Introduction
At local government level, property taxes can be considered one of the most popular options for raising revenue for financing public services. In this context, property taxes are defined as an annual tax on land and buildings.

Some well-known characteristics of property taxes are likely to contribute to their popularity in integrating taxation systems. For instance, property taxes are considered easy to understand and enforce payment. They are cheap to collect and administer, difficult to evade, capable of producing a large and predictable yield, and easy to allocate to a particular local authority in terms of revenue. In addition, they represent a familiar concept to local administrators.

In spite of their high popularity in integrating taxation systems, property taxes are not free from imperfections. Indeed, administrators of property taxes face serious difficulties in establishing their systems. Property taxes are strongly criticised due to inequities present in current systems.

Frequently, assessment bias is identified in the tax base estimated. In many cases, high-value properties tend to be under-appraised relative to low-value properties. Another major criticism concerns the relatively higher burden placed on low-income taxpayers. Indeed, the most usual tax bases adopted, i.e. real estate market values, rental values and site values, are not related directly to ability-to-pay.

Assessment inequities can both reduce the tax base and cause taxpayers to lose confidence in the system. Due to their high visibility, property taxes are subject to extensive pressures because unfairness, inefficiency, and administrative problems are clearly perceptible (Kitchen, 1992).
The present study is concerned with analysing the current property tax system in the city of Porto Alegre, Brazil, focusing mainly on the tax base assessment and the tax burden distribution. The paper is subdivided into four main sections. The present section provides an overview of the study. The second section describes the property tax system, covering generically all property-use classes, including vacant land, residential and non-residential property. The third section reports a critical analysis of the current system. The analysis is limited to the segment of the residential market represented by apartment buildings, and covers a three-year period of taxation (from 1993 to 1995). Methods currently used for estimating market value, sources of data available, and property data management are investigated. The final section presents some alternatives for improving the property tax system in Porto Alegre.

Property Tax in Porto Alegre: Describing the Current System

In Brazil, the property tax on urban land and buildings is imposed at local government level. Revenues from property taxes represented 3.26% as a percentage of the total tax revenue, or 0.8% of GDP in 1995 (Meneghetti Neto, 1995). Regarding the city of Porto Alegre, the property tax is the second most important source of revenue from taxes contributing approximately 33% to the total amount collected on average between 1993 and 1995.

Porto Alegre is the capital of the state of Rio Grande do Sul, which is the southernmost state of Brazil. In the context of Brazil, high standards of living are achieved in Porto Alegre, including investment in education, public transport, communications, city cleaning and sanitation. Its Gross Domestic Product (GDP) per head was US$ 5,228 in 1992 (FEE, 1995), while the national GDP per head was only $3,018 in 1993 (The Economist, 1996). The city covers 500 km² of area and had approximately 1.5 million inhabitants in 1994, being the largest city in the South Region. The residential segment accounted for about 81% of the properties and more than 55% of them were residential apartments.

The National Fiscal Code (CTN) establishes the property tax base. Therefore, the tax base does not vary in different local authorities in Brazil. Other specifications concerning property taxes are defined at local government level. As a consequence, procedures related to establishing the tax base and property tax rates vary considerably around Brazil.

The basic characteristics of the property tax system in Porto Alegre are summarised below. The financial information provided by the following sections is transformed into American dollars.

**Tax Base**

Market value is the property tax base, defined as “the most probable price in terms of money that a property would sell in a competitive and open market, assuming that seller and buyer are acting prudently and knowledgeably, without any special stimulus” (Basic law of the municipality, 1973). The tax base includes land and immovable improvements attached to land. The tax covers all property-use classes, including vacant land, residential and non-residential property.
**Assessment**

The cost approach is the method employed traditionally for assessing real estate property for taxation purposes in Porto Alegre. According to the cost approach, the property market value is established by the mathematical model below.

\[ MV = LV + BC \]  

Where \( MV \) is market value, \( LV \) is land value and \( BC \) is building cost.

\[ LV = ULV \times LA \]  

\[ BC = UBC \times BA \times (1 - D) \]

Where \( ULV \) is a typical land value per unit land area [US $/square metre], \( LA \) is land area [square metre], \( UBC \) is a typical building cost per unit building area [US $/square metre], \( BA \) is building area [square metre], and \( D \) is the depreciation factor [%].

