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Spatio-Temporal Diffusion in US Metropolitan House Prices

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Agenda

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- Background and Motivation
- Literature Review
- Methodology
  - The Panel Model
  - The Dynamic Panel-Spatial Model
- Results
- Conclusion

Background and Motivation

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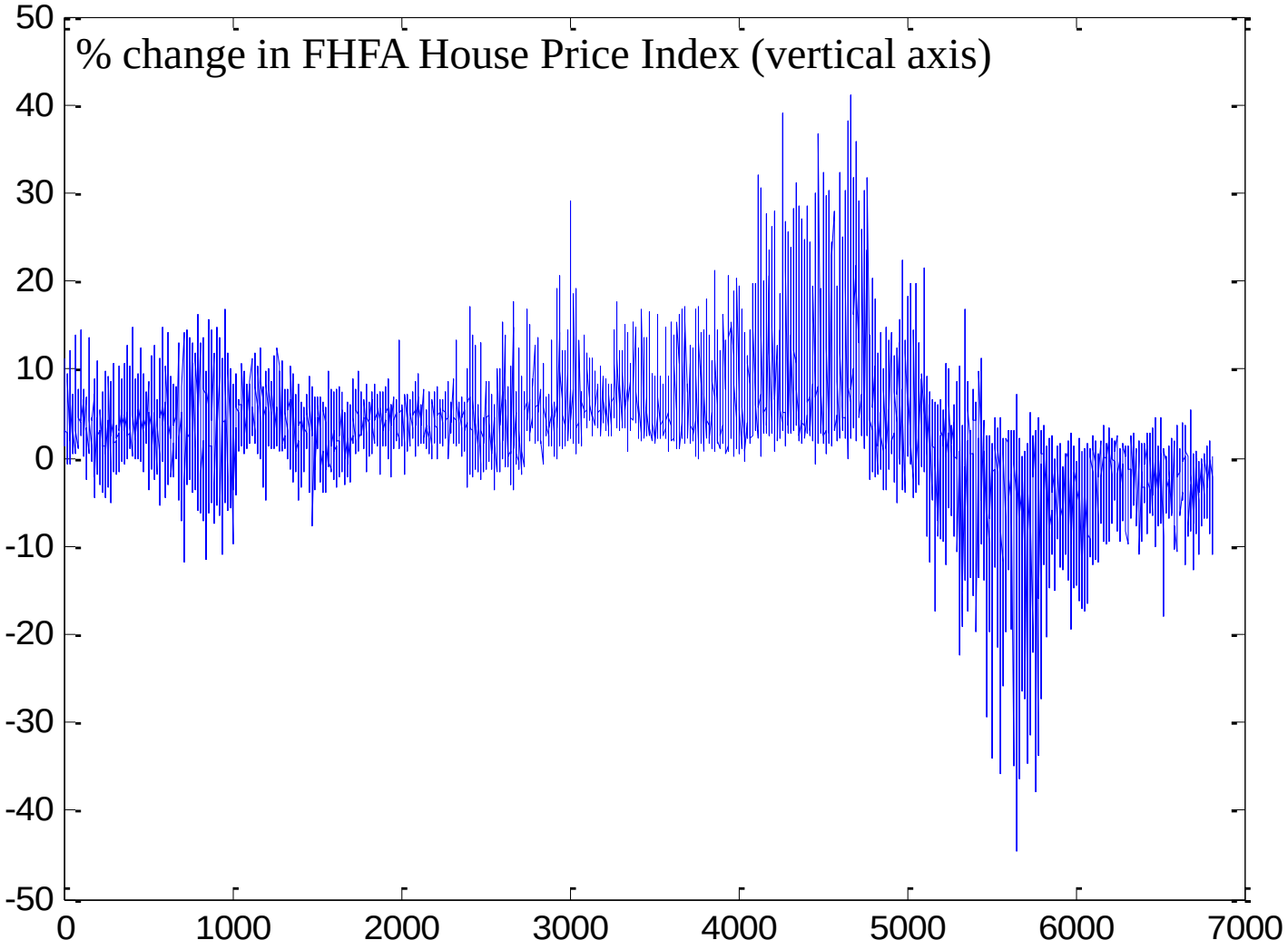
341 US Metro Areas over 1993-2012



Background and Motivation (cont.)

