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Assessing the impact of local taxation on property prices: a spatial matching contribution

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Abstract: This paper provides empirical evidence on the impact of local taxation on property prices in an urban French context, using data on property taxation and real estate transactions, over the period 1994-2004. Our empirical methodology pairs transactions in the same spatial environments to estimate the impact of property taxation, controlling for the local public spending effect. Spatial differencing and Instrumental Variables methodology allow us to compare sales across municipality boundaries and to control for the potential endogeneity of local taxation and public spending. Our results suggest that the local property tax rate has no impact on property prices, while the amount of taxes paid appears to have a negative effect on property price.

Keywords: fiscal capitalization, local taxation, property prices, borders.

Titre en français : Evaluer l'impact de la fiscalité locale sur les prix immobiliers : une contribution de l'appariement spatial.

Résumé : Ce papier contribue à comprendre l'impact de la fiscalité locale sur les prix d'achat des maisons dans un contexte urbain et français, à l'aide de données sur la fiscalité locale sur les transactions immobilières réalisées sur la période 1994-2004. Notre méthodologie apparie les transactions ayant eu lieu dans le même environnement spatial afin d'estimer l'effet de la taxe foncière en contrôlant les effets des dépenses publiques locales. La différenciation spatiale ainsi que la méthode des variables instrumentales nous permettent de comparer les ventes de part et d'autre des frontières communales et de contrôler l'endogénéité potentielle de la fiscalité et des dépenses publiques locales. Nos résultats tendent à montrer que le taux de taxe foncière n'a pas d'impact sur les prix d'achat, alors que le montant de taxe acquitté par les propriétaires semble avoir un effet négatif sur les prix des transaction foncières.

Mots clés : capitalisation fiscale, fiscalité locale, prix des transactions foncières, effets frontières.

ASSESSING THE IMPACT OF LOCAL TAXATION ON PROPERTY PRICES: A SPATIAL MATCHING CONTRIBUTION

by

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1 Introduction

Issues surrounding the impact of local taxation and public services are the key concern in a wide literature based on Tiebout (1956) which shows that individuals reveal their preferences by "voting with their feet." If citizens are faced with choosing among several communities that offer different types or levels of public goods and services, then they will choose the community that best satisfies their own individual requirements. Citizens needed high levels of public goods will be concentrated in communities with high levels of public services and high taxes, while those with low level demand will tend to choose other communities with lower levels of public services and lower taxes. If households were perfectly mobile, Tiebout (1956) argues that an efficient pattern of local services would be attained without the intervention of a central government. However, Tiebout's argument does not cope with property tax or capitalization. Later analyses combined the introduction of a property tax with Tiebout's key assumptions (perfect mobility across jurisdictions, complete information, multiple jurisdictions). On the one hand, Oates (1969) and Brueckner (1979) argue that capitalization exists when lower property taxes or better local public services lead to higher house values. On the other hand, Edel and Sclar (1974), Hamilton (1975), and Epple, Zelenitz and Visscher (1978) focus on supply responses to rent differentials and predict the disappearance of this capitalization (see Yinger (1982) and Starret (1981) who discuss the validity of land capitalization).

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Following Oates (1969, 1973), numerous empirical analyses have addressed capitalization of interjurisdictional fiscal differentials. From this large literature, Cushing (1984) was the first to consider that if capitalization of interjurisdictional fiscal differentials occurs, it should be most obvious at the border between two jurisdictions. He and others including Black (1999) or Gibbons and Machin (2003), use housing price differentials between adjacent blocks at the border of two jurisdictions to study capitalization.

This paper is aimed at providing empirical evidence on the impact of local taxation on property prices, improving the methodology described above and applying it to the French context. We use data on individual housing which are available for two French urban areas (Dijon and Besançon) for about 10,000 house sales, for the period 1994 to 2004. After identifying transactions close to the jurisdiction borders, we can control for housing characteristics to isolate time-varying local property taxes. We focus on the local property tax that applies to buildings and is based on the property's theoretical rental value. The impact of this tax rate on property prices has been the subject of numerous debates in France (Mercier, 2000) since the theoretical values estimated by the French administrations is often very different from the actual property values.[1]

Our empirical methodology pairs transactions to estimate the impact of property taxation on prices. Spatial differencing and instrumental variables (IV) methods allow us to compare sales and to control for the endogeneity of local taxation. Our results suggest that the local property tax rate does not have the expected impact on property price levels. However, when it is crossed with variables used to evaluate the base, it has a significant and negative effect when the base proxy is large. We can conclude that buyers are more sensitive to the amount of taxes they will have to pay than to the tax rate. This is logical, since in France local property bases vary substantively.

The paper is organized as follows. Section II provides a short review of the literature on fiscal capitalization. Section III presents the data and summary statistics. The methodology is described in Section IV and the main results are contained in Section V. Section VI presents some robustness checks and section VII concludes.

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[1] The last major updating was in 1970.

2   Literature review

We describe the theoretical background and the econometric issues associated with the estimation of hedonic models.

2.1   Theoretical background

We use the simple model of Yinger (1982) to introduce the capitalization of property rate into house value. Households are assumed to be similar. When choosing a residential location, we assume that a household considers the property tax rate, t, and the level of local public services per household, G, in each jurisdiction. The amount a household is willing to pay for one unit of housing services depends on the supply of public goods and the tax rate that apply to a jurisdiction. As a consequence, the bid function for one unit of housing is given by:

$P = P(G,t)$. Assuming that a house contains H units of housing services, the value of the house to the household may be given by: $V(G,t) = P(G,t)H/r$ where r is the discount rate.

Each household has to pay a property tax that is proportional to the value of the house, i.e. $tP(G,t)H/r$. The household's income Y is used to buy a composite consumption good X whose price is unitary, housing services in quantity H at price P and property taxes at rate t. The maximization problem for the household is as follows:

$$\max_{Z,H,G,t} U(X,H,G)$$
$$s.t. Y = X + P(G,t)H[1 + t/r]$$

To describe the effect of property tax on house values for a given level of public services G^*, we must solve the following equation given by one first-order condition:

$$\frac{\partial Y}{\partial t} = \frac{\partial P}{\partial t}H[1 + t/r] + P(\frac{H}{r}) = \frac{\partial P}{\partial t}(r + t) + P = P'(r + t) + P = 0 \qquad (1)$$

with $P' = \frac{\partial P}{\partial t}$ .The solution for this differential equation (1) can be written as:

$$P(G^*,t) = P'H/(r + t) \qquad (2)$$

Combining this solution into the equation for house value, we can derive the capitalization of property tax rate into house values for a given level of public services:

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$$V(G^*, t) = P(G^*, t)H/r = P'H/(r+t) \tag{3}$$

If we let the level of public goods supply vary, equation (2) becomes:

$$P(G, t) = rP'(G)/(r+t)$$

where $P'(G)$ describes each household's bid for housing services before tax, i.e. for $t = 0$.