**a. Methodology for estimating the land value:**

- The city is classified into 88 urban zones that represent a type of stratification in geographic areas with similar characteristics.
- Data related to sales of vacant land (undeveloped sites) that have been sold in a period close to the assessment date are collected for each zone.
- An average land value per unit land area is calculated for each zone according to the information collected about sales of vacant land. Only standard sites are considered in establishing the average land value. Standard sites are sites with 30.00m or 40.00m of depth according to the zone on which they are situated.
- The typical land value per unit land area established is adjusted for each site, considering basically two groups of information, which are the infrastructure equipment and the physical characteristics of the site.

The infrastructure indicators taken into account and their adjustment factors are summarised in Table 1. These factors are applied to the typical land value, when the site is not supplied with these infrastructure facilities. A large group of objective factors defined deterministically are employed in trying to adjust the typical land value to each individual site.

<table>
<thead>
<tr>
<th>Infrastructure Equipment</th>
<th>Adjustment Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric light and power</td>
<td>if not, 0.85</td>
</tr>
<tr>
<td>Water supply</td>
<td>If not, 0.85</td>
</tr>
<tr>
<td>Sewer System</td>
<td>if not, 0.85</td>
</tr>
<tr>
<td>Paved roadway</td>
<td>if not, 0.95</td>
</tr>
<tr>
<td>Public School</td>
<td>if not, 0.90</td>
</tr>
</tbody>
</table>

According to the specific physical characteristics of each site, the typical land value per unit land area can be further adjusted. Adjustments on typical land value are applied for non-standard sites.
in an extensive number of situations. The basic adjustments are due to site depth, shape and corner influence.

- For each individual site, the land value is estimated according to equation (2) considering the typical land value per unit land area, already adjusted, multiplied by the land area of the site.

b. Methodology for estimating the building cost:
A unit cost for building area of constructing various types and styles of building is estimated based on information related to typical dwellings. The estimated costs are arranged for classes of building in cost tables and they are used to estimate costs for each individual property. There are about thirty different typical building costs defined, classified according to type of building, walls, roof, storeys, and building quality. For each individual property, the building cost is estimated according to equation (3) considering the typical building cost value per unit building floor area multiplied by the property floor area and its respective depreciation factor.

c. Depreciation factors:
Depreciation factors vary from zero to 45% for brick wall and from zero to 50% for other types of wall only taking into account the year of construction.

Time Lags Between Valuations
No legal requirement exists concerning intervals between general valuations. However, all properties must be assessed at the same assessment date. The last general valuation took place in 1991 (tax collected for 1992) and the next revaluation is planned for this year (1997). For years without valuations, the tax base has been readjusted generically according to prevailing inflation rates. Some capping systems have been adopted in order to guarantee that taxes between consecutive periods will not overtake the ability-to-pay.

Property Data Management: Real Estate Cadastre and Market Information
Currently, property data management for taxation purposes in Porto Alegre is structured into three basic systems that are described briefly in Table 2.

<table>
<thead>
<tr>
<th>Cadastre</th>
<th>Denomination</th>
<th>Managed Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>System 1</td>
<td>Real Estate Cadastre</td>
<td>• fiscal control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• physical characteristics of properties</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• information about zones</td>
</tr>
<tr>
<td>System 2</td>
<td>Cadastre for Real Estate Transfers</td>
<td>• real estate transfers</td>
</tr>
<tr>
<td>System 3</td>
<td>Cadastre for Real Estate Valuation</td>
<td>• information for assessing the tax base</td>
</tr>
</tbody>
</table>

System 1, the real estate cadastre, is a register that manages a large group of dynamic information. It gathers three subsets of data. Subset 1 identifies tax liabilities, including taxpayer’s name, property address, and property-use class (vacant land; residential; and non-residential property). Previous tax bases and bills, and eventual fiscal debt associated with the property recorded are also included. Subset 2 manages data on the physical characteristics of properties, including the site and improvements. Attributes related to improvements vary
according to the building-type class. Subset 3 includes information on zones. Basically, the
supply of infrastructure services and equipment, and data that identifies similarities between
geographical regions in the city are recorded.