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To investigate the dynamics of urban house prices, especially to what extent the housing sub-markets converge or diverge over time in US.

Research Questions

I. Do changes in the house price of a region transmit to its neighbouring regions?

II. Does the transmission mechanism follow spatial and temporal diffusion processes?

Literature Review

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Determinants of Co-movements of Regional Housing Markets

Study	Causes
Pollakowski and Ray (1997)	**Positive feedback effect** House price in one region is determined by its own lagged prices and by the adjacent regions' lagged house prices
Meen (1999)	**Migration, equity transfer, spatial arbitrage and local economic developments**
Can (1990) Ioannides and Zabel (2003)	**Neighbourhood effects** Positive changes in nearby structures would create positive feedback effects on house values
Oikarinen (2006)	**Substitute effects** Changes in one region's house price would generate another region's house price with a time lag
Brueckner (2000) Couch and Karecha (2006) O'sullivan (2009)	**Urban sprawl** Rising incomes and low commuting costs boost demand for space in distant locations where land is relatively cheap causing urban expansion

Literature Review (cont.)

House Price Diffusion

Study	Estimated method and period	Results
Pollakowski and Ray (1997)	1975-1994 in the US by using VAR model	Existence of lead-lag relations between neighbouring areas
Stevenson (2004) Oikarinen (2006) Lee and Chien (2011)	1978 Q1- 2002 Q2 in Ireland and Northern Ireland; 1987-2004 in Finland ; 1993-2005 in Taiwan by using VAR and VECM	Housing price diffusion first from the main economic centre to regional centres and then to the peripheral areas
Meen (1999) Shi et al. (2009)	1973-1994 in the UK Based on life-cycle model; 1994-2004 in New Zealand by using VECM	Ripple effect is caused by adjustments within regions rather than between regions
Brady (2011) Holly et al. (2011)	1995m1-2002m12 in 31 California counties by using spatial dynamic panel; 1973Q4–2008Q2 in 12 UK regions by using spatial and temporal diffusion of shocks in a dynamic system	Ripple effects could be examined properly over time and space due to spatial dependence
Nanda and Yeh (2014)	41 Taipei sub-markets over the period from 1992 to 2010; spatial panel models using annual data on median residential land prices	specific area and time effects have significant influences on local housing markets.

Methodology

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Standard Panel Data Models

$$y_{it} = \boldsymbol{\alpha} + \beta x_{kit} + \eta y_{it-s} + \mu_i + \lambda_t + \varepsilon_{it}$$

Spatial Panel Data Models

$$y_{it} = \boldsymbol{\phi} y_{it-1} + \beta x_{kit} + \rho \mathbf{W} y_{jt} + \mu_i + \lambda_t + \varepsilon_{it}$$

$$(|\rho| + |\phi| < 1)$$

Spatial Durbin Models

$$y_{it} = \boldsymbol{\phi} y_{it-1} + \beta x_{kit} + \rho \mathbf{W} y_{jt} + \theta \mathbf{W} y_{jt-1} + \gamma \mathbf{W} x_{jt} + \mu_i + \lambda_t + \varepsilon_{it}$$

$$(|\rho| + |\phi| + |\theta| < 1)$$

The spatial matrix *W* is pre-determined by contiguity, where value of the spatial correlation is 1 if the region *i* and region *j* are neighbours; otherwise the value is 0

The spatial matrix is normalised with each row summing up to unity

Summary Statistics

Simple parsimonious model - *house price, population and per capita income*

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Variables	Mean	SD
USA (341 MSAs – 20 years – 1993-2012) 6820 obs		
House Price Growth	3.106	6.161
Population Growth	1.103	1.426
Region-1: CA, NV, AZ (33 MSAs) 660 obs		
House Price Growth	2.958	11.824
Population Growth	1.635	1.606
Region-2: MA, NH, ME, VT, NY, CT, RI, NJ, PA, MD, DE, DC, VA (57 MSAs) 1140 obs		
House Price Growth	3.103	5.686
Population Growth	0.541	1.042
Region-3: NC, GA, SC, FL (52 MSAs) 1040 obs		
House Price Growth	2.882	7.437
Population Growth	1.632	1.427
Region-4: WI, IL, IN, MI, OH, MN (65 MSAs) 1300 obs		
House Price Growth	2.648	3.866
Population Growth	0.443	0.971

