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Abstract

In this article, we measure changes over time in the synchronization of housing price cycles across Spanish cities. In doing so, we rely on a regime-switching framework that identifies the housing price cycles of pairs of cities, and simultaneously infers the evolving relation between those cycles. These bilateral relationships are then summarized into an aggregate synchronization index of city-level housing cycles. The estimates suggest that Spanish housing prices have followed a convergence pattern, which picked in 2009 and slightly decreased afterwards. We also identify the cities that have been the main contributors to this convergence process. Moreover, we show that differences in population growth and economic structure are key factors to explain the evolution of housing price synchronization among Spanish cities.

Keywords: housing cycles, synchronization, Spain.

JEL classification: E31, C32, R11.

Resumen

Este documento trata de medir la sincronía cíclica de los precios de la vivienda entre las ciudades españolas y su evolución a lo largo del período considerado. Para ello, se utiliza un modelo con regímenes markovianos que identifica los ciclos de los precios de la vivienda para cada par de ciudades y, al mismo tiempo, obtiene la evolución de la relación entre esos ciclos. Finalmente, estas relaciones bilaterales se sintetizan en un índice agregado de sincronía del precio de la vivienda de las ciudades españolas. Las estimaciones indican una sincronización creciente entre los precios de la vivienda hasta 2009, y después un patrón de leve desacoplamiento. Además, el análisis identifica las ciudades que han contribuido mayormente a este desarrollo. Por último, se muestra que las diferencias en el crecimiento de la población y en la estructura productiva son los factores clave para explicar la evolución de la sincronía de los precios de la vivienda entre las ciudades españolas.

Palabras clave: ciclos de la vivienda, sincronía, España.

Códigos JEL: E31, C32, R11.

1 Introduction

The housing market has played a fundamental role for the Spanish economy during the last decades. In particular, housing prices have exhibited remarkable swings over time at the national level. For instance, Martín et al. (2021) show that the housing boom in Spain affected the rest of the economy by increasing bank net worth and expanding credit supply. Yet, the evolving heterogeneity of housing prices at the city level is a key feature that has remained somewhat overlooked. In Figure 1, we show the evolution of the dispersion of housing prices associated to 50 of the major cities in Spain. While the cross-sectional distribution of housing prices in levels seems to have widened with time, the distribution of growth rates appears to have slightly shrunk. Based on this evidence it is not easy to assess whether the cycles exhibited in Spanish city-level housing prices have evolved in a converging or rather diverging pattern over time.

This paper aims to filling this gap by measuring changes over time in the synchronization of housing price cycles across cities in Spain. Our analysis is based on a a regime-switching framework that identifies the housing price cycles of pairs of cities, and simultaneously infers the evolving relation between those cycles. We then summarize these pair-wise relationships into an aggregate synchronization index of housing cycles at the city-level. Our results show that Spanish housing prices converged over time. The convergence was maximum in 2009 and slightly decreased afterwards. In addition, we identify the cities that played the role of main drivers of the convergence process. To do this, we compute the steady-state or "average" probability of being in a given regime (e.g. low price growth regime). We then use this metric to classify cities with similar housing cycle dynamics. This allows us to distinguish between cities that exhibit high price synchronization and cities that shows low price synchronization in the considered period. Accordingly, the latter cities (e.g. Madrid and Barcelona) are those which are mostly related to the convergence process. In the last exercise of the paper, we study what factors explain the synchronization pattern of city-level housing prices in Spain. We rely on a gravity-model type of equation as in Funke et al. (2019) and consider demographic and economic factors to explain the price synchronization pattern of Spanish cities. Results show that differences in population growth and economic structure are key factors to explain the evolution of Spanish city-level housing price synchronization.

The literature on the evolution of housing prices heterogeneity is scarce. Some studies have investigated the developments of housing price synchronization across countries (e.g., Katagiri and Raddatz, 2018; Hirata et al., 2013; He et al., 2018) by means of factor models, while few papers have focused on the heterogeneity of housing prices at the city level.[1] For instance, Miao et al. (2011) estimate a dynamic spatial equilibrium model and show that house price contagion in US cities can be explained by migration spillovers between cities. Schubert (2021) analyze spatial dependencies of housing prices across a number of US cities and show that volatility linkages are more intensive during the boom period of the real estate market. This paper contributes to this literature by providing evidence on the evolving heterogeneity of city-level housing prices in Spain and studying the price synchronization pattern across Spanish cities.

A large bulk of the literature on Spanish housing prices focuses on the period until the Great recession and mostly focus on specific aspects related to the price bubble that characterized Spain until 2007. For instance, Gimeno and Martínez-Carrascal (2010) study the links between house purchase loans and house prices in the Spanish economy, and show that while these two dimensions are interdependent, there is evidence of causality from house purchase loans to house prices. By modeling potential disequilibria in both markets at the same time, they show that disequilibria in house prices can result in a false sense of no overindebtedness and vice versa. In addition, Gonzalez and Ortega (2013) study the impact of immigration on house prices and construction activity in Spain over the period 2000-2010. According to their analysis, immigration implied an important increase in the working-age population and was responsible for one quarter of the increase in prices and about half of the construction activity over the decade. Moreover, Rodriguez and Bustillo (2010) study the determinants of foreign real estate investment in Spain. The latter has grown considerably since 2000 and the bulk of these flows includes mainly the investment of foreign tourists in real properties. Finally, Arrazola et al. (2015) estimate housing supply and demand elasticities for the 1975-2009 period in Spain, and find that demand is highly sensitive to the labor market situation as opposed to prices. By contrast, supply shows great sensitivity to variations in prices and interest rates. The authors argue that this different behavior of supply and demand with respect to prices makes the Spanish real estate market particularly prone to property bubbles.