The cadastre aims at gathering the most important attributes that might be influencing variations
in market value, which are supposed to vary according to building-type class (type of dwelling).
The information managed allows the tax base to be assessed and, consequently, tax bills to be
produced. Therefore, real estate cadastre is a basic requisite of any valuation system for property
taxation purposes.

System 2 records information on real estate transfers for the Tax on Real Estate Transfers. Only
a small information is stored, including the address of the property that has been sold, the new
owner’s name, the sale date and price, and the payment conditions. The sale prices are declared
by new owners. On the transfer of ownership, a tax is collected (its rate is 3% of property
market value). In order to avoid taxation, part of the price is declared under the real value of the
sale. A team of fiscal valuers is responsible for assessing the property and judging if the declared
price can be considered as evidence of market price. When declared prices are accepted for
taxation purposes, this information is directed to System 3.

The cadastre for real estate valuation (System 3) manages market information. This system aims
at assessing properties, being quite flexible in terms of search, printing options, and importing
data to statistical software. Selling prices are drawn from System 2. Some asking prices are
collected in the real estate market in order mostly to check the information provided by System
2. The basic attributes of improvements, sites and zones are inserted, which are drawn from the
real estate cadastre (System 1).

Property Tax Rate
In Porto Alegre, the rates for property tax are progressive according to market value assessed.
The progressive rates aim at inserting an element to identify the ability-to-pay in the property
tax. The tax is calculated by the sum of the market value corresponding to each class of value
multiplied by its respective rate (sliding rates). Different property-use classes attract different
rates. For instance, rates for vacant land vary from 5.0 to 6.0% of the assessed property value,
while the maximum rate for residential property reaches 1.2%. High rates applied to vacant land
aim at stimulating land development and deterring land speculation.

Taxpayer
The property owner is primarily responsible for paying the property tax. The occupier or user,
even without legal authorisation to use the property, can be requested to pay the tax. Some
properties are exempted from property tax, such as properties used for governmental purposes,
for defence and infrastructure purposes and for public or social interest without profit purposes.
For individual taxpayers, relief is guaranteed for taxpayers with a unique property used for
owner-occupation and an income up to three minimum salaries, since the property is assessed up
to approximately US $ 3,000. Relief is also guaranteed for pensioners, retired people, widows,
and mentally deficient people under similar circumstances.

Critical Analysis of the Current System
This section is concerned with an analysis of the current property taxation system in the city of Porto Alegre, focusing mostly on the tax base assessment and the tax burden distribution. The analysis is limited to the segment of the housing market that includes only residential apartments. As demonstrated earlier, residential properties represent more than 81% of the total number of properties, but they contribute only 39% in terms of revenue. Additionally, residential apartments represent more than 55% of all the properties.

Property Tax Assessment

Difficulties in assessing the property tax base are common for local authorities in many countries (both developed and developing). The low performance in valuation for taxation purposes may be related to poor access to market information, omission of important attributes in estimating the tax base, use of non-representative samples on which the estimates are based, lack of frequent revaluations and inaccuracies present in the real estate cadastre.

♦ Tax base
Market value is the property tax base adopted in Porto Alegre. The choice of which tax base to use depends on many factors including tax liability, administrative capabilities and the real estate market (McCluskey, 1991). There are many reasons for keeping market value as the property tax base in Porto Alegre. A large amount of evidence for open market transactions is recorded. From 1993 to 1995, approximately 23,000 transactions were recorded in annual intervals. Additionally, the real estate market for sales suffers fewer governmental interventions than the real estate market for rents considering the annual rental value as the second option for the tax base. Finally, market value represents a familiar concept to local administrators and taxpayers.

