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A fixed effects panel data model to analyze the relationship between real estate market indicators and Real Property Transfer (RPTT) and Stamped Legal Documents (SLD) taxes in Spain

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ÍNDICE

Abstract

This paper contributes to the empirical literature on the use of a panel data model to identify fundamental factors related with regional property tax revenues in Spain (Real Property Transfers Tax, (RPTT), and Stamped Legal Documents, (SLD)).

The RPTT and SLD is an element that could determine, through slight fluctuations, the recovery of the property demand, generating positive effects also on the construction sector. In previous studies we have reached this tax revenues through the estimation of the tax base using leading indicators of activity in the construction sector such as *the number of annual approvals for new residential constructions* entered as exogenous regressor in ARX models. These models have successfully reproduced the past and have made predictions that have been subsequently confirmed by the backtesting exercises. However, this methodology has the disadvantage of using an independent ARX model for each autonomous community in Spain, losing the perspective of a joint analysis of all the regions in a single model, which would enrich the range of results.

In this paper our goal is to be able to use a single model (a fixed effect panel data model) for all autonomous communities (AC) operating under the common regime along with two very significant indicators to estimate the tax base in each region: the *total value of property transfers in dwellings in the free market* drawn by the Spanish Ministry of Public Works and Transport and the *total mortgage payments* from the Spanish National Statistics Institute. The results of the backtesting exercises, highlight the predictive ability of the model and the high degree of predictive capacity of the selected regressors.

Keywords: normative tax collection, fiscal capacity, property tax, revenue forecasting, panel data models.

JEL classification numbers: : H71 ,C53, H68, C22.

1. INTRODUCTION

One of the main topics in the financing system of the Spanish regions is the leveling system design, that is, the configuration of a transfer system designed to reduce the gap between the expenditure needs and the fiscal capacity of each autonomous community (AC).

Following López-Laborda, J. (2016) expenditure needs are the expense that an AC must incur to provide the same level of public services as the rest. Fiscal capacity can be defined as the performance that an AC can obtain from its ceded taxes if it imposes a certain fiscal effort on its citizens and acts with a certain degree of efficiency in tax management. In the Spanish regional model, fiscal capacity has traditionally been called "regulatory or normative collection".

There are important contributions both about the leveling system (López-Laborda, J., 2014) and (Cuenca García, A., & Llera, R. F., 2017) on the measurement of the spending capacities of the ACs (de La Fuente, A., 2017) and (Perez, F. & Cucarella, V., 2015) and also on the degree of efficiency and fiscal responsibility of ACs (Cuenca, A., 2009 and 2014).

In this study, we focus on measuring the fiscal capacity of ACs that is, the normative collection, and specifically in regard to Real Property Transfers Tax (RPTT), and Stamped Legal Documents (SLD). Among the ceded taxes, the RPTT and STD tax stands out, which accounts for more than half of the total set of ceded taxes and that has come to represent, in the years of the real estate boom, more than 20% of the resources of the financing system of the Spanish ACs.

In this regard there are numerous studies that illustrates the problem related to the normative collection for the traditional ceded taxes, as it is highlighted in the applied studies of López-Laborda (2016) and De La Fuente (2012, 2014 and 2016). In these works different alternatives have been analyzed with different degrees of complexity in their application. They could be summarized in four choices (López-Laborda (2016)):

1. Apply, as a rule for updating the normative tax collection of ‘traditional’ ceded taxes, the growth rate of the normative tax collection of ‘new’ ceded taxes (Personal Income Tax, Value Added Tax, and the Special Tax on Manufacturing) in each AC.
2. Quantify normative tax collection in the most accurate way possible, as is already done, for example, with Personal Income Tax, based on information regarding tax settlements provided by AC.
3. Establish normative tax collections by assessing, through simple indicators, the base of each tax, which would then be subject to the additional tax rate set by the State.
4. Identify normative tax collections based on the revenue that an AC could receive if the average rate effectively applied by all communities were applied to its ceded taxes.

In this framework, our work is framed in the third alternative, as we propose a more fair calculation of the normative value of the RPTT and SLD obtained from a panel data model using the information provided from two simple indicators to estimate the tax base.

Thus, the main goal of this paper is to approximate the actual and future revenue collection of Real Property Transfers (RPTT) and Stamped Legal Documents (STD) that will be obtained in each AC applying the actual tax rates to a forecasted tax base. This tax base is the result of a panel data model using as regressors two of the most frequently used indicators related to residential investment: the *total value of property transfers in dwellings in the free market*[1] drawn from the Spanish Ministry of Public Works and Transport and *total amount borrowed at the mortgages statistics*[2] released by the Spanish National Statistics Institute. These two indicators are the best available proxy we found to estimate this tax base.

All data referring to tax on Property Transfers and Stamp Duty by AC have been provided by The General Inspectorate of the Ministry of Finance and Civil Service.

In previous studies[3] we focused on *the number of annual approvals for new residential constructions* by region which is a leading indicator of activity in the construction sector. Taking this indicator as an exogenous regressor in a ARX model (a linear autoregressive model with exogenous regressors) for every AC allowed us to obtain precise estimates of the tax base as well as confidence intervals for them. The disadvantage of this model is that each AC is estimated separately and has its own equation, since the coefficients of the ARX model are similar but not equal between regions. Therefore the use of a different model for each AC does not allow regional comparisons in terms of efficiency in tax management.

