to some contribution the costs of the subway development and operation and reduce by only 3% to revenues of the municipality, without increasing the tax burden of property owners that could produce relocation effects as previously mentioned.

CONCLUSIONS

This paper presents an assessment of the land value capture potential of the Lisbon subway and estimates the financial outcome of the creation of a special assessment tax in the municipality of Lisbon and the integration of the subway real estate windfalls in the current land value taxation system.

A Monte Carlo simulation procedure is used to estimate the market composition of the residential, commercial and office sectors from the census aggregated statistical data available at city block level, leading to an estimate of the value capture potential of the subway in the Lisbon municipality, using spatial hedonic pricing models developed in previous stages of the study to estimate the extent to which access to transportation infrastructure currently is capitalized into property prices. The potential value capture estimate is then used to estimate an annual Special Assessment tax and the integration of subway value capture with the current land value tax.

The results obtained show that these value capture policies could represent a significant boost to the subway network construction pace and to reduce the operational deficit of the subway company. Nevertheless, tax burden issues can emerge that can lead to residential and firms relocations within the Lisbon municipality or even at metropolitan scale.

REFERENCES

Berry, J. and L. Sims (1999). North American Examples of Innovative Funding for Public Transport. *UITP*.

Borhart, R. J. (1994). Corridor Reservation - Implications for Recouping a Portion of the "Unearned Increment" Arising From Construction of Transporation Facilities. *Report VTRC 94-Rl5*. Virginia Transportation Research Council, Charlottesville, Virginia.

Cervero, R. and K. Kockelman (1997). Travel demand and the 3Ds: Density, diversity, and design. *Transportation Research Part D-Transport and Environment* Vol.2, No.3, pp. 199-219.

Cervero, R., S. Murphy, C. Ferrell, N. Goguts, T. Yu-Hsin, A. G. B., B. John, J. Smith-Heimer, R. Golem, P. Peninger, E. Nakajima, E. Chui, R. Dunphy, M. Myers, S. Mckay and N. Witenstein (2004). Transit-Oriented Development in the United States: Experiences, Challenges, and Prospects. *TCRP Report 102*. Transit Cooperative Research Program - The Federal Transit Administration, Washington D.C.

Cervero, R. and B. Susantono (1999). Rent Capitalization and Transportation Infrastructure Development in Jakarta. *Review of Urban and Regional Development Studies* Vol.11, No.1, pp. 11-23.

Doherty, M. (2004). Funding Public Transport Development Through Land Value Capture Programs. Ecotransit.

Dueker, K. J. and M. J. Bianco (1999). Light-Rail-Transit Impacts in Portland. The First Ten Years. *Transportation Research Record - Transportation Planning, Programming, Public Participation, and Land Use* Vol.1685.

Faber, O. (2000). Fair and Efficient Pricing in Transport - The Role of changes and Taxes European Commission DG TREN.

Glaister, S. and D. J. Graham (2005). An evaluation of national road user charging in England. *Transportation Research Part a-Policy and Practice* Vol.39, No.7-9, pp. 632-650.

Godier, P. (2002). Securing Finance for a Complex Urban Rail System. London Underground.

GVA Grimley (2003). Funding London's transport needs. Royal Institution of Chartered Surveyors (RICS).

GVA Grimley (2004). Developing a Methodology to Capture Land Value Uplift around Transport Facilities. Scottish Executive.

Hack, J. (2002). Regeneration and Spatial Development: a Review of Research and Current Practice. IBI Group, Toronto.

Hass-Klau, C. (2006). Capture of Land Value Premiums as a Source of Funding for Public Transport: Evidence and Practice in selected European Metropolitan Areas. European Metropolitan Transport Authorities (EMTA).

Hass-Klau, C., G. Crampton and R. Benjari (2004). Economic Impact of Light Rail: The Results of 15 Urban Areas in France, Germany, UK and North America. Environmental & Transport Planning.

Hold, J. (2004). Greenfield Development Without Sprawl: The Role of Planned Communities. *ULI Catalog Number: 664A*. Urban Land Institute, Washington D.C.

Hong, Y.-H. (1996). Can Leasing Public Land Be An Alternative Source of Local Public Finance? *Working Paper WP96YH2*. Lincoln Institute of Land Policy.