♦ Assessment method
As explained earlier, the cost approach is the traditional method employed for assessing market value for taxation purposes. The approach requires estimates of land value, the current cost of constructing improvements and depreciation rates. At a theoretical and practical level, a large group of weaknesses might arise from adopting this approach in real estate valuation.

A typical land value has to be determined for estimating the land value of all properties subject to taxation. An absolute lack of market information on site prices tends to exist in central areas in which all land might already have been developed. In this sense, evidence for land value would not be available and estimates would not be related to the real estate market since vacant land does not exist. Biases would be expected in land value estimates.

The typical land values established must be adjusted in order to reflect the particular characteristics of individual sites. The use of deterministic factors to adjust them is absolutely subjective and does not provide any scientific basis for estimates of market value at the individual site level. As a consequence, these adjustments might not reflect variations in terms of land value. In Porto Alegre, the same factors have been used for at least more than 10 years.

Additionally, typical geographical stratification of the area under analysis into neighbourhoods is common. The 88 neighbourhoods established in Porto Alegre were defined by subjective criteria.
As a result, biases might occur in estimating the land value due to incorrect neighbourhood breakdown and incorrect typical land value attributed to neighbourhoods (Sunderman et al., 1990).

The cost tables adopted present a weakness that is frequently identified in other systems. They are designed to represent average properties. Consequently, biases are likely to occur at the individual property level (Sunderman et al., 1990). Buyers’ preferences concerning property types are also unlikely to be reflected in construction cost manuals. Finally, Jensen (1993) highlights the importance of realising that building price is not necessarily market value.

Moreover, the most significant weakness in the cost approach seems to be the establishment of depreciation rates. In order to simplify this process, some “ad hoc” rates were established considering generically all building-type classes. The rates established do not have any correlation with the dynamic movements of the real estate market in Porto Alegre.

In summary, some theoretical weaknesses of the approach associated to the extensive number of simplifications requested for its application are likely to result in assessment bias. The cost approach seems to be useful for assessing special-purpose properties, for which sale data are scarce. When the real estate market is in equilibrium, the cost approach might result in consistent estimates for new houses, which have less depreciation and have more easily estimated construction costs (International Association of Assessing Officers - IAAO, 1990).

♦ Assessment equity
Assessment equity in property taxes is the degree to which assessment bears a consistent relationship to market value for all properties at the assessment date. There is perfect equity when the ratio between assessed value and market value is constant, no matter what the specific value (Paglin and Fogarty, 1973). Assessment bias occurs when some classes of property have a ratio of assessment to value significantly different from the ratio of others in the same taxing jurisdiction (IAAO, 1978).

Assessing equity is briefly investigated empirically based upon data related to a sample of approximately 1700 residential apartments, which were sold from January 1993 to December 1995 in the city of Porto Alegre. In order to better understand eventual assessment bias, some subsets of the sample data were analysed, including a general data set, sets of properties classified according to the assessment year and to price ranges. Properties were classified into three ranges of prices (low, middle and high-price properties). Additionally, properties were also classified into ten ranges of prices, with approximately the same number of properties in each. The lowest-price and highest-price properties are gathered in Subset 1 and Subset 10 respectively.

The analysis of the degree of assessment performance involved a comparison of assessed and market values. As with any ratio study, sale prices were used to represent market values. The assessed value considered for each individual property was the actual basis on which the property tax was levied in the year in which its sale took place. In Porto Alegre, assessed values are estimated on annual basis at a fixed date (Dec., 31st).
Indicators of assessment level and uniformity are summarised in Table 3. The mean and median of the assessed value to sale price (A/S) ratio were used to indicate the appraisal level, which represents the overall level at which properties were assessed in relation to sale prices.