This paper covers this disadvantage of the previous study by estimating a fixed-effect panel data model for all AC operating under the common regime. This will allow each region to have a constant effect different from the others (we expect this fixed effects to capture the different relationships between regional indicators and revenue collection due to socioeconomic differences) but will unify the coefficients that multiply the regressors of the model. As usual in this type of exercise in which the indicators are highly correlated, we will use principal components analysis as a dimension reduction technique, summarizing the information into one factor. This factor will be the regressor used in the panel data model. The reported results include the estimates and the predictions of the tax base and, as a consequence, of the tax revenue collection, and can be used in the calculation of "credit into account" made by the Central Government to the AC' budgets every year.

Thus, the real estate indicators observed data, for the purpose of calculating the final settlement in terms of AC financing system, are known with a maximum delay of just months, much earlier than with the current system, where the value of the update rates is known more than two years late.

This paper is organized as follows. Section 1 presents a review of related literature and provides a framework for the objectives of this study, highlighting the importance within the ACs financing

1 https://www.fomento.gob.es/be2/sedal/34020110.XLS

2 https://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736170236&menu=ultiDatos&idp=1254735576757

3 "Exploring the predictive capacity of real estate sector indicators in forecasting regional tax revenues on Real Property Transfers (RPTT) and Stamped Legal Documents (STD)" (2019). *Papeles de Trabajo*. Instituto de Estudios Fiscales.

system of the RPTT and STD tax collection. Section 2 outlines the derivation of the model employed and describes the estimation technique and the empirical framework. In addition, it presents the estimation results and the forecast evaluation for the fifteen ACs. The last section provides the main conclusions of this study.

2. ESTIMATION STRATEGY AND EMPIRICAL FRAMEWORK

2.1. Principal Component analysis as a dimension reduction technique. Empirical results

The first step in our estimation strategy is to summarize the information provided by both indicators, the transactions price of dwellings and the total amount borrowed at the mortgages statistics by AC. Descriptive statistics of both variables in this study are presented in Table 1.

Table 1

MEAN AND STANDARD DEVIATION OF VARIABLES "TOTAL VALUE OF PROPERTY TRANSFERS IN DWELLINGS IN THE FREE MARKET "AND "MORTGAGES: TOTAL AMOUNT BORROWED"

PCA to summarize the information of the real estate indicators

The FACTOR Procedure

Input Data Type	Raw Data
Number of Records Read	225
Number of Records Used	225
N for Significance Tests	225

Means and Standard Deviations from 225 Observations		
Variable	Mean	Std Dev
TRANS	5206766.7	6272823
HIPOTECAS	8164725.1	11380539

Taking into account that the variables are expressed in thousands of euros we see that there is a notable difference in the average value between the two variables: 5,206 million euros for transactions price of dwellings and 8,164 million euros for the total amount borrowed in mortgages. The difference between the variance of the two variables is much more significant: the mortgages lending amount is a variable with much more dispersion than the total value of property tranfers of dwellings.

These differences are not a problem since we analyze the standardized variables so that the analysis focuses on correlations between variables.

The correlation matrix is as follows:

Table 2

CORRELATION MATRIX OF VARIABLES "TOTAL VALUE OF PROPERTY TRANSFERS IN DWELLINGS IN THE FREE MARKET" AND "MORTGAGES: TOTAL AMOUNT BORROWED"

Correlations			
		TRANS	HIPOTECAS
TRANS	TRANS	1.00000	0.93298
HIPOTECAS	HIPOTECAS	0.93298	1.00000

From this matrix we observe that the degree of linear association between both variables is 0.93, which would have caused serious multicollinearity problems if we had introduced both variables as regressors in the panel.

The first step of the Principal Components Analysis is the calculation of the eigenvalues of the correlation matrix

Table 3

EIGENVALUES OF THE CORRELATION MATRIX

The FACTOR Procedure
Initial Factor Method: Principal Components

Prior Communality Estimates: ONE

Eigenvalues of the Correlation Matrix: Total = 2 Average = 1				
	Eigenvalue	Difference	Proportion	Cumulative
1	1.93297971	1.86595942	0.9665	0.9665
2	0.06702029		0.0335	1.0000

In this matrix the first eigenvalue is 1.93, which implies that with a single main component, 96% of the variance of the set formed by the two variables can be explained. This means that the main component constitutes a good summary of the information of both variables. Taking into account the Kaiser rule, only the main components associated with eigenvalues greater than one are considered.

In this case, the factor loadings, which vary from -1 to 1, are the correlation coefficients between the original variables and the principal component, so they indicate the strength of the relationship between the variables and the component extracted. In this case both variables are strongly correlated with the factor, since the two charges are positive and very high.

Table 4

FACTOR LOADINGS OF VARIABLES "TOTAL VALUE OF PROPERTY TRANSFERS IN DWELLINGS IN THE FREE MARKET" AND "MORTGAGES: TOTAL AMOUNT BORROWED"

1 factor will be retained by the NFACTOR criterion.

Factor Pattern		
		Factor1
TRANS	TRANS	0.98310
HIPOTECAS	HIPOTECAS	0.98310

Notice that the charges are equal but the variables are standardized. In order to understand the principal component as a linear combination of the two initial variables (standardized) we use the standardized coefficients:

Table 5

STANDARDIZED SCORING COEFFICIENTS ON FACTOR 1

Standardized Scoring Coefficients		
		Factor1
TRANS	TRANS	0.50859
HIPOTECAS	HIPOTECAS	0.50859

According to this coefficients, the principal component equation is outlined below:

Factor1= $$0.50859*\left[\frac{trans-5206766.7}{6272823}\right]+0.50859*\left[\frac{hipotecas-8164725.1}{11380539}\right] \quad (1)$$

Where

- *Trans* stands for the variable *"Total value of property transfers in dwellings in the free market".*
- *Hipotecas* stands for the variable *"Mortgages: total amount borrowed".*

Notice that the variables have been rescaled to have a mean of zero and a standard deviation of one.