To determine the form of $P'(G)$, we have to compute the housing demand H. We thus have to specify the utility function. Choosing a Cobb-Douglas utility function, we get:

$$U(X, H, G) = \alpha \ln(X) + \beta \ln(H) + \gamma \ln(G)$$

The household's bid function is for every pair (G, t):

$$P(G, t) = \frac{CrG^{\frac{\gamma}{\beta}}}{r+t}$$

where C is a constant of integration. If we assume that housing services are a multiplicative function of housing characteristics, Z_1 to Z_n, the value of a house becomes:

$$V(G, t) = P(G, t)H/r = \left(\frac{CrG^{\frac{\gamma}{\beta}}}{r+t} \right) \prod_{i=1}^{n} Z_i^{a_i}$$

or

$$\ln(V) = \ln(C) + \frac{\gamma}{\beta} \ln(G) - \ln(r+t) + \sum_{i=1}^{n} a_i \ln(Z_i) \tag{4}$$

This relationship (4) describes how the value of a house capitalizes for a given discount rate r, public services G weighted by their preferences $\frac{\gamma}{\beta}$, property tax t and the housing characteristics. Yinger's definition of capitalization when households are assumed to be similar is thus the following. Local fiscal variables are completely capitalized into house values when the variation in house values within or between the jurisdictions exactly reflects what households are willing to pay for the different public goods-tax couplings in different locations.

2.2 The empirical tests

Let us turn now to the empirical estimation of the resulting model which is called the traditional hedonic specification:

$$V = c + \zeta G - \tau t + \sum_{i=1}^{n} a_i Z_i + \eta N + \varepsilon$$

where N are neighborhood characteristics and ε is a vector of i.i.d. error terms.

There are numerous empirical analyses of capitalization of interjurisdictional fiscal differentials. Oates's (1969, 1973) seminal papers found significant capitalization of public services and almost complete capitalization of property tax rate differentials for a sample of cities in the state of New Jersey. Follain and Malpezzi (1981), on the other hand, concluded that fiscal surplus, i.e. public service expenditures minus taxes per capita, differentials were not capitalized into house values. Other studies have produced diverse results (see e.g. Edel and Sclar, 1974; King, 1977; Rosen and Fullerton, 1977; Wales and Wiens, 1974; Sonstelie and Portney, 1980; Chaudry-Shah, 1989, etc.)

An important consideration is how locational effects, positive as well as negative, are capitalized into house values. Can (1992) distinguishes between two levels of externalities. The first captures the neighborhood effects, i.e. the impact of common neighborhood characteristics on housing prices. The second level includes spatial spill-over effects - adjacency effects - such as the impact of the prices of neighboring structures. These effects are not confined to jurisdictions, they can cross boundaries. As argued by Can (1992), locational effects require the use of different specifications for the housing price equation (see details in the appendix). We need to test for spatial effects to detect the existence of spatial dependence and/or spatial heterogeneity and to choose the right specification. To circumvent the problems associated with spatial effects, we use an alternative methodology, first implemented by Cushing (1984) and developed by Black (1999)[2] to test the theoretical prediction that housing prices are influenced by the quality of schools. The main estimation problem is that measuring the effects of school quality on housing prices raises an endogeneity problem since better schools tend to be located in wealthier neighborhoods because of the higher performance of children from more privileged families. Black (1999) suggested comparing the prices of houses located on opposite sides of a common elementary school district boundary. She assumes that changes in school quality are discrete at the boundaries, whereas changes in neighborhood characteristics are smooth. She goes on to relate the differences in mean prices of houses located at opposite sides of attendance district boundaries, to performance in school examinations. Then, houses differ only in terms of elementary schools. Her sample is based on a selection of the sales located within 0.15 of a boundary. She finds that parents are willing to pay 2.5% more in house prices for a 5% increase in test scores.

Gibbons and Machin (2003) estimated the premium attracted by differentials in primary school quality in England for 1996 and 1999. They built a hedonic property price model. It

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[2] Holmes (1999) used the discontinuity border effect to test the impact of US state policies on local development.

is well known that the difficulty of this approach is to specify what to include in the hedonic price function since neighborhood composition is endogenous in a property value model. To circumvent the problem of simultaneity between property prices and performance, they used IV for school performance. They isolated schools characteristics - historically determined school-type characteristics - that influenced performance but were not affected by local property prices or neighborhood socio-economic status. They exploited the co-variation in house prices and school performance within narrowly defined spatial groups and computed spatially weighted means for the variables in their model at each observation, whereby the nearest observation receives the highest weight. Since these means capture general, unobserved, area and amenity impacts on the housing market, centered at the location of the unit of observation, they were able to transform the data into deviations from these spatially weighted means. Finally, Gibbons and Machin used a weighting function with a bandwidth that included housing density to specify how rapidly weights decay with distance. They found that a percentage point increase in the neighborhood proportion of children reaching the government-specified target grade pushed up neighborhood property prices by 0.67%.

The paper by Fack and Grenet (2007) provides empirical evidence on the impact of middle school quality on housing prices in Paris, using data on both school zoning and real estate transactions over the period 1997-2003. Building on Black's (1999) approach, they used a matching framework to compare sales across school attendance district boundaries and to deal with the endogeneity of school quality. Their sample included some 200,000 real estate transactions and prices, their detailed characteristics and their precise geographical locations (Lambert grid coordinates). Fack and Grenet modified Black's methodology, first because the characteristics of flats do not have the same impact on prices across Paris, and second because the unobservable characteristics shared by two houses or flats located on either side but at opposite ends of the segments of a common boundary, are not necessarily the same if the border is a long one. They adopted a matching framework to compare each transaction with a constructed counterfactual transaction. They deleted the set of boundary fixed effects in Black's (1999) hedonic equation by restricting a transaction's comparison group to sales located on the other side of the school boundary and within a given radius of specific sales. They made reference sales all transactions located within a distance of 0.20 miles of a school attendance boundary. Every reference sale was associated to a fictive counterfactual sale, which is supposed to be a measure (all else being equal) of the amount involved in a reference sale if the property were located in another

school zone. The price of the counterfactual transaction was computed as the weighted geometric mean of the prices of all transactions that took place in the same neighborhood but in a different school zone. Finally, transactions were weighted by the inverse of their distance from the reference transaction to give higher importance to closer sales. Their estimates were similar to those found in US and UK studies (Black, 1999; Gibbons and Machin, 2003): a standard deviation increase in school quality raises prices by about 2%.