Considering all the cases of the data sample, properties were assessed on average at 44% of their sale prices. The median of the overall assessment level for all cases was 40%. When the last real valuation took place for taxation purposes in Porto Alegre, valuations aimed at achieving an assessment ratio of 60%. Therefore, the actual assessment level apparently is much less than the desired level. However, as the last real valuation was undertaken in December 1991, the influence of the time lag without valuations should be considered. The assessment level computed on the subset of data related to the assessment year 1993 is closer to the level desired than those computed to other assessment years. Indeed, properties were assessed on average at 55%, 43%, and 33% of their sale prices in 1993, 1994, and 1995 respectively (See Table 3). The investigation confirms that lack of frequent valuations can reduce the tax base. The assessment ratio for 1991 must have been close to 60%.

Table 3 - Measures for Assessment Performance: A/S ratio

<table>
<thead>
<tr>
<th>Measures</th>
<th>Assessed Value to Sale Price (A/S) Ratio</th>
<th>Mean</th>
<th>Median</th>
<th>Data</th>
<th>Minimum</th>
<th>Maximum</th>
<th>COD median</th>
<th>COV mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>General data set</td>
<td></td>
<td>0.44</td>
<td>0.40</td>
<td>1741</td>
<td>0.0523</td>
<td>1.3799</td>
<td>37.73</td>
<td>45.11</td>
</tr>
<tr>
<td>Assessment Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td></td>
<td>0.55</td>
<td>0.53</td>
<td>574</td>
<td>0.0543</td>
<td>1.3693</td>
<td>31.11</td>
<td>38.58</td>
</tr>
<tr>
<td>1994</td>
<td></td>
<td>0.43</td>
<td>0.41</td>
<td>593</td>
<td>0.0523</td>
<td>1.3799</td>
<td>32.87</td>
<td>41.42</td>
</tr>
<tr>
<td>1995</td>
<td></td>
<td>0.33</td>
<td>0.31</td>
<td>574</td>
<td>0.1027</td>
<td>1.1746</td>
<td>30.18</td>
<td>40.03</td>
</tr>
<tr>
<td>Price Criterion 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25% low</td>
<td></td>
<td>0.59</td>
<td>0.56</td>
<td>435</td>
<td>0.1532</td>
<td>1.3799</td>
<td>30.52</td>
<td>37.36</td>
</tr>
<tr>
<td>50% mid</td>
<td></td>
<td>0.39</td>
<td>0.36</td>
<td>870</td>
<td>0.0523</td>
<td>1.2878</td>
<td>34.26</td>
<td>42.46</td>
</tr>
<tr>
<td>25% high</td>
<td></td>
<td>0.37</td>
<td>0.35</td>
<td>436</td>
<td>0.0543</td>
<td>1.2094</td>
<td>33.11</td>
<td>41.73</td>
</tr>
<tr>
<td>Price Criterion 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>0.66</td>
<td>0.63</td>
<td>174</td>
<td>0.1917</td>
<td>1.3799</td>
<td>29.35</td>
<td>35.09</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>0.55</td>
<td>0.54</td>
<td>174</td>
<td>0.1872</td>
<td>1.3374</td>
<td>28.65</td>
<td>35.13</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>0.49</td>
<td>0.47</td>
<td>174</td>
<td>0.1532</td>
<td>1.3693</td>
<td>31.88</td>
<td>39.16</td>
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<tr>
<td>4</td>
<td></td>
<td>0.42</td>
<td>0.38</td>
<td>174</td>
<td>0.1432</td>
<td>1.2878</td>
<td>35.80</td>
<td>43.62</td>
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<tr>
<td>5</td>
<td></td>
<td>0.40</td>
<td>0.37</td>
<td>175</td>
<td>0.1285</td>
<td>0.9164</td>
<td>32.15</td>
<td>39.25</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>0.38</td>
<td>0.36</td>
<td>174</td>
<td>0.0523</td>
<td>1.0338</td>
<td>31.60</td>
<td>39.92</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>0.37</td>
<td>0.34</td>
<td>174</td>
<td>0.1255</td>
<td>1.0897</td>
<td>35.16</td>
<td>44.97</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>0.36</td>
<td>0.33</td>
<td>174</td>
<td>0.0534</td>
<td>1.0530</td>
<td>35.72</td>
<td>45.64</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>0.37</td>
<td>0.33</td>
<td>174</td>
<td>0.1198</td>
<td>1.2094</td>
<td>40.15</td>
<td>47.86</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>0.37</td>
<td>0.37</td>
<td>174</td>
<td>0.1027</td>
<td>0.8144</td>
<td>25.30</td>
<td>31.32</td>
</tr>
</tbody>
</table>