2.2. Fixed effects panel data model: empirical results

2.2.1. *Model specification*

Our empirical analysis exploits the panel structure of the dataset for the fifteen ACs operating under the common regime over the period 2004-2018 by a fixed effects panel data model taking into account unobserved region-specific effects. Problems arising from the multicollinearity of regressors in the panel are dealt with by using principal component analysis in the previous step.

As for the advantages of the standard techniques of panel data is the possibility of controlling for the effect of specific factors in each AC, which are extremely difficult to quantify[4]. This is achieved by specifying the individual effects a_i different for each region, but constant throughout the period, which reflect the influences of such individual factors upon the tax base of each AC.

In a previous specification of this model time effects were proposed, in order to represent those changes over time which also affect such tax base, but the estimates of the time effects were not significant in most regions.

[4] Following Baltagi (2003) or Hsiao (2007), It should be noted that the omission of these factors when proposing a model has potentially very negative effects upon the quality of the estimations.

For our purposes, we propose the following simple specification:

$$Y_{it} = \beta_0 + \beta_1 . X_{it} + a_i + u_{it} \qquad (2)$$

i=1,..,15

t = 2004, ..., 2018

Where:

Y_{it} represents the tax base of RPTT and SLD in year t for region i-th

β_0 is the constant of the model

β_1 is the coefficient of the principal component that we use as a regressor which summarizes the variation of total value of property transfers in dwellings in the free market and the mortgages lending in the AC in year t.

The variable a_i is not observable, it represents the unobserved heterogeneity that is, the fixed effect in each AC. Thus, we are considering that the individual effects are understood to be fixed and we have decided to include them in the model as variables.

The error term of the model is u_{it}. It includes unobserved factors that affect the tax base (Y_{it}) and that change over time and with the AC.

2.2.2. *Model estimation*

The procedure we shall employ will be to estimate the model by a typical regression of Ordinary Least Squares (OLS), a fixed effects regression. Specifically, an F-test of the joint significance of the fixed effects will determine whether the estimation of the model with fixed effects is better than the OLS estimation.

It should be noticed that that our analysis is intended to control for the differences which exist between the fifteen ACs operating under the common regime in the whole country which comprise the total population under the common regime in Spain; i.e. in our analysis, the situation is not that each AC under the common regime is taken randomly from a wider set of ACs in the same situation, and thus a random effects estimation would not really be appropriate.

Table 7

FIT STATISTICS AND F TEST FOR THE JOINT SIGNIFICANCE OF THE FIXED EFFECTS

The PANEL Procedure
Fixed One Way Estimates

Model Description	
Estimation Method	FixOne
Number of Cross Sections	15
Time Series Length	15

Fit Statistics			
SSE	4.397532E14	DFE	209
MSE	2.104082E12	Root MSE	1450545.559
R-Square	0.9831		

F Test for No Fixed Effects			
Num DF	Den DF	F Value	Pr > F
14	209	5.79	<.0001

According to the results of the F-test, the need to employ individual effects is confirmed in the model we propose and therefore it is not necessary to perform a Breusch-Pagan test, which allows us to determine if the random effects model is better than the OLS estimation. In the model we are proposing, the null hypothesis of absence of correlation of individual AC effects a_i with the principal component obtained in the previous step X_{it} can be rejected, and thus the fixed effects specification is the most appropriate.

As for endogeneity problems with de regressor (principal component) we can assume that our variable of interest is exogenous. Such an assumption is not difficult to make since in Spain the allocation of taxes and expenditure among the various levels of government has been determined more by historical and political issues than by indicators related to economic development.

The parameter estimates of the model are shown in table 8.

Table 8

PARAMETER ESTIMATES FOR THE FIXED EFFECTS PANEL DATA MODEL

Parameter Estimates						
Variable	DF	Estimate	Standard Error	t Value	Pr > |t|	Label
CS1	1	-1810577	600395	-3.02	0.0029	Cross Sectional Effect 1
CS2	1	1911830	529961	3.61	0.0004	Cross Sectional Effect 2
CS3	1	-1218505	601636	-2.03	0.0441	Cross Sectional Effect 3
CS4	1	-2435282	628940	-3.87	0.0001	Cross Sectional Effect 4
CS5	1	-662074	545004	-1.21	0.2258	Cross Sectional Effect 5
CS6	1	-2228818	625176	-3.57	0.0005	Cross Sectional Effect 6
CS7	1	-1982767	603918	-3.28	0.0012	Cross Sectional Effect 7
CS8	1	-2258816	609930	-3.70	0.0003	Cross Sectional Effect 8
CS9	1	-2287211	622748	-3.67	0.0003	Cross Sectional Effect 9
CS10	1	-2387346	620187	-3.85	0.0002	Cross Sectional Effect 10
CS11	1	-2226671	596565	-3.73	0.0002	Cross Sectional Effect 11
CS12	1	-2597039	595331	-4.36	<.0001	Cross Sectional Effect 12
CS13	1	-797910	530540	-1.50	0.1341	Cross Sectional Effect 13
CS14	1	-1966427	605670	-3.25	0.0014	Cross Sectional Effect 14
Intercept	1	10157752	441220	23.02	<.0001	Intercept
Factor1	1	9846998	153342	64.22	<.0001	

The equation of the panel data model is:

$$Y_{it} = 10157752 + 9846998(X_{it}) + a_i + u_{it} \quad \text{i=1, 15} \qquad (3)$$

$$\text{t = 2004, ..., 2018}$$

where x_{it} stands for the principal component as explanatory variable in the panel for the AC i-th and year t.