By contrast, the most recent literature on Spanish housing prices mostly describes the housing price evolution since the recovery in 2014, both at the aggregate and at the city-level. Urtasun and Alves (2019) describe the recovery of the Spanish real estate sector

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[1] Katagiri and Raddatz (2018) also uses city–level datasets to corroborate their findings based on around 30 cities in China and 8 cities in France.

since 2014 and argue that the increasing trend in both quantity and price-based indicators reflects positive labour market developments and low cost of borrowing. López-Rodríguez and de los Llanos Matea (2019) study the Spanish rental housing market, which has gained weight since 2014, and discuss the main factors that have contributed to the recent increase in demand for residential rentals in Spain: e.g. high unemployment, precarious new employment contracts, the reduction in the average loan-to-value ratios of new mortgages, and the concentration of economic activity in geographical areas with a rigid supply of residential housing (especially Madrid and Barcelona).

The contribution of this paper to this recent literature is twofold: (i) construct a metric to measure changes over time in the synchronization of housing price cycles across cities in Spain; (ii) study the convergence process of city-level housing prices, by looking at which cities contributed the most to price convergence and which factors explain the evolution of Spanish city-level housing price synchronization.

The paper is structured as follows. Section 2.1 presents the methodology used to measure changes in housing cycles synchronization, while in Section 2.2 we discuss the results and describe the convergence process of the city-level housing cycles. In Section 3 we study the factors that explain the evolution of the city-level housing price synchronization in Spain. Finally, Section 4 concludes.

2 Changes in housing cycles synchronization

2.1 Methodology

This section describes the methodology used to measure changes in the degree of synchronization between city-level housing price cycles. We rely on the approach proposed in Leiva-León (2017) because on two main reasons. First, it does not need to employ rolling window procedures to obtain time-varying measures of synchronization. Second, it takes into account the nonlinear nature inherent in the dynamics of housing price cycles. In sum, the framework consists on a bivariate regime-switching model that provides inferences on the cycles associated to each of the two underlying series and simultaneously evaluates the evolving degree of interdependence between such cycles.

The model can be briefly describe as follows. Let $y_{i,t}$ and $y_{j,t}$ be the growth rate of the housing price index associated to cities i and j, respectively, and assume that they are interrelated through the following model,

$$\begin{bmatrix} y_{i,t} \\ y_{j,t} \end{bmatrix} = \begin{bmatrix} \mu_{i,0} + \mu_{i,1} s_{i,t} \\ \mu_{j,0} + \mu_{j,1} s_{j,t} \end{bmatrix} + \begin{bmatrix} \epsilon_{i,t} \\ \epsilon_{j,t} \end{bmatrix}, \tag{1}$$

where $s_{i,t}$ denotes a latent variable that can take two values. If $s_{i,t} = 0$, it implies that housing prices of city i are in a low growth regime at time t, given by $\mu_{i,0}$. In contrast, if $s_{i,t} = 1$, it indicates that housing prices in city i are experiencing a high growth regime at time t, which takes the value of $\mu_{i,0} + \mu_{i,1}$. The same definition applies for the latent variable $s_{j,t}$. Each latent variable follows a Markovian process of first order with transition probabilities between the two states given by p_{00} and p_{11}, respectively.[2] The vector of disturbances $\epsilon_t = [\epsilon_{i,t}, \epsilon_{j,t}]'$ is assumed to be normally distributed, $\epsilon_t \sim N(0, \Omega)$.

To assess the time-varying relationship between the latent variables measuring the housing price cycles, $s_{i,t}$ and $s_{j,t}$, we define

$$P(s_{i,t} = s_{j,t}) = P(v_{ij,t} = 1) = \delta_{ij,t}, \tag{2}$$

where $v_{ij,t}$ denotes a latent variable that takes the value of one if $s_{i,t}$ and $s_{j,t}$ are totally dependent, or the value of zero if they are independent, at time t. Therefore, the term $\delta_{ij,t}$ provides information regarding the time-varying synchronization between the cycles $s_{i,t}$ and $s_{j,t}$. Accordingly, the latent variable $v_{ij,t}$ is also assumed to follow a Markovian process of first order with transition probabilities $p_{ij,v}$.

The model in equations (1)-(2) is estimated with Bayesian methods due to the nonlinear dynamics that it entails. For more details about the model and the estimation procedure, see Leiva-León (2017). This methodology has been previously employed to study changes in business cycles synchronization between US states (Leiva-León, 2017; Camacho and Leiva-León, 2019), European regions (Gadea-Rivas et al., 2019), and world's countries (Ductor and Leiva-León, 2016).

2.2 Empirical Results

This section provides a comprehensive evaluation of the changes in the synchronization of housing cycles across Spanish cities. We use data on housing prices at the biannual frequency for 50 of the major cities in Spain, which are listed in Table 1. The data come

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[2] In particular, the transition probabilities are defined as $\Pr(s_{\iota,t} = 0 | s_{\iota,t-1} = 0) = p_{00,\iota}$ and $\Pr(s_{\iota,t} = 1 | s_{\iota,t-1} = 1) = p_{11,\iota}$, for city $\iota = \{i, j\}$.

from the Real Estate Registry Statistics (Estadística Registral Inmobiliaria in Spanish) which gathers the universe of all registrations made in the Property Registry regarding real estate transactions and their mortgage financing. The sample spans from 1989:S1 until 2018:S1.

To illustrate how the empirical framework works in practice we provide the detailed results associated to two selected pairs of cities that exhibited different synchronization patterns. The first case focuses on measuring the synchronization of housing cycles between Santander and Badajoz. The left charts of Figure 2 show the output of the model which consists on (i) the probability that housing prices in Badajoz are in a low growth regime, (ii) the probability that housing prices in Santander are in a low growth regime, and (iii) the synchronization between the cycles of Badajoz and Santander. The estimates show that between the late 1980s and early 1990s the housing markets of these two cities exhibited different cyclical positions. This is reflected in the low values of the estimated synchronization, $\delta_{badajoz,santander}$. However, since the mid 1990s both cycles engaged in a synchronized phase that has remained until the present, as it is shown by the increase in the synchronization measure. The second case focuses on the synchronization of the housing cycles associated with Barcelona and Madrid. Similarly to the first case, the right charts of Figure 2 show (i) the probability that housing prices in Barcelona are in a low growth regime, (ii) the probability that housing prices in Madrid are in a low growth regime, and (iii) the synchronization between the housing cycles of Barcelona and Madrid, $\delta_{barcelona,madrid}$. Unlike this first case, the estimates suggest that housing prices in these two cities have remained highly synchronized during the entire sample period.