Where A/S is assessed value to sale price ratio; COD is the coefficient of dispersion of median of A/S; and COV is the coefficient of variation of mean of A/S.

Comparing the mean and median of the assessment ratios for the groups established, systematic inequities are clearly indicated. Focusing on the range of prices, low-price properties were appraised at a higher assessment level than high-value properties. Low-price properties were assessed at 59% of sale prices on average, while high-price properties were assessed at only...
Comparing the results achieved for small subgroups of properties, the phenomenon identified can be confirmed (See results in Table 3). It suggests that low-price properties were over-assessed in relation to high-price properties. This aspect will be discussed further later.

The basic measure for identifying the variability of A/S ratios is the coefficient of dispersion (COD) of the median. Additionally, the coefficient of variation (COV) can also provide an indication of the assessment level variability between different groups of properties. According to IAAO (1990), depending on the similarity between properties, an acceptable degree of uniformity could be indicated for a COD up to a maximum of 15%.

As demonstrated in Table 3, again inequities are clearly perceptible. CODs computed vary from approximately 31 to 48%, indicating a low degree of assessment uniformity. A histogram can also be used to represent the distribution of the assessment level (See Figure 1). The great spread of the assessment ratios is confirmed in the histogram. The desired effect would be a high concentration of assessment ratios around any specific value, in this case around 0.60 (ratio of 60%).

Sale prices and assessed values do not refer to the same date. Due to high inflation during part of the period covered by the analysis, both prices and assessed values were transformed into American dollars in order to make a comparison of A/S ratios possible. The effects of inflation during the period of the analysis were minimised. However, variations in sale prices may not necessarily reflect inflation movements. As a consequence, part of this clear inequity identified might be attributed to the methodology of investigation.

In order to explore the effects caused by the procedure adopted, a new subset was formed only considering data on which sales and assessments took place in the same month. COD was computed for a general data sample, containing 142 cases, and for subsets classified according to assessment year. In all subsets, CODs were larger than the ones achieved initially. Consequently, the high assessment variability indicated can not be attributed to time lag effects.
Many models have been proposed to verify if assessment bias in property taxes is related to price of properties (For a summary about these models, see Sunderman et al., 1990 and Sirmans et al., 1995). This phenomenon relates to vertical inequities, which are systematic differences in appraisal levels for groups of properties defined by value. They can be either regressive, when high-price properties are under-appraised relative to low-price properties, or progressive, when the opposite occurs.

Basically, regression models between sale prices and assessment values are employed for testing the vertical assessment equity in property taxes. There are two basic differences among the many models established. The first is the form of the relationship assumed between the variables, and the second is which variable should be used as the independent one. Regarding the form of the relationship, some models are superior to others since they make it possible to adjust for a large number of situations. The model proposed by Sunderman et al. (1990) is capable of covering both the linear and non-linear relationships between sale prices and assessed values at the same time.

The possibility of inconsistent results, when different measures and tests are used to indicate vertical inequities, is demonstrated empirically in Cannaday et al. (1987) and Sirmans et al. (1995). In general when assessed values are used as dependent variable, models indicate regressivity. As assessed values are used as independent variable, models indicate progressivity. The results achieved using the data sample from Brazil confirm inconsistent results, exactly as explained above. Due to the inconsistent results achieved, the models are not included in the paper.

The effects of introducing a variable for representing the difference between sale and assessment date into the usual models were explored. In general, the introduction of this variable reduced the level of vertical inequity, confirming the importance of adjusting date differences between sales and assessments.