As for the estimation, the fixed effects a_i have been specified in the variables cs1-cs14 corresponding to the following ACs:

1. Cs1 fixed effect relative to Castilla la Mancha

2. Cs2 fixed effect relative Madrid .

3. Cs3 fixed effect relative Islas Baleares

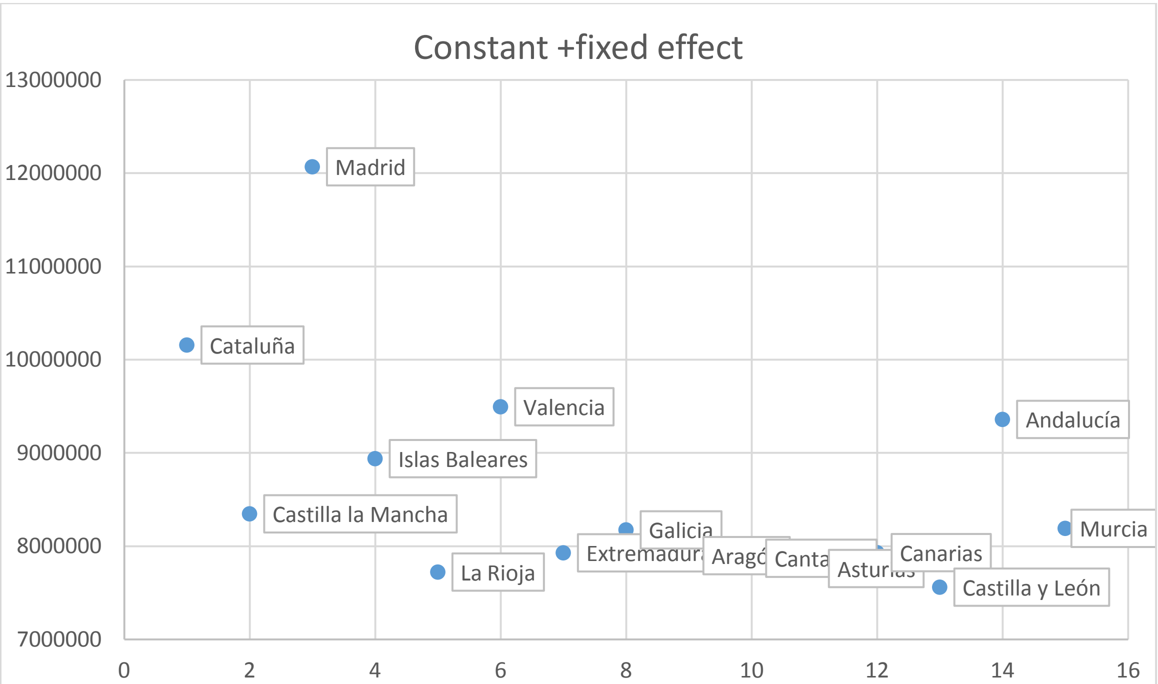
4. Cs4 fixed effect relative La Rioja

5. Cs5 fixed effect relative Valencia

6. Cs6 fixed effect relative Extremadura
7. Cs7 fixed effect relative Galicia
8. Cs8 fixed effect relative Aragón
9. Cs9 fixed effect relative Cantabria
10. Cs10 fixed effect relative Principado de Asturias
11. Cs11 fixed effect relative Islas Canarias
12. Cs12 fixed effect relative Castilla y León
13. Cs13 fixed effect relative Andalucía
14. Cs14 fixed effect relative Región de Murcia

The region taken as reference to control for the differences which exist between the other ACs under the common regime for fixed effects is Cataluña.

As can be observed, the individual effects of each of the AC are very significant except for the regions of Valencia and Andalucía, which present a lower degree of significance according to usual thresholds of 95%. We will consider a threshold of 78% as an acceptable result taking into account the level of joint significance of all the fixed effects and the precision of the estimates offered by the model shown in the results section. The following graph shows the sum of the constant term in the model plus the estimate of the fixed effect relative to the AC.