Lari, A., D. Levinson, Z. J. Zhao, M. Iacono, S. Aultman, K. V. Das, J. Junge, K. Larson and M. Scharenbroich (2009). Value Capture for Transportation Finance: Technical Research Report. *CTS 09-18*. Center for Transportation Studies, University of Minnesota.

Lichfield, N. and O. Connellan (2000). Land Value and Community Betterment Taxation in Britain: Proposals for Legislation and Practice. *Working Paper WP00NL1*. Lincoln Institute of Land Policy.

Martínez, L. M. (2009). *Metropolitan Transportation Systems Financing Using the Value Capture Concept*. Doctoral, Civil Engineering Department, IST- Technical Universty of Lisbon.

Martínez, L. M. and J. M. Viegas (2009). Effects of Transportation Accessibility on Residential Property Values: A Hedonic Price Model in the Lisbon Metropolitan Area. *88nd Annual Meeting of the Transportation Research Board*, Washington, D.C.

McGreal, S., J. Berry, G. Lloyd and J. McCarthy (2002). Tax-based mechanisms in urban regeneration: Dublin and Chicago models. *Urban Studies* Vol.39, No.10, pp. 1819-1831.

Nakagawa, D. and R. Matsunaka (1997). *Funding Transport Systems: A Comparison Among Developed Countries*: Pergamon.

Oates, W. E. (1969). Effects of Property Taxes and Local Public Spending on Property Values - Empirical Study of Tax Capitalization and Tiebout Hypothesis. *Journal of Political Economy* Vol.77, No.6, pp. 957-971.

Oates, W. E. (1973). Effects of Property Taxes and Local Public Spending on Property Values - Reply and yet Further Results. *Journal of Political Economy* Vol.81, No.4, pp. 1004-1008.

Potoglou, D. and P. S. Kanaroglou (2008). Modelling car ownership in urban areas: a case study of Hamilton, Canada. *Journal of Transport Geography* Vol.16, No.1, pp. 42-54.

Prest, A. P. (1969). *Transport Economics in Developing Countries*: Praeger.

Riley, D. (2001). *Taken for a Ride: Trains, Taxpayers and the Treasury*: Centre for Land Policy Studies.

Rodriguez, D. A. and F. Targa (2004). Value of accessibility to Bogota's bus rapid transit system. *Transport Reviews* Vol.24, No.5, pp. 587-610.

Roeseler, W. G. and D. Vondosky (1991). Joint Development in Urban-Transportation - a Practical Approach to Modern Growth Management. *Landscape and Urban Planning* Vol.20, No.4, pp. 325-346.

Rybeck, R. (2004). Using Value Capture to Finance Infrastructure & Encourage Compact Development. *Public Works Management Policy* Vol.8, pp. 249-260.

Scheurer, J., P. Newman, J. Kenworthy and T. Gallagher (2000). Can Rail Pay? Light Rail Transit and Urban Redevelopment with Value Capture Funding and Joint Development Mechanisms. Institute for Science and Technology Policy.

Simon, O. (1999). Briefing: The Private Finance Initiative - An Introduction. The Institution of Civil Engineers.

Smith, J. J. and T. A. Gihring (2006). Financing Transit Systems Through Value Capture. An Annotated Bibliography. *American Journal of Economics and Sociology* Vol.65, No.3, pp. 751-786.

Tsukada, S. and C. Kuranami (1990). Value Capture with Integrated Urban Rail and Land Development: The Japanese Experience and Its Applicability to Developing Countries. *Seminar M, PTRC Transport and Planning Annual Meeting*, University of Sussex, England.

Ubbels, B. and P. Nijkamp (2002). Unconventional funding of urban public transport. *Transportation Research Part D-Transport and Environment* Vol.7, No.5, pp. 317-329.
Urban Land Institute and G. Associates (1979). *Joint Development: Making the Real Estate-Transit Connection*: Urban Land Institute.
Viegas, J. (2005). Organisation and Financing of Public Transport. *European Conference of Ministers of Transport (ECMT) 2005 - Sustainable Urban Travel*.
Vivier, J. (1999). Urban Transport Pricing. *Public Transport International* Vol.Vol. 48, Nº5, pp. 28-35.
Worsey, S. (2000). Funding Public Transport Infrastructure in the UK: Private Finance and Risk Tranfer. Allens Arthur Robinson.