Comparing the overall results achieved in the analysis, the mean and median established for a range of prices demonstrated clearly that the assessment level for low-price properties was significantly larger than the level for others. It indicates that high-price properties, on average, were assessed at lower ratios than low-price properties. This might suggest that the models that indicated assessment regressivity, on which assessed value was used as the dependent variable, provide more consistent results. Further investigation is required into this subject. The problems concerning the method adopted to assess properties for taxation purposes in Porto Alegre are supposed to have contributed to the assessment inequity identified.

♦ Possible options to improve the system
The initial and primary issue for achieving more accuracy in assessing the tax base is to radically change the approach used for establishing market values. Principally, concerning residential apartments, estimates of the market value based on market behaviour seem to be more suitable.

The sales comparison approach estimates market value based on the prices of a group of
properties that have been sold in a period close to the assessment date. The most traditional and widely-known method for identifying the most important factors determining prices and to estimate the value of those properties that have not traded is hedonic multiple regression analysis (MRA).

More recently, several studies have examined the application of artificial neural networks (NN) in valuation for taxation purposes. Part of the research undertaken suggests promising possibilities for the application of neural networks in valuation for taxation purposes (Tay and Ho, 1994; and Borst and McCluskey, 1996). However, James and Lam (1996) are not so conclusive, suggesting further research in the area. Worzala et al. (1995) note the possibility that using the same variables (inputs), estimates can be different if different software is used.

Rossini (1997) compares MRA and NN for residential properties. In the majority of the cases tested, better results in terms of prediction are implied when using MRA. Borst (1995) compares comparable sales analysis, MRA, and NN. The author concludes that all the techniques performed similarly. In comparative terms, MRA is quicker and results achieved are considered more consistent. The application of MRA for taxation purposes seems to represent a less risky alternative. McCluskey (1996) refers to the methodological problems associated with MRA, such as the need to impose linearity by using data transformations and to avoid multicollinearity.

The advantages of neural networks are pointed out with small data sets (Rossini, 1997) and their ability to cope with a non-linear relationship (McCluskey, 1996). However, the approach is recognised as a “black-box” in nature and they can produce some excellent predictions but some which are equally poor (Rossini, 1997). Processing time might be considered a further problem in using neural networks. As reported in Rossini (1997), a model with “223 cases and 42 variables did not reach a suitable global minimum after 23 hours”.

Even adopting a more suitable approach for estimating market value, difficulties in establishing the real market value are frequent. The fact may be explained for the request, common to any technique, for a reliable data set on which to base predictions. The accuracy of the information on sale prices is not known (Kathmann, 1993). Information concerning the real estate market is not perfect. There is a poor access to data on sales caused by legislative restrictions on data release and by conservative attitudes (Wyatt, 1996). Additionally, in order to avoid taxation, buyers and sellers may be discouraged from stating accurate sale prices (IAAO, 1990).

Moreover, attributes that can not be easily quantified and qualified are not incorporated in models easily (Dwyer, 1996), leading to wrong conclusions due to the omission of important variables. Finally, the concept of market value is subjective.

**Time Lags Between Valuations**

The lack of frequent re-valuations can reduce the tax base and cause taxpayers to lose confidence in the system. The usual lag between assessments in a dynamic housing market accentuates the initial price-related assessment bias, because low priced and deteriorating structures tend to decline more quickly in value than the better ones (Paglin and Fogarty, 1973).

General indices based on inflation applied to all properties in order to adjust values between
valuations are likely to result in additional assessment bias. Inflation rates are only one of the many factors that may explain variations in market value. Another criterion should be considering taking into account real market movements.

_property data management_

Although the structure of property data management in Porto Alegre is conventional, it does not represent a major problem. The three systems created to manage data are able to provide the necessary information for good performance for taxation purposes.

The use of information about real estate transfers, upon which estimates of market value are based, seems to be the cheapest, quickest, and most efficient option, considering that data on sales is recorded by the local authority. The criterion of considering only representative sales, i.e. sales that can be used as market evidence, contributes to the gathering of reliable data.