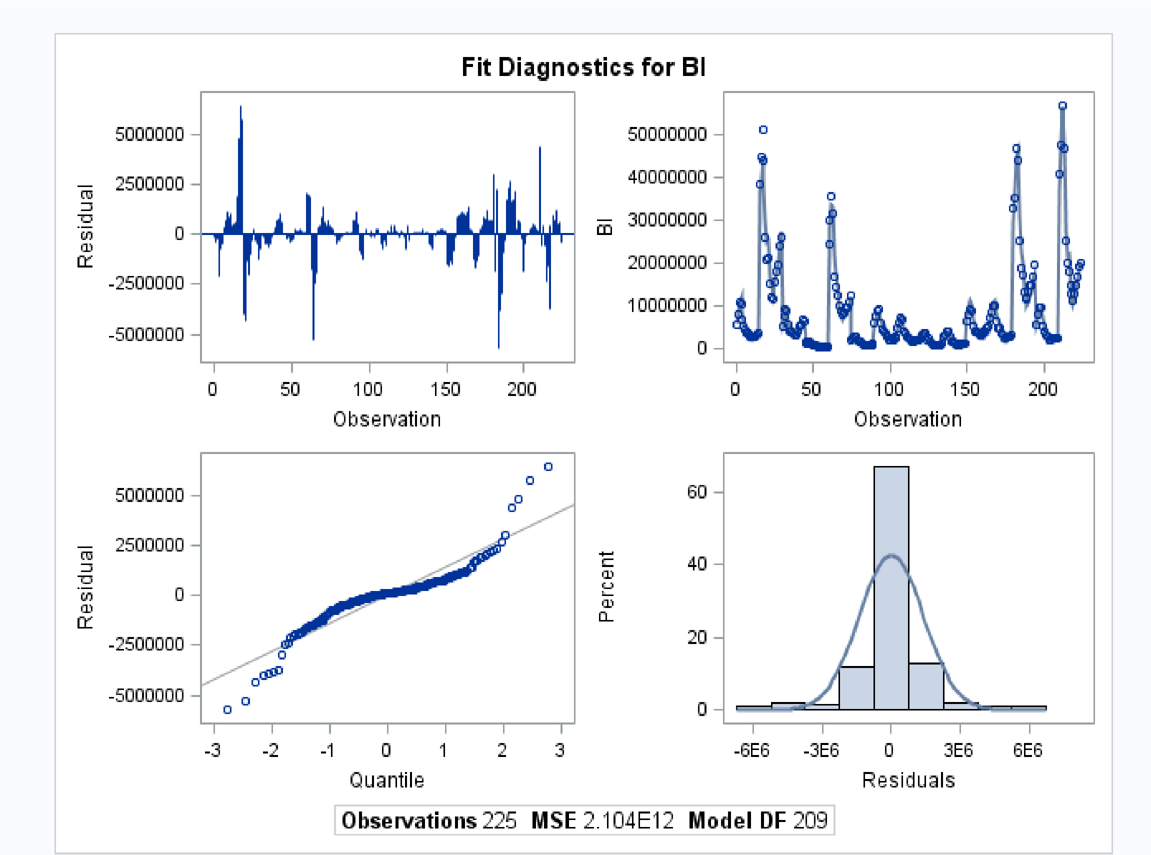


As for the regressor, the principal component, our results would appear to indicate that it has a strong positive direct effect upon the RPTT and SLD tax base.

2.2.3. *Diagnostic of the model*

Table 9

DIAGNOSIS FIT FOR ESTIMATING THE TAX BASE WITH THE FIXED EFFECTS PANEL DATA MODEL



From table 9 we can conclude that residuals of the model follow a Normal Distribution with zero mean and constant variance.

2.2.4. *RPTT and SLD tax base forecasts*

The following graphs show the model forecast of the RPTT and SLD tax base (blue dashed line) according to the data obtained from the total value of property transfers in dwellings in the free market and the total amount borrowed from the mortgages statistics.

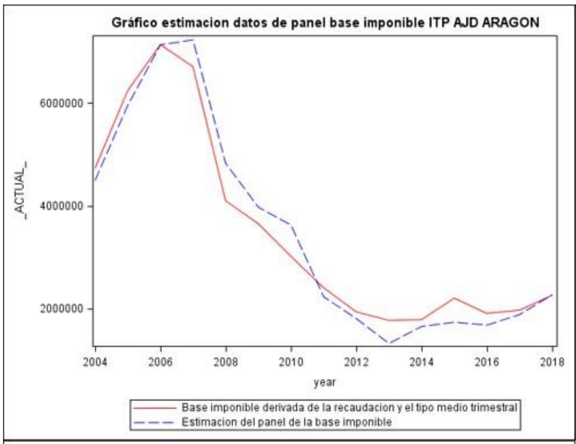


Gráfico estimacion datos de panel base imponible ITP AJD ARAGON
ACTUAL
year
Base imponible derivada de la recaudacion y el tipo medio trimestral
Estimacion del panel de la base imponible

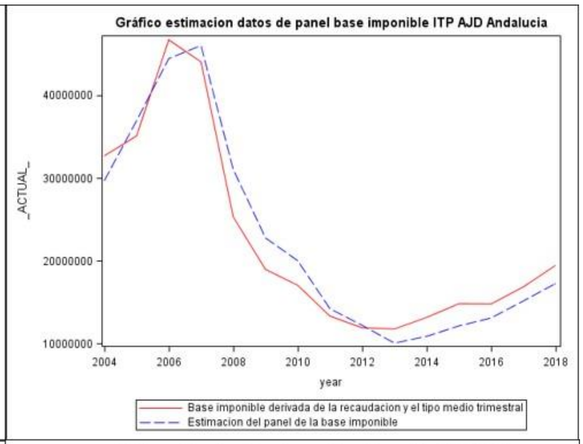


Gráfico estimacion datos de panel base imponible ITP AJD Andalucia
ACTUAL
year
Base imponible derivada de la recaudacion y el tipo medio trimestral
Estimacion del panel de la base imponible

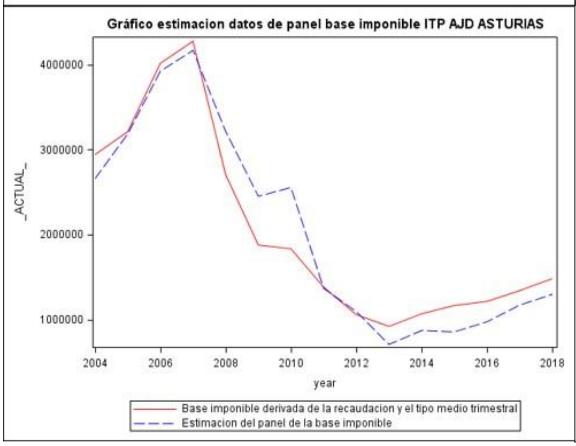


Gráfico estimacion datos de panel base imponible ITP AJD ASTURIAS
ACTUAL
year
Base imponible derivada de la recaudacion y el tipo medio trimestral
Estimacion del panel de la base imponible