Although their study was of the impact of local taxation on employment growth and not the influence of school quality on housing prices, the methodology used by Duranton, Gobillon and Overman (2007) is an improvement on Black's (1999) and Gibbons and Machin's (2003) methodologies in that it corrects for unobserved local effects, unobserved establishment heterogeneity and endogeneity of local taxation (rather than school quality). Using plant level data for UK manufacturing establishments, Duranton, Gobillon and Overman's strategy consists of identifying pairs of firms that are neighbors but are on opposite sides of jurisdictional boundaries. Because of the spatial correlation in site characteristics, these establishments have very similar unobserved characteristics but face different tax rates. To deal with the existence of heterogenous establishments, they used the panel dimensions of their data to remove establishment and jurisdiction fixed effects. Finally, to circumvent the problem of endogeneity of tax rates with employment and locations decisions, they instrument the levels of local taxation by local political variables. Their preliminary results suggest that local taxation has a negative impact on employment growth.

3 Data and summary statistics

In this section, we present the data. Since data are transactions and therefore do not constitute panel data, the methodology used here is closer to that in Fack and Grenet (2007) than to the methodology employed by Duranton, Gobillon and Overman (2007).

3.1 Housing prices

Our data on property sales come from Perval, which was created by the Notary Chambers in France - all property sales are registered with Notary offices. For each transaction, we have information on the sale price of the property (see figure 1), along with details of features such as size, number of rooms, date of construction, etc. and precise geographical location. The geographical precision of geocoded data, i.e. Lambert grid coordinates, is about 10 meters. Our
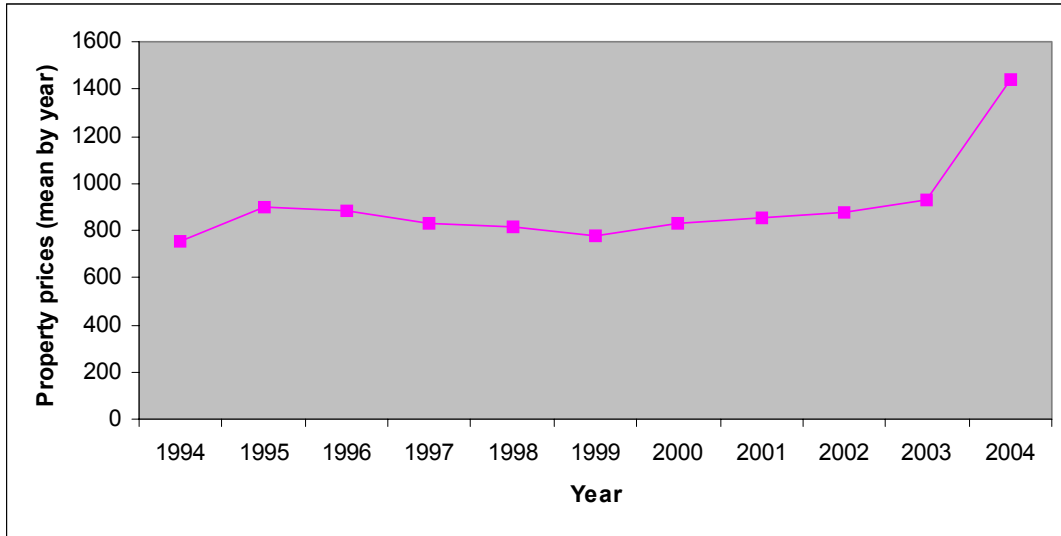
Figure 1: Property prices per square meter

sample is restricted to house sales in two urban areas (Dijon and Besançon) between 1994 and 2004, giving a sample of around 10,000 transactions. It should be noted that value added tax on real estate is payable by the seller for a property sold in the first 5 years after its construction. This is charged at the rate of 19.60% of the selling price. We include this tax as an explanatory variable.

3.2 French local taxation

France is usually considered as unitary in terms of government although different layers of local governments have wide fiscal autonomy. The structure of local government is broadly four tiered. The lowest tiers consist of 36,600 municipalities and 13,000 groups of municipalities. The third tier consists of 96 departments and the top tier is the 22 regions that are at the highest level of local government. Local revenue sources derive mainly from local taxes (54%), central government grants (23%) and borrowing (10%). Each level of local government sets its own tax rates, on a common tax base, for a large range of local direct taxes, which account for 75% of local tax revenues. Local authorities have considerable latitude in the tax rates for these four types of taxation. The "local tax varying power" is the proportion of local resources represented by tax revenue, over which local authorities have some control; France has the second highest level of tax autonomy (54%) in the European Union, compared with 20% in Germany which is a federal country, and Spain (35%) which is close to being a federal country, and the UK at 14%.

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There are two local taxes that are based on theoretical rental value according to the local land registry. Property tax is payable by the owner, while housing tax is payable by the occupier. Property tax is made up of two different tax rates that apply respectively to the buildings and to the land belonging to the property.

New buildings and new renovations are exempt from tax for two years. Taxes are also not applicable to buildings used for agricultural purposes or if the premises are used exclusively for farming, business or student lodgings. People aged over 75 and those with disability pensions are also exempt from property/housing tax and discounts are available for some people over 65 on low incomes.

The local business tax (the so-called Taxe Professionnelle) is the major source of tax revenue for local governments since it accounts for approximately 45% of the revenue from direct local taxation. Its tax base is mainly capital goods and it is calculated on the rental value of the buildings and the equipment.

There is an institutional rule in France that ties the increase in local business tax rates to the increase in household taxes (property and housing tax rates). A jurisdiction cannot set a higher (lower) tax rate for business if it has not increased (decreased) its housing tax rates. Consequently, the relationship between the local business tax rate and the housing tax rate is often complementary (Charlot and Paty, 2007). Although collected centrally these taxes are distributed to local jurisdictions and are used to finance local public services, such as rubbish collection, street cleaning, schools and other community facilities, as well as the administration of these services.

We focus on the property tax (PT) rate that applies to buildings and is based on the theoretical rental value of the property.[3] The impact of this tax rate on property prices has been much debated in France (Mercier, 2000). Since the last major updating of property bases in 1970, theoretical property values often differ widely from actual values.