US Metro Map

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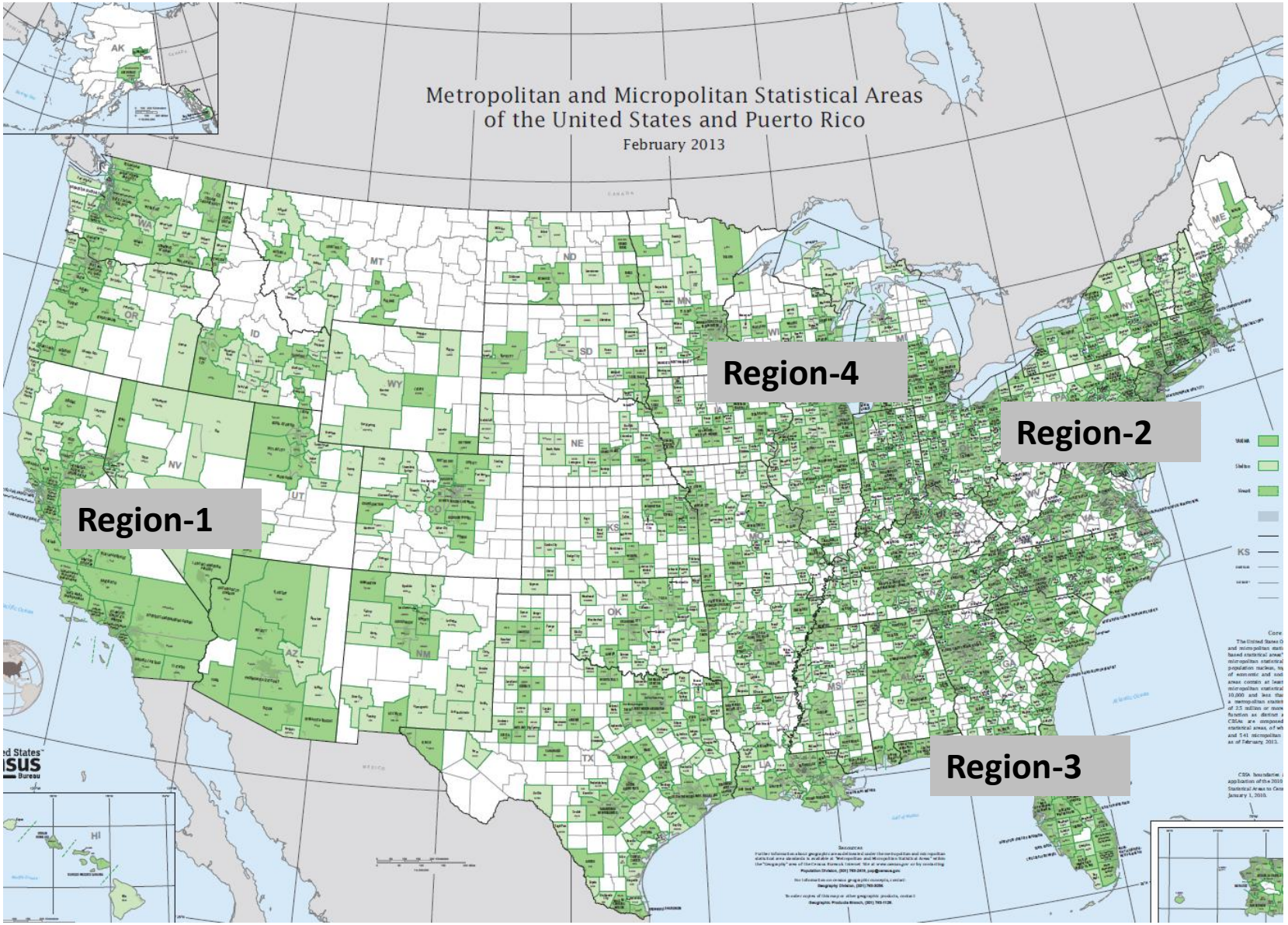