The bivariate model in equations (1)-(2) is estimated for all the possible pairs of cities listed in Table 1, and the synchronization measures associated each pair, $\delta_{i,j}\ \forall\ i \neq j$, are saved. In Chart A of Figure 3, we plot the evolution of the cross-sectional distribution associated to all the estimated synchronization measures along with its corresponding mean and median. The figure shows a salient feature which consists of a shrinkage of the cross-sectional distribution over time. This feature points to a remarkable convergence pattern of city-level housing price cycles. In particular, during the 1990s and early 2000s there was a group of cities experiencing a convergence process in housing price cycles towards another group of cities that has remained highly synchronized for the entire sample. Also, Chart B of Figure 3 makes a zoom into the mean and median of the cross-sectional distribution. These statistics provide information about the changing degree of the intra-synchronization of the Spanish housing market, suggesting that it persistently increased until the burst of the housing bubble in 2008, and decreased afterwards.

The convergence of the city-level housing cycles has been a gradual but persistent process that started several decades ago. This is illustrated in Figure 4, which plots the kernel densities associated to the synchronization measures for three selected time periods: (i) the beginning of the sample in 1989, (ii) the housing bubble in 2007, and (iii) the end of the sample in 2018. Besides documenting this convergence pattern of the regional housing cycles, it is also crucial to identify the cities that have mainly contributed to such convergence.

In order to identify the cities that have acted as main drivers of the convergence process, we classify them based on their cyclical commonalities. For each pair of cities, we compute the steady-state or "average" probability of being in a given regime.[3] Based on these steady-state probabilities, cities are classified into groups with similar housing cycle dynamics, which are shown in Figure 5. The cluster tree, or dendrogram, suggests the existence of three salient groups of cities. The height of each U-shaped line represents the cyclical dissimilarity between the two cities being connected. Accordingly, there is a large group of cities in blue that exhibits a relatively low dissimilarity, or high synchronization. Also, there is another large group of cities in red, which show a relatively higher degree of dissimilarity, or lower synchronization. Lastly, there is a small group in green, which is composed by only three cities and that also exhibits a low degree of synchronization. Based on this classification, it can be inferred that since the groups in red and green exhibit a lower synchronization degree, the cities contained in these groups could be mostly related to the convergence process.

Since the convergence of city-level housing cycles has been a dynamic process, it is important to evaluate in a time-varying fashion the cities' cyclical affiliations to provide an accurate assessment of the main contributors of such process. Therefore, we rely on multidimensional scaling analysis to provide a mental mapping of the association between cities over time by controlling for the importance of steady-state grouping patterns. Figure 6 plots the dynamic mapping of housing price synchronization for selected periods, including the beginning and end of the sample, and the middle of the housing bubble. Each point in the charts represents a city and the closeness between two points in the plane

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[3] The steady-state probability, $\bar{\delta}_{ij}$ is computed by using the estimated transition probabilities of the latent variable $v_{ij,t}$ that measures the synchronization between cities i and j. In particular, $\bar{\delta}_{ij} = \frac{1-p_{ij,v=1}}{2-p_{ij,v=0}-p_{ij,v=1}}$, where $p_{ij,v=\iota}$ is the transition probability of staying in regime $\iota = \{0, 1\}$.

refers to their degree of synchronicity, that is, the closer the points are, the larger their synchronization.[4] The figure shows that the synchronization between the cities in the blue cluster has remained high and stable over time. Instead, cities in the red cluster have exhibited an increasing degree of synchronization over time, while the cities in the green cluster have remained mostly unsynchronized. This features confirm that the cities in the red cluster have contributed the most to the convergence process of housing cycles since they engaged in a synchronized phase with the cities in the blue cluster, yielding a decline in the cross-sectional heterogeneity of housing prices.

3 Related housing market characteristics

In this Section we study what factors explain the synchronization pattern of Spanish city-level housing prices. Following the literature, we consider demographic and economic factors.[5]

First, the population growth is expected to affect the demand for housing and hence housing prices. In Spain the population grew sharply at the end of the '90, which was explained by an important increase in immigration. To account for this we control for population growth (POP). In addition, another relevant factor may be the demographic structure of the population. A larger fraction of the working age population is expected to increase the demand for housing, thereby raising the housing prices. To account for this, we construct the dependency ratio at the city-level (DEP), which is defined as the fraction of population below 15 years old and above 65 years old divided by the working age population (15-64 years old).

Another relevant factor to explain the housing prices dynamics is disposable income. The wealthier the households, the higher the demand for housing and the higher the pressure on prices. We use the unemployment rate growth (UR) at the city-level as a proxy for the local economic situation.[6]

In addition, we consider the economic structure at the city-level. Intuitively, cities whose economy is mostly driven by the service sector or the industry sector are likely to face higher demand for housing and hence higher housing prices, as opposed to cities which

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[4] For more details on how the multidimensional scaling maps are constructed, see Leiva-León (2017).

[5] See Belke and Keil (2018) for a very recent analysis on real estate prices determinants for Germany. A recent contribution for Spain is Arrazola et al. (2015).

[6] Unfortunately, more direct measures of disposable income at the city level are available yearly and for a short span.

are mostly characterized by the agricultural sector. To account for this, we consider the fraction of employees working in the agricultural sector in each province as a city-level proxy for the weight of agriculture in the local economy.

We expect that the divergence in housing prices between two cities is associated with differences in terms of the weight of agriculture in the local economy, population growth, demographic structure, and disposable income.