As we are interested in local tax variations, where applicable, the municipal tax rate is

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[3]The property tax base is half of the property's theoretical rental value; the housing tax base is the whole value.
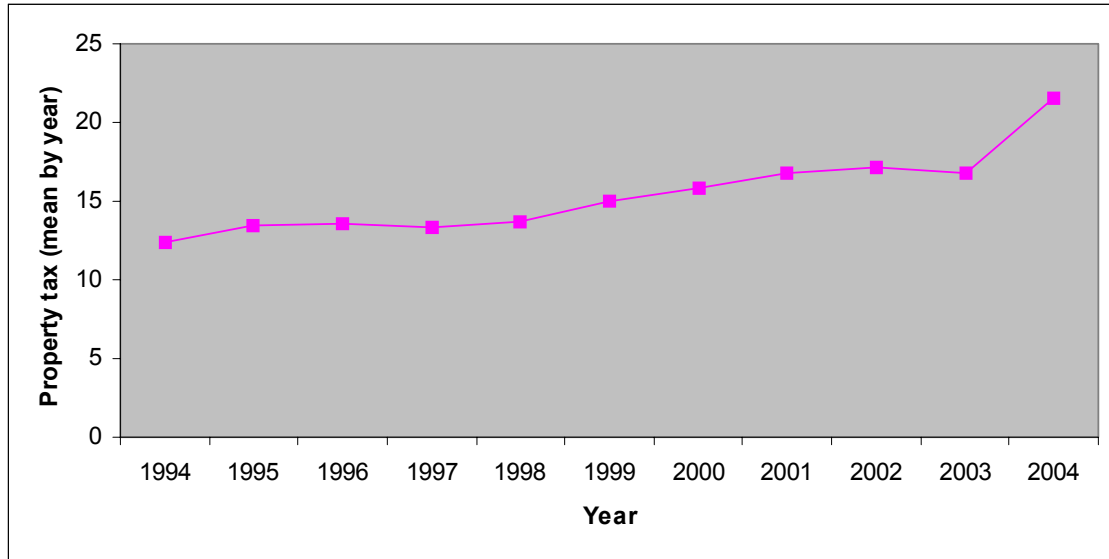
Figure 2: Property tax rate (%)

summed to the tax rates of the group of municipalities.[4] Fiscal data are from the Direction
Générale des Collectivités Locales (DGCL, Ministère de l'Intérieur).

Figure 2 shows that the evolution of property prices more or less matches the evolution of
property tax rates. Table 1 provides some descriptive statistics for each fiscal variable.

| Variable	N	Mean	Std Dev	Minimum	Maximum
Property tax (%)	13577	16.049	5.817	1.000	34.770
Prop. Prices (Euros psm)	13577	873.172	566.217	0.213	4380.15
Living space (sm)	10362	94.106	44.856	8.000	602.000
GardenSize	10362	5.733	13.789	0.000	588.086
Rooms number	10362	4.242	1.806	0.000	17.000

Table 1: Descriptive statistics

Maps 1 and 2 show that property tax rate and mean property price are spatially correlated.
Both increase with a decrease in the distance from the city center. This can be explained in

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[4]Groups of localities (or EPCI) are not formal local governance structure since they are not compulsory and
they do not apply to the whole territory. Localities can decide not to join these groups. However, where they exist,
they have autonomy for setting tax rates using the same tax base as the other three levels (localities, counties
and regions).

a variety of ways. Both variables are strongly correlated to urban amenities and access to employment. The significant relationship between theses variables therefore may have little to do with land capitalization but may be due to the location of the property.
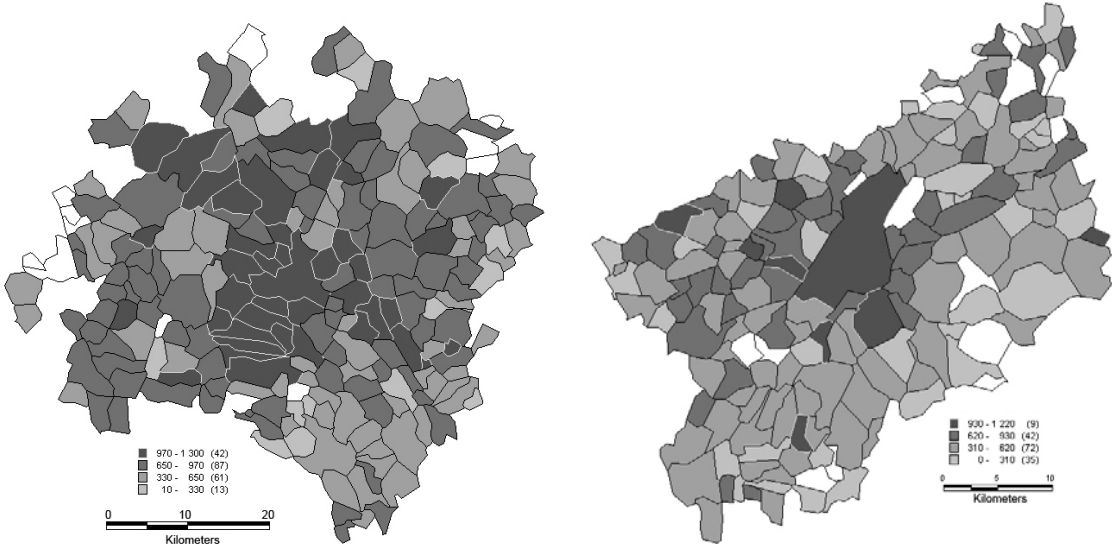
Map 1: Property prices (square meter) in the urban areas of Dijon and Besancon
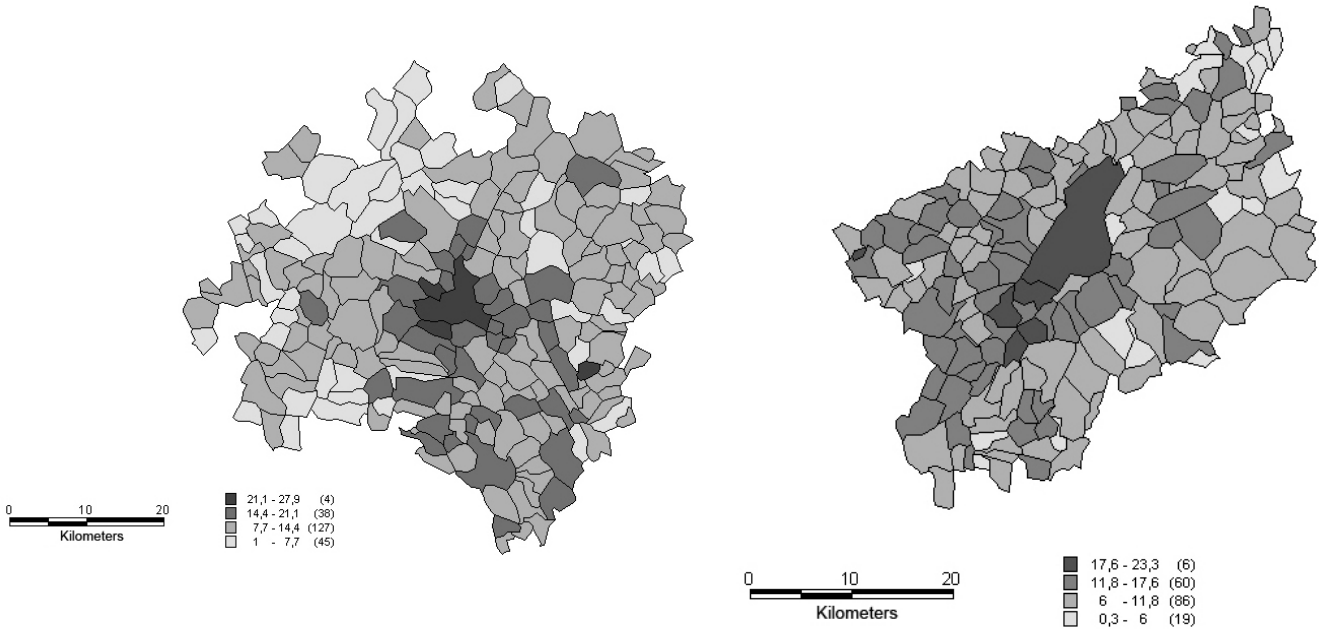
Map 2: Property tax rates in the urban areas of Dijon and Besancon