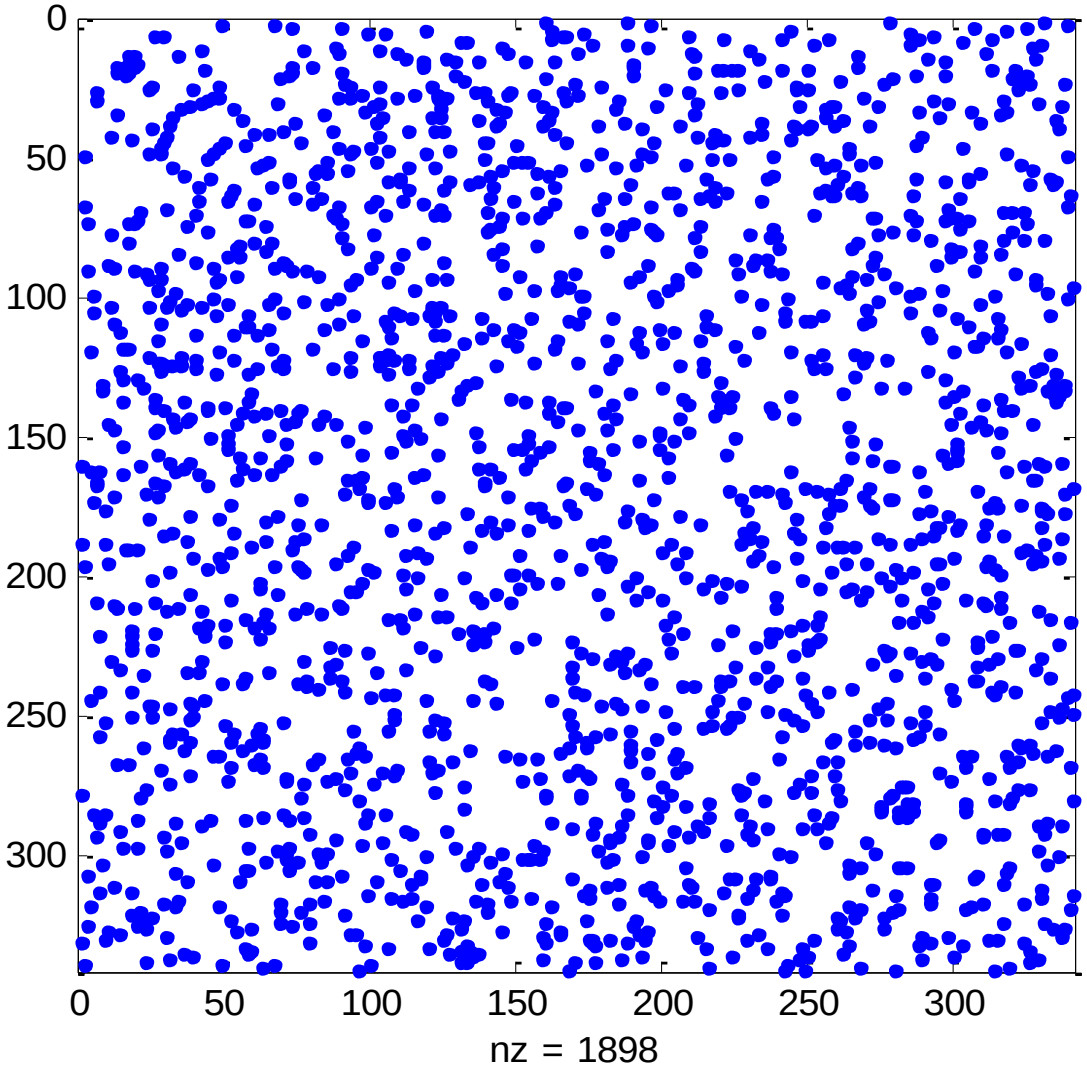
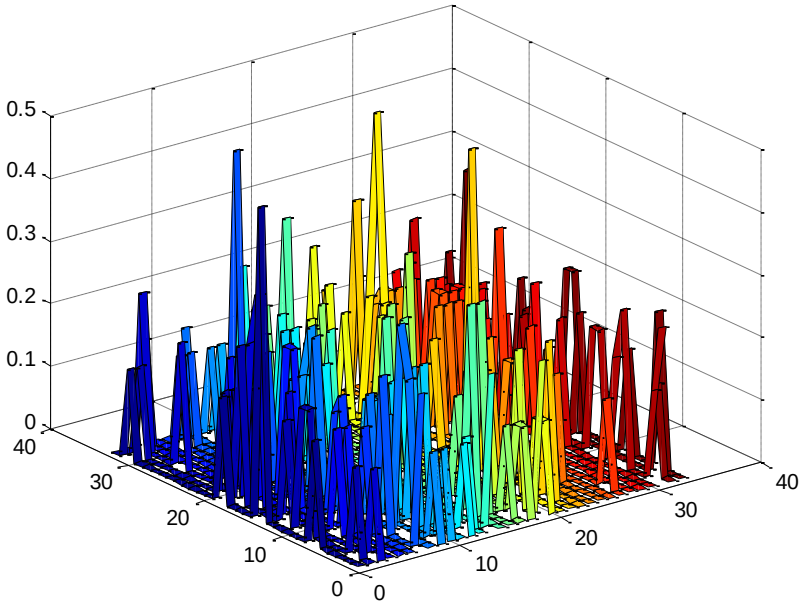