We borrow the econometric framework from Funke et al. (2019) which carried out the same analysis for the Chinese case. We consider the period 1989S1-2018S1. The unit of observation is a pair of city $\{i, j\}$, and we consider 50 Spanish capitals of province.[7] We estimate the following equation:

$$(1-\delta_{ij,\tau}) = \alpha_0 + \sum_n \alpha_{1n} \left|X_{n,i,\tau-1} - X_{n,j,\tau-1}\right| + f_{ij} + f_t + v_{ij,\tau}, \tag{3}$$

where δ_{ij} is the city-pair-level price synchronization metric, so that the dependent variable represents the degree of divergence in the price between two cities.[8] All explanatory variables are defined at the city-pair level and observed every 6 months. Since the unit of observation is the city-pair {i,j}, all explanatory variables X_n are transformed as absolute differences between city i and city j. The definitions of these variables and their data sources are reported in Table 2 of the Appendix. All regressors are lagged by one period (6 months) to minimize endogeneity concerns.

In line with the estimation of gravity models in the empirical international trade literature, the equation includes city-pair fixed effects (f_{ij}) to control for time-invariant characteristics affecting the city-pairs, as well as year fixed effects (f_t) to control for common trends affecting the price cycles of all city-pairs (Baltagi et al., 2014). The equation is estimated by OLS method, clustering standard errors at the city-pair level. Controlling for city-pair fixed effects is relevant since it allows to account for invariant characteristic of the city-pair, such as whether cities are turistic, and the geographical distance between the two cities: the closer the cities, the more synchronized the housing prices, since the demand for housing may overlap due to commuting. In any case, results are qualitatively the same, if anything slightly more significant, when we replace the fixed effect for the city-pairs with a fixed effect for city i and a fixed effect for city j, and cluster standard

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[7] These are all Spanish capitals of province, except for Ceuta and Melilla.

[8] This transformation is applied to to ease the interpretation of the results.

errors with two-way clustering on city i and city j to allow for correlation between errors within the same cluster (Cameron et al., 2011).[9]

Results are reported in Table 3 (see Columns (1) and (4) for the baseline models with city-pair fixed effects and fixed effects for city i and j, respectively). As expected, the coefficients associated with the population growth (POP) and the economic structure ($AGRI$) are statistically significant and with a positive sign. This suggests that differences in these factors between two cities are associated with housing prices divergence. By contrast, the demographic structure (DEP) and the local economic situation seem not to play a role in explaining the the city-pair price cycles dynamics. Arguably, demographic variables evolve slowly, and the variable DEP does not show enough variation in our sample. In addition, to the extent that the city-level UR growth rate does not vary much across cities and rather follows the same aggregate trend, its absolute difference becomes not very informative of the differences in the local economic situation between cities.

The other columns of the Table report results of robustness exercises. The first one relates to the fact that in Spain most of the economic activity and jobs rotate around two major cities, Madrid and Barcelona. These two cities are also very different with respect to all other cities in terms of dimension. Hence, the housing prices dynamics in Madrid and Barcelona may be peculiar and might distort the analysis. Therefore, as a robustness exercise we estimate the models excluding Madrid and Barcelona (see Columns (2) and (5)). Finally, Columns (3) and (6) shows the results from estimating the models excluding the cities in the green cluster (Teruel, Avila, and Vitoria/Gasteiz) whose synchronization cycles follow independent patterns, based on the graphical analysis shown in the previous Section. These additional analyses confirm the baseline results.

4 Conclusions

This paper provides a metric to measure the synchronization of housing price cycles across Spanish cities and studies changes over time in city-level prices synchronization. We focus on the period from the first semester of 1989 until the first semester of 2018. To measure synchronization we first use a regime-switching framework that identifies the housing price cycles of pairs of cities, and simultaneously infer the evolving relation be-

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[9] Both specifications are standard in gravity models. However, the second estimation is less demanding, since the number of parameters to be estimated (fixed effects for 49 city i, 49 city j, and 29 semesters) is much lower than in our baseline case (fixed effects for 1225 city-pairs and 29 semesters).

tween those cycles. Then, we aggregate all these bilateral relationships into an overall synchronization index of city-level housing cycles. The evolution of this aggregate index suggests that Spanish city-level housing prices converged in the period considered, reaching a maximum in 2009 and slightly decreasing afterwards. In addition, we identify which cities contributed the most to price convergence and which factors explain the evolution of Spanish city-level housing price synchronization. According to our results, differences in population growth and economic structure are key factors to explain the evolution of housing price synchronization among Spanish cities.

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Table 1: List of cities with their corresponding ID

City	**ID**	**City**	**ID**
VITORIA / GASTEIZ	VIT	*LOGROÑO*	LOG
ALBACETE	ALB	*LUGO*	LUG
ALICANTE	ALI	*MADRID*	MAD
ALMERIA	ALM	*MALAGA*	MAL
AVILA	AVI	*MURCIA*	MUR
BADAJOZ	BAD	*PAMPLONA*	PAM
PALMA DE MALLORCA	PMA	*OURENSE*	OUR
BARCELONA	BAR	*OVIEDO*	OVI
BURGOS	BUR	*PALENCIA*	PAL
CACERES	CAC	*PALMAS DE GRAN CANARIA (LAS)*	PGR
CADIZ	CAD	*PONTEVEDRA*	PON
CASTELLON DE LA PLANA	CAS	*SALAMANCA*	SAL
CIUDAD REAL	CIU	*SANTA CRUZ DE TENERIFE*	TEN
CORDOBA	CRD	*SANTANDER*	SAN
CORUÑA (A)	CRU	*SEGOVIA*	SEG
CUENCA	CUE	*SEVILLA*	SEV
GIRONA	GIR	*SORIA*	SOR
GRANADA	GRA	*TARRAGONA*	TAR
GUADALAJARA	GUA	*TERUEL*	TER
SAN SEBASTIAN / DONOSTIA	SEB	*TOLEDO*	TOL
HUELVA	HUL	*VALENCIA*	VAL
HUESCA	HUE	*VALLADOLID*	VLL
JAEN	JAE	*BILBAO*	BIL
LEON	LEO	*ZAMORA*	ZAM
LLEIDA	LLE	*ZARAGOZA*	ZAR

Table 2: List of variables considered as determinants of housing price divergence between Spanish cities

Variable name	Variable description
$\lvert UR_i - UR_j \rvert$	Absolute difference of population growth rate between city i and city j.
$\lvert DEP_i - DEP_j \rvert$	Absolute difference of dependency ratio between city i and city j: $((pop.aged < 15 \,\&\, > 65)/pop.aged\ 15 - 64)$.
$\lvert POP_i - POP_j \rvert$	Absolute difference of unemployment growth rate between city i and city j.
$\lvert AGRI_i - AGRI_j \rvert$	Absolute difference of agriculture sector weight between city i and city j: (*Nr. employees in agriculture/ Total employees*).