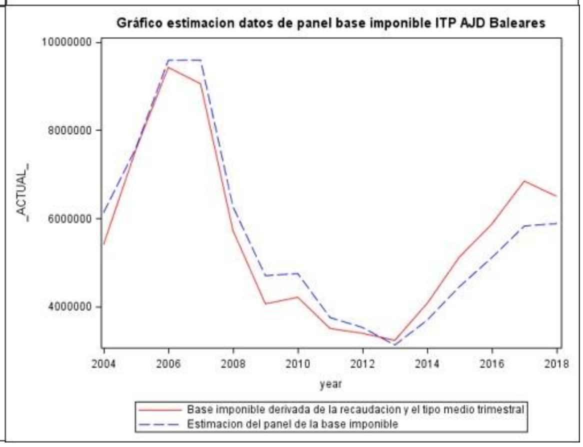


Gráfico estimacion datos de panel base imponible ITP AJD Baleares
ACTUAL
year
Base imponible derivada de la recaudacion y el tipo medio trimestral
Estimacion del panel de la base imponible

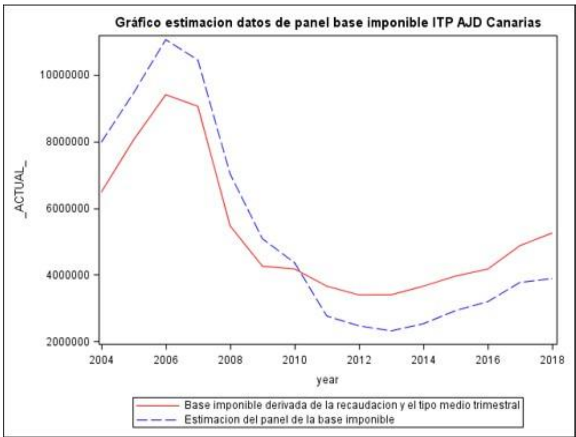


Gráfico estimacion datos de panel base imponible ITP AJD Canarias
ACTUAL
year
Base imponible derivada de la recaudacion y el tipo medio trimestral
Estimacion del panel de la base imponible

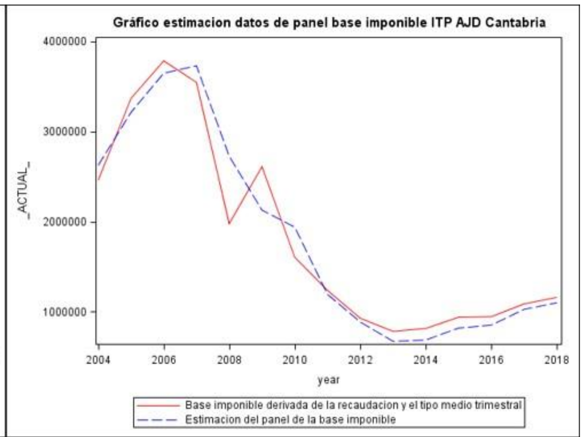


Gráfico estimacion datos de panel base imponible ITP AJD Cantabria
ACTUAL
year
Base imponible derivada de la recaudacion y el tipo medio trimestral
Estimacion del panel de la base imponible

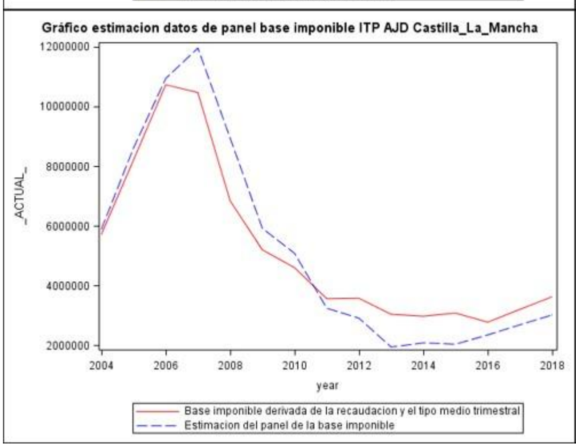


Gráfico estimacion datos de panel base imponible ITP AJD Castilla_La_Mancha
ACTUAL
year
Base imponible derivada de la recaudacion y el tipo medio trimestral
Estimacion del panel de la base imponible

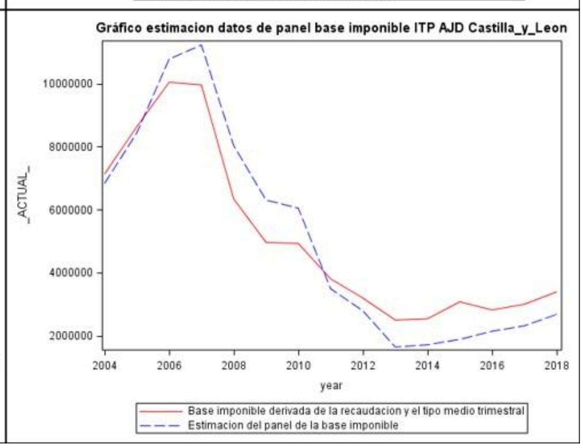


Gráfico estimacion datos de panel base imponible ITP AJD Castilla_y_Leon
ACTUAL
year
Base imponible derivada de la recaudacion y el tipo medio trimestral
Estimacion del panel de la base imponible