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4 Methodology

In order to estimate the impact of local taxation on property values, we estimate a "spatial difference" model similar to that of Fack and Grenet (2007). Their methodology is adopted to take account of the variability in density of large urban areas. In a first step prices are estimated and then transformed. The transformation is a spatial difference to control for the location specific effect. This methodology is aimed at comparing each individual transaction to any other transaction located close by, and therefore within the same environment. Each transaction is matched with another close by transaction.

This is a two-step estimation. In the first step, the house price is assumed to depend on its characteristics.

$$\ln p_{i,m,t} = \alpha + \sum_i \beta_i X_i + \epsilon_{i,m,t} \tag{5}$$

where X_i is the vector of property's characteristics.

Once individual characteristics are controlled, as in Fack and Grenet (2007), the price of houses located in neighborhood n, in municipality m and occurring at time t, is assumed to be a sum of a neighborhood fixed effect, a municipal fixed effect, a time fixed effect and an error term, $\epsilon_{n,m,t}$:

$$\ln p_{n,m,t} = \Psi_n + \Psi_m + \Psi_t + \epsilon_{n,m,t} \tag{6}$$

The municipal fixed effect is assumed to be a linear function of the log of the local tax rate in the year of the transaction, τ_m, municipal public spending per capita, PS_m, and an error term, δ_m:

$$\Psi_m = \gamma + \rho \ln PS_m + \pi \ln \tau_m + \delta_m \tag{7}$$

Municipal public spending is introduced to proxy for the quantity of public services provided locally.

Introducing (7) in (6) leads to:

$$\ln p_{n,m,t} = \Psi_n + \Psi_t + \gamma + \rho \ln PS_m + \pi \ln \tau_m + \delta_m + \epsilon_{n,m,t}$$

If one transaction that takes place in one municipality, m_1, were to be transposed to another, m_2, but within the same neighborhood, and the same year, the difference in the fixed effects

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combination would be Ψ_m. We compute a counterfactual sale, which evaluates the price of one transaction if it were in another municipality, when the price would be $\widetilde{p_{n,m,t}}$. Under these assumptions, we can write:

$$\ln p_{n,m_1,t} - \ln \widetilde{p_{n,m_2,t}} = \rho(\ln PS_{m_1} - \ln \widetilde{PS_{m_2}}) + \pi(\ln \tau_{m_1} - \ln \widetilde{\tau_{m_2}}) + \delta_{m_1} - \delta_{m_2} + \epsilon_{n,m_1,t} - \epsilon_{n,m_2,t} \quad (8)$$

As noted by Fack and Grenet (2007, p.16), *the measurement error induced by the estimation of the counterfactual sale price only affects the dependent variable* and hence will not bias the estimation of ρ and π.

For each transaction for property sales within a certain distance (described in more detail later), we construct a "counterfactual" sale. This counterfactual transaction is the weighted mean of the estimated prices and characteristics of all the transactions occurring within this distance, and in the same year. For each variable X_i characterizing the transaction i, we calculate the counterfactual variable using the following transformation:

$$\widetilde{X_i} = \frac{1}{\sum_j \frac{1}{d_{i,j}}} \sum_j \frac{1}{d_{i,j}} X_j$$

where j are all the transactions that took place within the defined distance from transaction i occurring in the same year. $d_{i,j}$ is the euclidean distance between i and j.

We now describe the criterion used to decide which transactions j are chosen to build the counterfactual variables. Our data apply to large urban areas, including urban and suburban environments where the latter is less dense. In order to examine whether access to local amenities is more sensitive to distance in very dense contexts than in less dense ones, and in order not to give too much weight to urban transactions, we chose a maximum distance that depends on municipal population density, for each transaction. We therefore built our counterfactuals by considering all transactions within the distance threshold from i, $\overline{d}$, defined by:

$$\overline{d} = \frac{d_{\min}}{((density\ mun_i + density\ mun_j)/2)/density\ city\ center}$$

where *density mun$_i$* and *density mun$_j$* are the population density in the municipality where transaction i and transaction j takes place. *density city center*, the density of the city center, is introduced in order to take account of the fact that our observations are localized in two different urban areas: Dijon and Besançon. $d_{\min}$ is introduced for transactions in the city center, since otherwise $\overline{d}$ would be equal to 1. We also set a $d_{\max}$, for transactions that occur in less dense municipalities. The larger $d_{\min}$, the greater the weight given to the transactions occurring in

the denser municipalities, i. e. close to the city center. Conversely, the larger $d_{\max}$, the greater the weight given to less dense municipalities.

Finally, all transactions j from a distance smaller than $\overline{d}$ of transactions i, are used to calculate the counterfactual characteristics.