Notes: All variables are defined at the city level and at the 6 months frequency. Source: Spanish Statistical Office (INE).

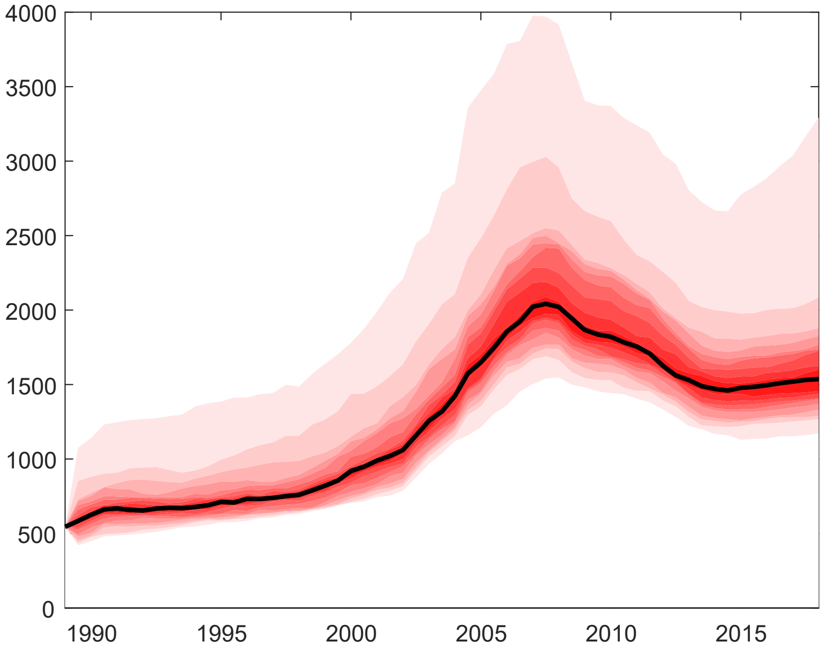
Table 3: Variables associated with housing prices divergence between Spanish cities

	City-pair FE			*City i & city j FE*		
	(1) All	(2) No MAD-BAR	(3) No Green Clu.	(4) All	(5) No MAD-BAR	(6) No Green Clu.
$\lvert UR_i - UR_j \rvert$	-0.007	-0.008	0.001	0.017	0.018	0.019
	(0.009)	(0.010)	(0.007)	(0.018)	(0.019)	(0.013)
$\lvert DEP_i - DEP_j \rvert$	0.077*	0.124***	-0.040	0.112	0.120	0.022
	(0.045)	(0.047)	(0.038)	(0.075)	(0.080)	(0.054)
$\lvert POP_i - POP_j \rvert$	1.552***	1.506***	1.392***	2.061**	1.903**	1.890***
	(0.286)	(0.299)	(0.276)	(0.881)	(0.897)	(0.564)
$\lvert AGRI_i - AGRI_j \rvert$	0.119***	0.142***	0.127***	0.182***	0.180***	0.202***
	(0.039)	(0.040)	(0.038)	(0.058)	(0.058)	(0.051)
City-pair FE	Yes	Yes	Yes	No	No	No
City i & city j FE	No	No	No	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	69,825	64,296	61,617	69,825	64,296	61,617
R-squared	0.607	0.609	0.503	0.430	0.431	0.299

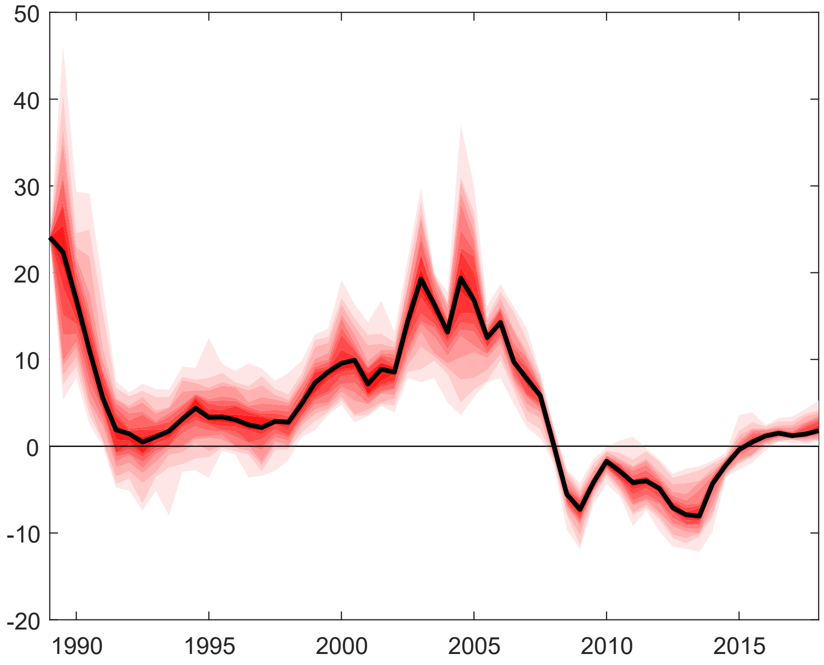
Notes: $***$, $**$, and $*$ indicate signficance at the 1%, 5% and 10%, respectively. Standard errors are shown in parenthesis beneath the coefficient estimates. For the models that include city-pair fixed effects, standard errors are clustered at the city-pair level. For the models which contain a fixed effect for city i in the pair and a fixed effect for city j in the pair, standard errors are two-way cluster-robust with clustering on city i and city j. All models include time fixed effects.