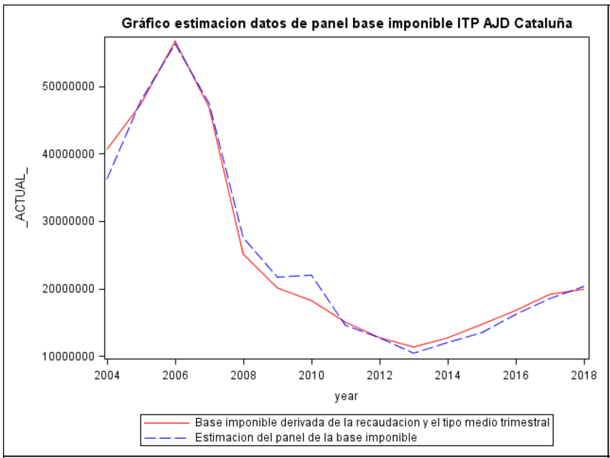


Gráfico estimacion datos de panel base imponible ITP AJD Cataluña
ACTUAL
10000000
20000000
30000000
40000000
50000000
2004 2006 2008 2010 2012 2014 2016 2018
year
Base imponible derivada de la recaudacion y el tipo medio trimestral
Estimacion del panel de la base imponible

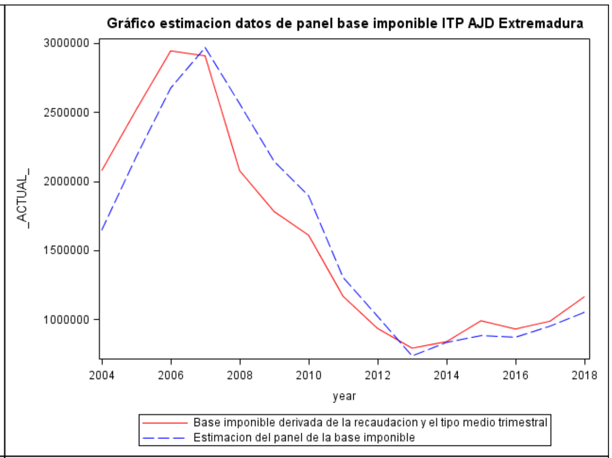


Gráfico estimacion datos de panel base imponible ITP AJD Extremadura
ACTUAL
1000000
1500000
2000000
2500000
3000000
2004 2006 2008 2010 2012 2014 2016 2018
year
Base imponible derivada de la recaudacion y el tipo medio trimestral
Estimacion del panel de la base imponible

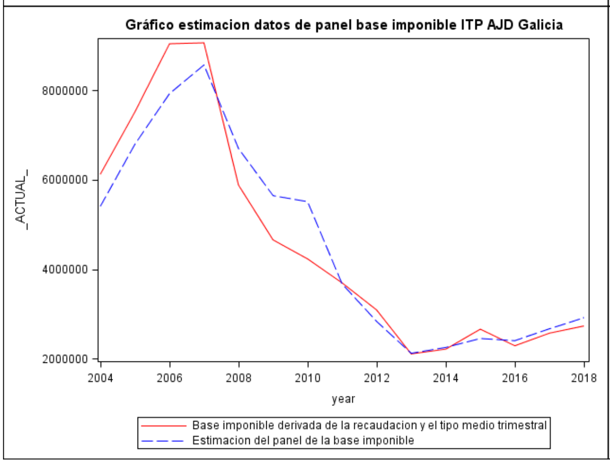


Gráfico estimacion datos de panel base imponible ITP AJD Galicia
ACTUAL
2000000
4000000
6000000
8000000
2004 2006 2008 2010 2012 2014 2016 2018
year
Base imponible derivada de la recaudacion y el tipo medio trimestral
Estimacion del panel de la base imponible

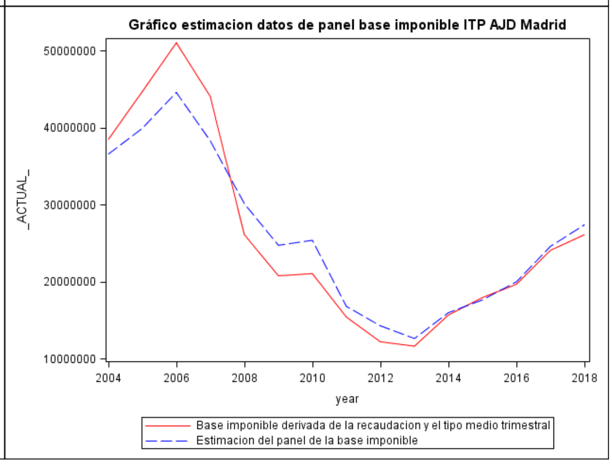


Gráfico estimacion datos de panel base imponible ITP AJD Madrid
ACTUAL
10000000
20000000
30000000
40000000
50000000
2004 2006 2008 2010 2012 2014 2016 2018
year
Base imponible derivada de la recaudacion y el tipo medio trimestral
Estimacion del panel de la base imponible