5   Results

To control for the impact of the distance threshold, we estimate the equations (8) for two different counterfactuals, depending on the maximum threshold distance; in the first case $d_{\max}$ is equal to 1,000 and in the second case equal to 2,000 meters. In the second case there are more transactions in the suburbs in the data. In order not to give too much weight to the more centrally located transactions, the $d_{\min}$ is quite small and always the same: 200 meters. The maps below show the transactions for which we were able to build a counterfactual, with $d_{\max} = 2,000$.
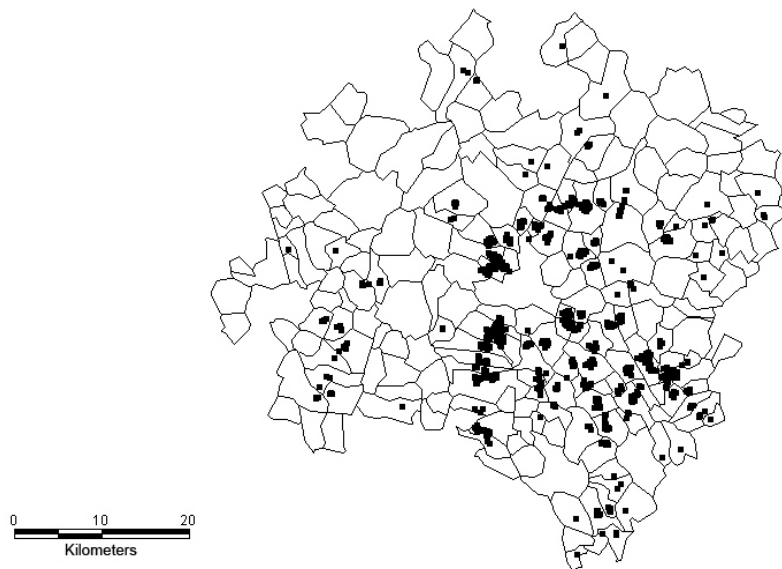
Map 3: Transaction location in the urban area of Dijon (dmax=2,000 m)

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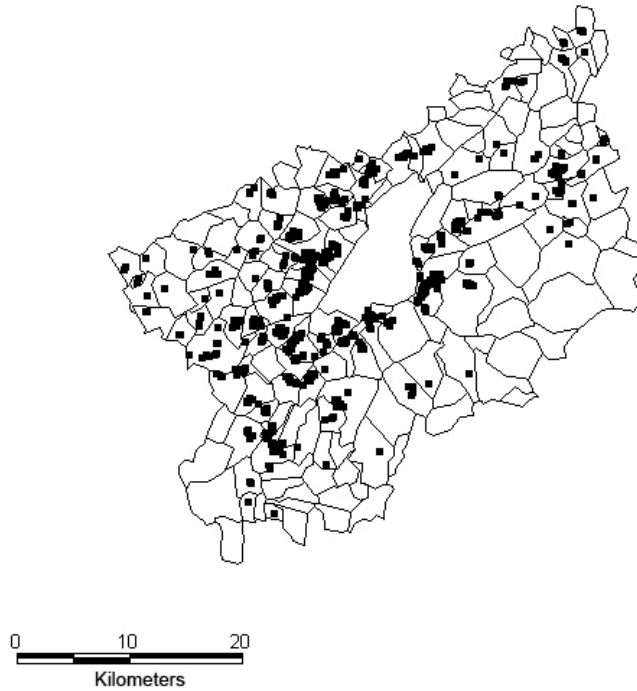
Map 4: Transaction location in the urban area of Besancon (dmax=2,000 m)

	Distance threshold		
Urban area	200/1000	200/2000	None
Dijon	16.45 (5.20)	13.98 (4.75)	17.36 (5.76)
Besançon	12.24 (2.70)	12.41 (3.55)	16.15 (5.64)
Total	15.36 (5.03)	13.44 (4.44)	16.90 (5.74)

Table 2: Average (standard deviation) property tax rate in %

Summary statistics on property tax rates are presented in Table 2. The average property tax rate depends on the urban area and the distance threshold. Higher average values are observed for Dijon and when no distance threshold is applied. When more transactions in the suburbs are introduced, the average property tax rate takes a lower value, about 13.4% with a standard deviation of 4.4. In our view, we have sufficient variation to perform our estimations for both thresholds.

In the first step we estimate the classical hedonic regression, in order to control for house characteristics:

$$\ln p_{i,m,t} = \alpha + \beta_1 S_i + \beta_2 Room_i + \beta_3 GS_i + \beta_4 Tconst_i + \beta_5 VAT + \beta_6 T_i + \epsilon_{i,m,t} \qquad (9)$$

where $p_{i,m,t}$ is the price per square meter of the housing good i, observed in the municipality m at period t. S_i is the living space of the housing good and GS_i is the size of the garden weighted by the living space, which takes the value zero when there is no garden. $Room_i$ is the number of rooms weighted by the living space. $Tconst_i$ is a set of dummies defining the date when i was built; $Tconst1$ takes the value 1 when the property was built before 1850, $Tconst2$ when it was built between 1850 and 1913, $Tconst3$ between 1914 and 1947, $Tconst4$ between 1948 and 1969, $Tconst5$ between 1970 and 1980, $Tconst6$ between 1981 and 1991. $Tconst7$ takes the value 1 when the property was built after 1992 and was not new at the time of the transaction, $Tconst8$ takes the value 1 when the property was built after 1992 and was new when the transaction occured. VAT_i is the value added tax on real estate. We also introduced a trend variable (T_i) in order to control for the global evolution of the housing market.

Table 3 shows the results for the first step regression.

Variables	(1)		(2) Dist. max=1,000		(3) Dist. max=2,000	
Estimation method	OLS		OLS		OLS	
Size	-0.00048***	(-5.86)	-0.00185**	(-5.00)	-0.00017	(-0.89)
Number of rooms	5.800***	(20.36)	3.855**	(2.79)	8.902**	(11.95)
Garden size	0.000251	(0.96)	0.0019**	(3.77)	0.00068	(1.67)
Timeconst1	-0.1507***	(-11.72)	-0.349**	(-4.77)	-0.3401**	(-10.74)
Timeconst2	-0.1746***	(-14.92)	-0.368**	(-6.34)	-0.2817**	(-10.43)
Timeconst3	-0.1032***	(-7.80)	-0.328**	(-4.99)	-0.2896**	(-7.20)
Timeconst4	-0.0352***	(-3.65)	-0.0953*	(-2.78)	-0.0500*	(-2.23)
Timeconst6	0.0997***	(9.68)	-0.0299	(-0.92)	0.0591**	(3.01)
Timeconst7	0.1824***	(11.81)	0.0474	(0.83)	0.0898**	(2.70)
Timeconst8	0.2078***	(8.42)	0.0747	(0.71)	0.1014	(1.50)
VAT	-0.0067***	(-6.46)	-0.0049	(-1.39)	-0.0049*	(-2.23)
1995	-0.0320	(-1.58)	-0.158*	(-2.96)	-0.0459	(-1.16)
1996	-0.0162	(-0.87)	-0.086	(-1.94)	-0.0048	(-0.14)
1997	-0.0342*	(-1.95)	-0.0587	(-1.18)	-0.0417	(-1.30)
1998	0.0116	(0.72)	-0.1455**	(-3.15)	0.0089	(0.32)
1999	-0.0444***	(-3.98)	-0.0966*	(-2.36)	-0.0795**	(-3.47)
2001	0.0675***	(6.01)	0.0131	(0.33)	0.0412	(1.68)
2002	0.0952***	(7.90)	0.0238	(0.46)	0.0708*	(2.38)
2003	0.1647***	(14.29)	0.1422*	(2.46)	0.183**	(6.80)
2004	0.3799***	(22.54)	0.2815	(1.33)	0.384**	(3.64)
Intercept	6.710***	(6.71)	7.122**	(72.68)	6.573**	(126.67)
Adj. R^2	0.2050		0.2156		0.2490	
Number of obs.	10,053		629		2,164	

Dependent variable: Observed sale price per square meter. ** : significant at 1%, * : significant at 5%.