Figure 1: Housing Prices Dispersion Across Spanish Cities

(a) Levels

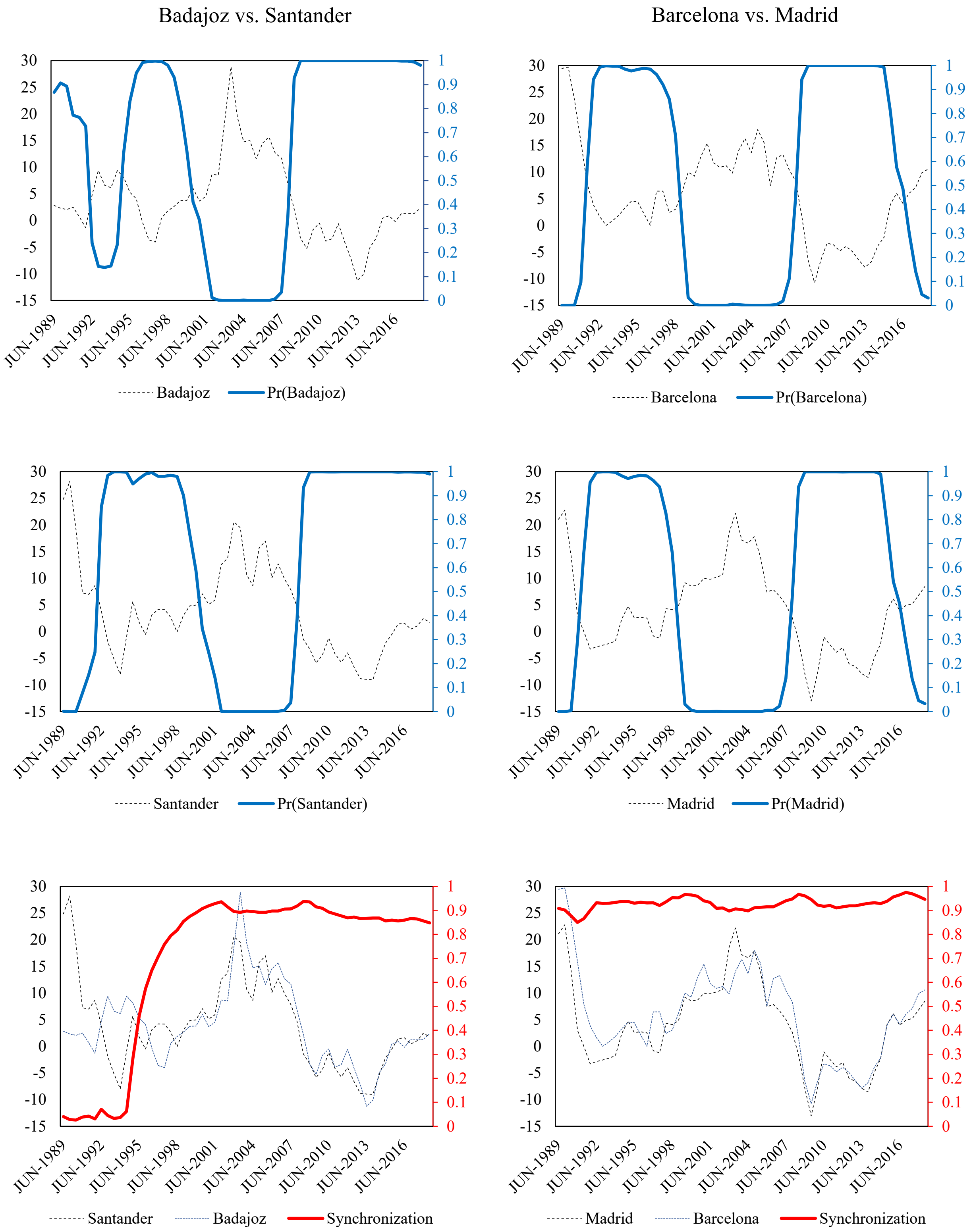


(b) Growth Rates



Note. The black line plots the median housing price dispersion (in level and annualized growth, respectively) across the fifty major cities in Spain. The red area corresponds to the cross-sectional distribution over time with probability mass between the 5th and 95th percentiles.

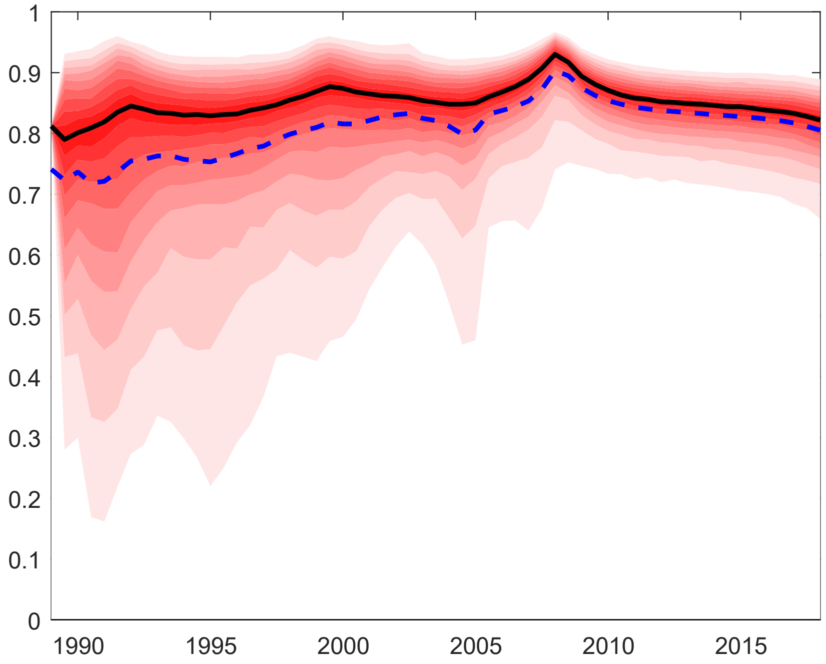
Figure 2: Selected Examples of Housing Cycles Synchronization