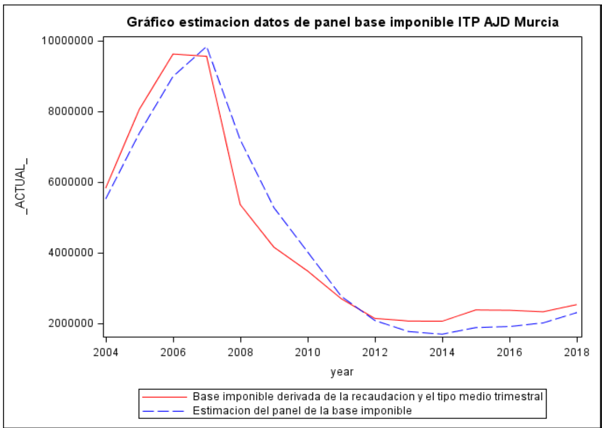


Gráfico estimacion datos de panel base imponible ITP AJD Murcia
ACTUAL
2000000
4000000
6000000
8000000
10000000
2004 2006 2008 2010 2012 2014 2016 2018
year
Base imponible derivada de la recaudacion y el tipo medio trimestral
Estimacion del panel de la base imponible

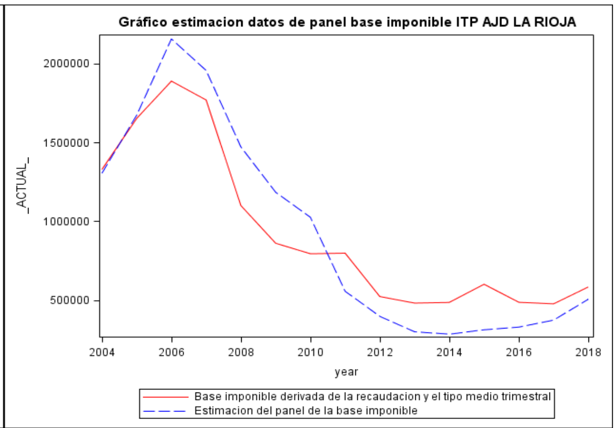


Gráfico estimacion datos de panel base imponible ITP AJD LA RIOJA
ACTUAL
500000
1000000
1500000
2000000
2004 2006 2008 2010 2012 2014 2016 2018
year
Base imponible derivada de la recaudacion y el tipo medio trimestral
Estimacion del panel de la base imponible

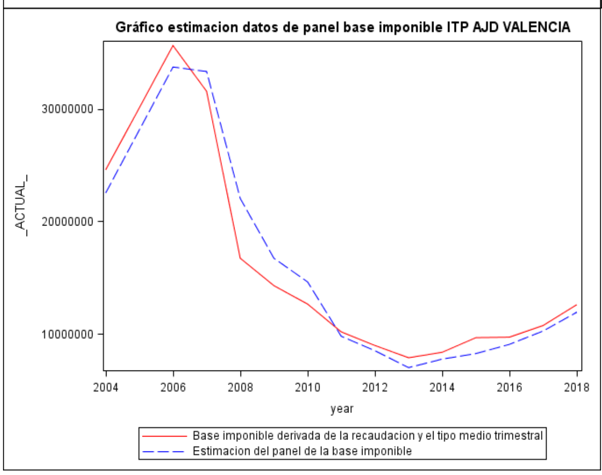


Gráfico estimacion datos de panel base imponible ITP AJD VALENCIA
ACTUAL
10000000
20000000
30000000
2004 2006 2008 2010 2012 2014 2016 2018
year
Base imponible derivada de la recaudacion y el tipo medio trimestral
Estimacion del panel de la base imponible

If we focus on the period from 2013 onwards when the real estate sector stops falling in most of the regions, we realize that the model is underestimating the RPTT and SLD tax base. For those regions with fewer housing transactions and mortgages credits, the estimates are significantly worse than in the rest (La Rioja, Castilla la Mancha, Castilla y León). On the contrary the model is more accurate in ACs with higher values of the real estate indicators such as Madrid, Cataluña and Valencia.

3. CONCLUSION

This study has presented a fixed effects panel data model for fifteen ACs operating under the common regime with a double objective: on the one hand, the RPTT and ITP tax base has been estimated in each AC; on the other hand, the model captures, in the estimates of the fixed effects, differences across regions that are constant in time, affecting this tax base.

As for the tax base estimation, the performance of the model in terms of accuracy is better y regions with higher values of the real estate indicators such as Madrid, Cataluña o Valencia.

In fact, if we take into account the accuracy in terms of the Mean Square Error and compare the tax base estimates obtained by the panel data model, the individual ARX models for every region and the estimation obtained from a simple regression model, the results are as follows:

	MIN MSE	MODEL
TOTAL	313.891.470.362,64	ARX model
CASTILLA_LA_MANCHA	24.762.859.744,8024	ARX model
MADRID	3.091.818.968.994,9000	ARX model
BALEARES	21.362.206.114,3061	Panel
La_Rioja	207.170.070.717,4880	ARX model
VALENCIA	135.814.474.263,5960	Simple OLS regression
EXTREMADURA	105.326.927.334,1200	ARX model
GALICIA	39.410.352.859,8217	ARX model
ARAGON	217.035.430.129,8180	Panel
CANTABRIA	190.269.785.220,2510	Panel
ASTURIAS	5.821.000.014.494,1200	ARX model
CANARIAS	170.966.778.355,5490	ARX model
CASTILLA_Y_LEON	4.258.609.846.798,1900	ARX model
ANDALUCIA	0,0000	ARX model
Region_Murcia	0,0000	ARX model
Cataluña	0,0000	Panel

This results demonstrates that, in terms of the estimation of the tax base (and not to the comparison between regions) it is preferable to use the ARX models to the fixed effects panel data model.

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