T-values in parentheses.

Table 3: Results of the hedonic model estimates

We see first (column 1) that the size of the property tax has a negative impact on the sale price (per square meter) and no impact when the distance threshold is extended to 2,000 meters. The room number weighted by the property size has a positive coefficient suggesting

that this characteristic increases the sale price. We obtained significant coefficients for the date of construction showing that older properties are less expensive than more recently built ones. Finally, the real estate value added tax has a negative impact on lodging prices.

In the second step we estimate the equation (8), relating spatial differences in price to spatial differences in municipal public policy variables.

Results of equation (8) estimated by OLS are given in Table 4[5].

Variables	(1) Dist. max=1,000	(2) Dist. max=2,000
Estimation method	OLS	OLS
Property tax rate	-0.01575 (-0.31)	-0.04905* (-1.91)
Local Public Spending	-0.0066 (-0.48)	0.00466 (0.64)
Adj. R^2	0.000	0.0008
Number of obs.	630	2163

Dependent variable: spatial difference of estimated sale price per square meter. *** : significant at 1%, ** : significant at 5%. , *: significant at 10%.T-values in parentheses.

Table 4: Results of the second step estimates in spatial differences with OLS

First, local public policy, in terms of property tax rate and public spending, does not explain any variance (or very little) in the price per square meter in our French data. The coefficient associated with local public spending per capita is never significant. Even when controlling for public spending, the property tax rate has no or a barely significant effect on property prices, once the effects of the local environment are controlled for using the spatial differences methodology. When transactions using in estimates are less concentrated in the denser areas, the elasticity of property price to the tax rate is almost 5%. Moreover, this coefficient is only significant at 10%. These results, which are very similar when the maximum distance is equal to 1,500 meters, suggest that neither property tax nor public spending has an effect on property prices.

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[5] Property tax rates and local public spending are not colinear. The Pearson correlation coefficient is equal to 0.39, when Dist.max=2,000, and it is equal to 0.59, when Dist.max=1,000.

6 Robustness checks

6.1 Tax base effects

Since in France, the property tax base may be disconnected from the price of the transaction, the amount of tax paid by owners of two houses with the same characteristics and costing the same can vary. We try to proxy for the tax base in order to control for its effect on the transaction price.

In the second step, the equation becomes the following:

$$\ln \widehat{p_{i,m,t}} - \ln \widetilde{\widehat{p_{i,m,t}}} = \rho_m (PS_{i,m} - \widetilde{PS_{i,m}}) + \pi(\ln \tau_{i,m,t} - \ln \widetilde{\tau}_{i,m,t})$$

$$+\phi(S_i \times Tconst_i \times \tau_{i,m,t} - S_i \times \widetilde{Tconst_i} \times \tau_{i,m,t}) \tag{10}$$

$$+(\epsilon_{i,m,t} - \widetilde{\epsilon}_{i,m,t}) \tag{11}$$

Recall that $PS_{i,m}$ is the amount of public spending by the municipality m where i is localized. $\tau_{m,t}$ is the local (municipal plus jurisdictional) local tax rate observed in the year of the transaction.

$S_i \times Tconst_i \times \tau_{i,m,t}$ is introduced to proxy for the amount of real taxes paid by the owners of each house. This is the tax rate multiplied by a proxy for the base related to each house. This base is not available from our data, but it clearly depends on the size of the house and its period of construction. We present the estimated results of equation (10) in Table 5 for $d_{\max}$ equals to 1,000 in the first column and to 2,000 in column 2.

Variables	(1) Dist. max=1,000		(2) Dist. max=2,000	
Estimation method	OLS		OLS	
Property tax rate	0.0177	(0.35)	0.02328	(0.93)
Local Public Spending	0.00013	(0.01)	0.01180	(1.63)
Timeconst1*Size*tax rate	0.000014	(0.54)	-0.000112***	(-9.96)
Timeconst2*Size*tax rate	-0.00004***	(-3.01)	-0.00007***	(-8.45)
Timeconst3*Size*tax rate	-0.00008***	(-3.08)	-0.000076***	(-5.16)
Timeconst4*Size*tax rate	-0.00002**	(-2.21)	-0.000028***	(-3.85)
Timeconst6*Size*tax rate	0.00004***	(2.91)	0.00003***	(4.11)
Timeconst7*Size*tax rate	0.000006	(0.34)	-0.000008	(-0.85)
Timeconst8*Size*tax rate	0.00003	(0.55)	0.000065**	(2.53)
Adj. R^2	0.0520		0.0959	
Number of obs.	629		2162	

Dependent variable: spatial difference of estimated sale price per square meter. *** : significant at 1%, ** : significant at 5%. , *: significant at 10%.T-values in parentheses.

Table 5: Results of the second step estimates in spatial differences with base proxy and OLS

Recall that $Tconst1$ takes the value 1 when the property was built before 1850, $Tconst2$ when it was built between 1850 and 1913, $Tconst3$ between 1914 and 1947, $Tconst4$ between 1948 and 1969, $Tconst5$ between 1970 and 1980, $Tconst6$ between 1981 and 1991. $Tconst7$ takes the value 1 when the property was built after 1992 and is not new when the transaction occurs, $Tconst8$ takes the value 1 when was built after 1992 and is new when the transaction occurs. $Tconst5$ is the reference.

Almost all the time dummies are significant and show that, all else being equal, the older the house, the more the tax rate weighted by size has a negative impact on the transaction price. This is true for houses built before 1991, just before the last updating of property bases. This result confirms that, in France, property tax matters for house prices, but it is necessary to take into account the variable base effect to observe the negative relationship.

6.2 Endogeneity

As described in the introduction, the Tiebout sorting effect implies that richer people have a preference for more public services, and leads to the fact that property prices and local pub-

lic policies can be simultaneously determined. This means that property tax rate and public spending may be endogenous; they also depend on local wealth and therefore on property prices. We test for potential endogeneity in both local variables. When local property taxation and/or public spending are endogenous, the IV method is used, as in Tables 6 and 7.