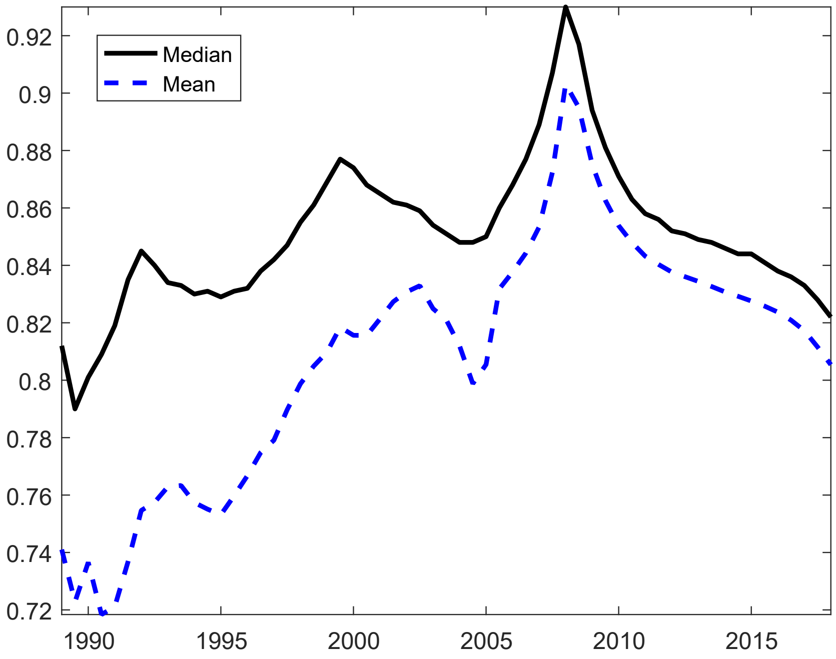
Note. Top and middle panels show housing prices in a city (dotted black line) against the probability that housing prices in that city are in a low growth regime (solid blue line). Bottom charts show housing prices in city i (solid blue line) and j (dotted black line) against the synchronization measure between the cycles of city i and j (solid red line).

Figure 3: Aggregate Synchronization of City-level Housing Price Cycles

(a) Distribution

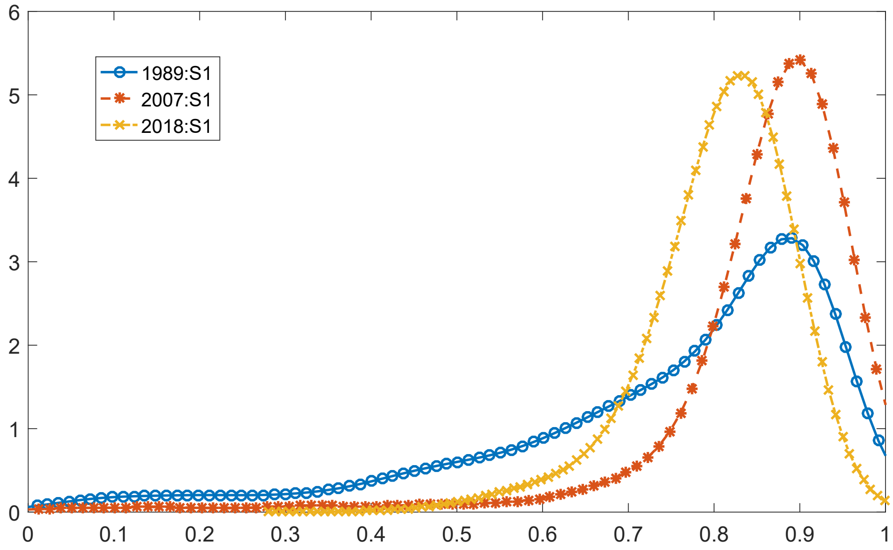


(b) Mean and Median



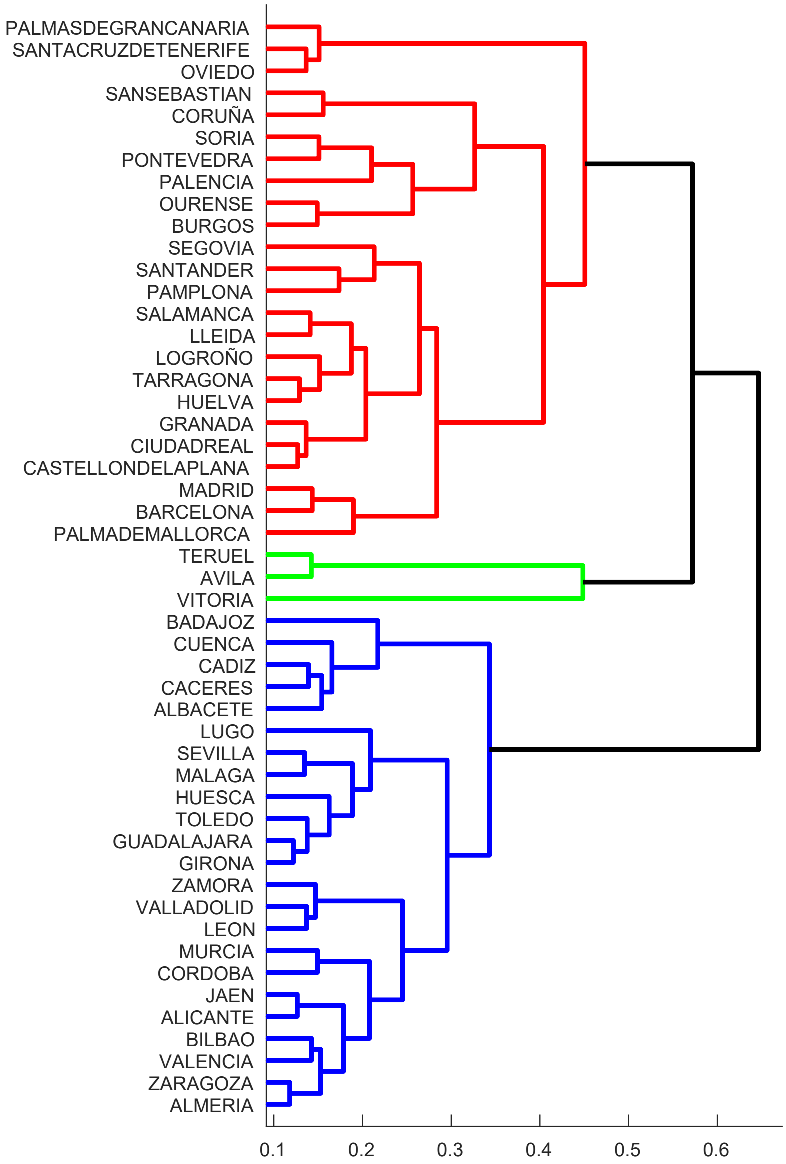
Note. Chart A plots the evolution of the cross–sectional distribution of the estimated synchronization measure along with its mean (dotted blue line) and median (solid black line). Chart B shows the mean (dotted blue line) and median (solid black line) of the cross–sectional distribution.