Information is also recorded accurately. The real estate cadastre is constantly updated either when new buildings are permitted for occupation or by systematic inspections. The eventual errors are estimated to be small. The real estate cadastre contains at least the most important information for estimating market value.

_tax burden distribution_

If equity in taxation is understood as the relationship between tax and the ability-to-pay, there is little consensus about its existence in property taxes. In general, a good relationship between wealth and real estate holdings seems to exist with ownership being concentrated among high-income groups. However, a number of exceptions to this assumption must be considered in that some low-income families might be exposed to heavy burdens (Aaron, 1975).

It may be a major factor contributing to the unpopularity of property taxes. The use of progressive rates for the property tax in Porto Alegre, which varies according to the property value assessed, is an attempt to insert an element to identify ability-to-pay into the system. However, the measure could be more effective in using family income to identify ability-to-pay.

_recommendations on property tax reform_

The principal drawbacks identified in the property taxation system in the city of Porto Alegre are concerned with the tax base assessment. The use of Multiple regression Analysis (MRA) is recommended to replace the cost approach for residential apartments due to its relatively easy application and good performance when compared with other valuation methods. The staff are used to this approach and the local authority is equipped in this sense. MRA has been used in many pilot studies and for individual valuations since 1992. Indeed, this alternative represents the simplest way to change the approach currently used for assessing properties immediately.

Whatever the approach used for assessing property value, tests for assessment equity are highly recommended for identifying eventual bias in the tax base assessment. They consist of an analysis of the valuation performance, where estimates of market values are compared with true market values. As there is no evidence for the real market value, sales prices are used to represent them.
Since property taxation systems often contain assessment inequities, some ways of adjusting them by applying equalisation factors are addressed in Birch et al. (1995). The methods reduce the effect of the inequity, but eliminate neither the need to make long-run corrections, nor its causes. In both methods, properties are divided into groups according to their assessed values (estimates of market values) and multipliers of assessed values to sale prices (A/S) ratios are defined for each group. The aim is to adjust groups so that the median A/S ratios are constant, reducing inequities.

Concerning time lags between valuations, they are recommended to be not longer than a maximum of three years. For years without a general valuation, a system for adjusting values based on index numbers is suggested. An index number equal to the ratio of sales prices for the assessment year and the previous assessed value could be employed (Fibbbens, 1995). According to the author, “price fluctuations for individual sub-market groups are examined to derive multipliers that can be used to update values annually”. Even considering that some problems might be associated with this approach, such as the selection of sub-market groups and representative properties, the method is superior to the one currently used based generically on inflation rates.

In order to actually reflect the ability-to-pay on property taxes, progressive rates of property tax should be established according to taxpayer income. The basic idea is to have progressive rates for different classes of income. In Brazil, where the inequality of income distribution is the most serious social problem in existence, this approach could represent an effective improvement in the property tax equity in terms of the distribution of the tax burden.

A method for producing a rates structure for property tax in order to fairly distribute the tax burden among different income groups is presented in De Cesare (1997). Estimates of market values, taxpayers’ income, and the revenue need for a community are used to define property tax rates that vary according to income class. The system proposed seems to be able to move towards an almost neutral incidence of the property tax in terms of income. Of course, the model is supposed to adjust the tax burden distribution just on average and according to a general model that describes the relationship between assessed values and income. The model proposed should be better explored with different databases.

These recommendations might not represent a significant advance in technological terms, but its implementation would allow the system to operate efficiently within the available resources, with a good degree of fairness.

The process of reform has already been started in the city of Porto Alegre. Some of the recommendations suggested are being implemented. After many years, the traditional method is finally going to be discarded and MRA will be used for the first time this year (1997). Tests for assessment equity and eventual adjustments are also programmed to be undertaken as part of the valuation process for taxation purposes. However, the progressive rates that vary according to assessed property-value are expected to continue.
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