Variables	(1) Dist. max=1,000	(2) Dist. max=2,000
Estimation method	OLS	IV
Property tax rate	-0.01575 (-0.31)	-0.0344 (-1.28)
Local Public Spending	-0.0066 (-0.48)	-0.0060 (-064)
Adj. R^2	0.000	0.0007
Number of obs.	629	2163

Dependent variable: spatial difference of estimated sale price per square meter. ** : significant at 1%, *
: significant at 5%. T-values in parentheses.

Table 6: Results of the second step estimates in spatial differences using the IV method

In Table 6, column (1) where public spending and the tax rate are both considered to be exogenous, this exogeneity is rejected.[6] OLS results are therefore reported. In column (2), exogeneity is rejected only for public spending (p. value=0.0652). It is instrumented by the housing tax,[7] and the national government grant ("Dotation Globale de Fonctionnement").[8] and the local public investments. When regressing the instruments on the residual, they are all rejected at 10%. The probability associated with the Sargan statistic is equal to 0.667.

In Table 7, column (1), exogeneity is rejected only for the tax rate (p. value=0.0038). For some crossed variables exogeneity cannot be rejected, but all variables are considered endogenous for coherence. They are instrumented by the housing tax, the housing tax rate multiplied by the size and the period of the building, and the national government grant ("Dotation Globale de Fonctionnement"). When regressing the instruments on the residual, they are all rejected at 10%. The probability associated with the Sargan statistic is equal to 0.289.

In column (2), exogeneity is rejected (p.value=0.103) only for the property tax rate. For some crossed variables exogeneity cannot be rejected, but all variables are, once again, considered to

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[6]Detailed results of instrumental regressions and exogeneity tests are available on request. In all instrumental regression, the first step adjusted R^2 is always greater than 0.6.

[7]The housing tax is also based on property rental value and payable by the occupier.

[8]Local revenue sources also come from central government grants (23%).

be endogenous. They are instrumented by the housing tax, the housing tax rate multiplied by the size and period of the building and the local public investments. When regressing the instruments on the residual, they are all rejected at 10%. The Sargan statistic is equal to 0.376.

Variables	(1) Dist. max=1,000		(2) Dist. max=2,000	
Estimation method	IV		IV	
Property tax rate	-0.077	(-1.13)	-0.0260	(-0.73)
Local Public Spending	0.01378	(0.89)	0.0177***	(2.29)
Timeconst1*Size*tax rate	0.000036	(1.30)	-0.00012***	(-10.19)
Timeconst2*Size*tax rate	-0.00003**	(-2.28)	-0.00007***	(-8.34)
Timeconst3*Size*tax rate	-0.00008***	(-3.09)	-0.00008***	(5.46)
Timeconst4*Size*tax rate	-0.00002**	(-2.23)	-0.00003***	(-3.96)
Timeconst6*Size*tax rate	0.000037***	(2.60)	0.00003***	(4.03)
Timeconst7*Size*tax rate	0.0000009	(0.32)	-0.000009	(-0.95)
Timeconst8*Size*tax rate	0.000038	(0.66)	0.000071***	(2.72)
Adj. R^2	0.0502		0.1033	
Number of obs.	630		2163	

Dependent variable: spatial difference of estimated sale price per square meter. ** : significant at 1%, * : significant at 5%. T-values in parentheses.

Table 7: Results of the second step estimates in spatial differences using the IV method

Let us first comment on the result associated with the local public spending, which is that it has a significant positive effect on house prices. This result seems to confirm the assumption that local public services may be positively capitalized in property prices, especially in less densely populated areas. We can see that the distance threshold affects this result.

The property tax rate alone never has a significant impact on the property prices (per square meter). When the maximum threshold is equal to 1,000 meters, only four periods of construction time, size and tax rate have a significant effect. These effects are coherent with the assumption that the amount of taxation is more important than the rate; the older the house is, the lower the impact of the tax rate multiplied by the size on the prices. This effect is larger for houses built between the two World Wars. Column 2 also shows that property tax rates seem not to

have a significant impact on property prices, when considered alone. However, almost all crossed variables are significant; the newer and larger the house, the more the tax rate increases the house price. We can conclude that the house price capitalizes the local taxation, but the amount of taxes paid by the owner has a greater impact on their choice of house than the tax rate.

7 Conclusion

The aim of this paper was to provide empirical evidence on the impact of local taxation on property prices, controlling for the amount of local public spending, in two French urban areas: Dijon and Besançon, using data on property taxation and real estate transactions for the period 1994-2004. We used an empirical methodology that allowed us to compare sales in the same spatial environment and to control for endogeneity in local taxation and public spending. We found first that local public spending has almost no effect or a very small effect, on property prices. We also found that local property taxation does not have the expected negative impact on transaction prices. However, buyers are more sensitive to the amount of taxes they will have to pay than to the tax rate.

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9   Appendix: Econometric issues related to estimation of the hedonic model

Considering capitalization into house values, Can (1992) distinguishes between two levels of externalities. The first captures the neighborhood effects, i.e. the impact of common neighborhood characteristics on housing prices. The second includes spatial spill-over effects - adjacency effects- such as the impact of prices of neighboring buildings on the price of a given property. These effects are not confined to jurisdictions, they can cross boundaries. As argued by Can (1992), locational effects require the use of different specifications for the housing price equation. The first includes neighborhood effects as direct determinants of house values. The resulting model is called the traditional hedonic specification:

$$V = c + \zeta G - \tau t + \sum_{i=1}^{n} a_i Z_i + \eta N + \varepsilon$$

where N are neighborhood characteristics and ε is a vector of i.i.d. error terms.

The second specification incorporates spatial heterogeneity. Neighborhoods are no longer treated as direct determinants of housing prices but as determinants of spatial drift in the structural parameters. This model is called the spatial expansion specification:

$$V = c + \zeta G - \tau t + \sum_{i=1}^{n} (a_{iO} + a_{k1}N)Z_i + \varepsilon$$

The next two specifications include both neighborhood effects and adjacence effects.

The traditional hedonic autoresgressive specification is as follows:

$$V = c + \rho WV + \zeta G - \tau t + \sum_{i=1}^{n} a_i Z_i + \eta N + \varepsilon$$

where WV is the spatially lagged dependent variable and ρ its parameter. Finally the last model, the inclusion of the autoregressive term leads to the spatial expansion autoregressive specification:

$$V = c + \rho WV + \zeta G - \tau t + \sum_{i=1}^{n}(a_{iO} + a_{k1}N)Z_i + \varepsilon$$

Spatial effects are present in three out of four of these model specifications. In the spatial expansion specification, spatial heterogeneity is introduced in the form of varying-parameters. In the traditional hedonic autoregressive model, spatial dependence is included using the autoregressive form. Both spatial heterogeneity and dependence are incorporated in the final specification. Tests for spatial effects need to be run to detect the existence of spatial dependence and/or spatial heterogeneity and to choose the right specification.