Figure 4: Distributions of Housing Cycles Synchronization for Selected Periods



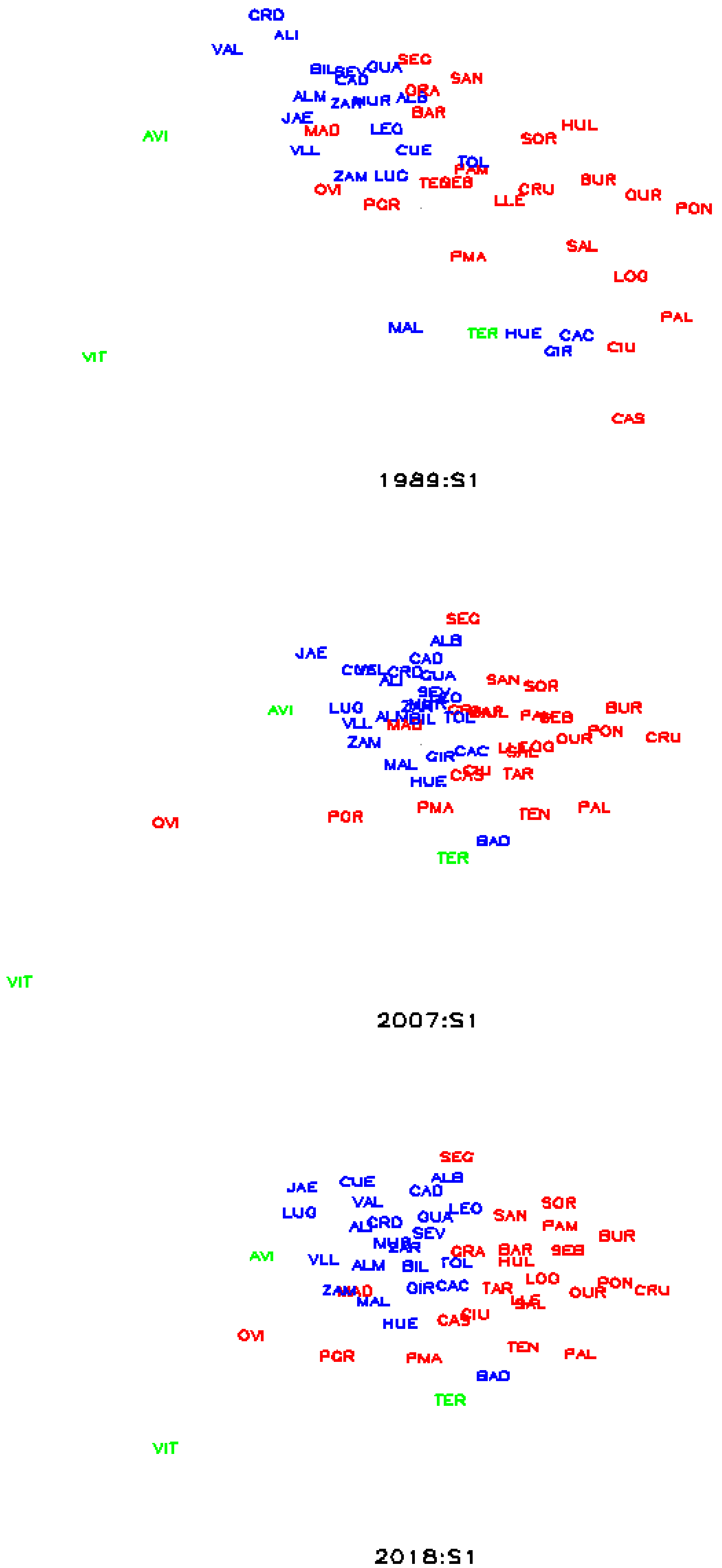
Note. The graph shows kernel densities associated to the pair-wise synchronization measures for three selected time periods: (i) the beginning of the sample in 1989S1, (ii) the housing bubble in 2007S1, and (iii) the end of the sample in 2018S1.

Figure 5: Clustering Pattern of Housing Cycles Across 50 Major Spanish Cities



Note. The figure plots the dendrogram based on the stationary (or time-invariant) synchronization between housing prices across 50 major cities in Spain, which, for each city, is measured by the steady-state probability of being in a given regime ($\bar{\delta}_{i,j}$).

Figure 6: Dynamic synchronization mapping between housing prices of Spanish cities.



Note. Each chart in the figure plots the multi-dimensional scaling map based on housing prices synchronization for the corresponding time period and the 50 major Spanish cities. The closer the cities are in the map, the stronger their synchronization.

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