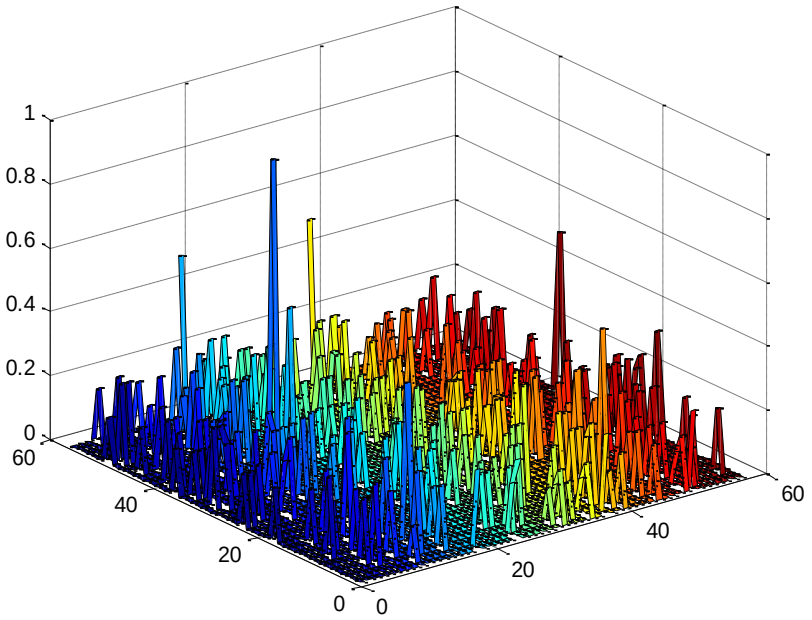
Spatial Matrix



Spatial Matrix

Region-1 and Region-2





Results-I

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Table 2: Dynamic Spatial Durbin Models
(Dependent Variable: house price growth)

	USA (341 MSAs)	Region-1 (33 MSAs)	Region-2 (57 MSAs)	Region-3 (52 MSAs)	Region-4 (65 MSAs)
	(1)	(2)	(3)	(4)	(5)
Spatial regressor	0.833***	0.665***	0.775***	0.824***	0.531***
W* House Price Growth	(109.75)	(20.54)	(41.09)	(51.92)	(18.67)
Space-time regressor:	0.545**	0.396	0.493	-0.147	0.477
W* House Price Growth (lag1)	(2.21)	(0.43)	(0.744)	(-0.21)	(1.21)
House Price Growth (lag1)	0.121	-0.349	-0.156	-0.364	0.096**
	(1.04)	(-0.882)	(0.48)	(-0.99)	(0.49)
Model Description	MSA & Time Fixed Effects	MSA & Time Fixed Effects	MSA & Time Fixed Effects	MSA & Time Fixed Effects	MSA & Time Fixed Effects
N	6,820	660	1,140	1,040	1,300
σ^2	7.554	16.652	5.363	7.501	3.761

Note: All variables are specified in percentage change. *t* statistic is reported within the parentheses based on robust standard errors. '***', '**', and '*' denote 1 percent, 5 percent and 10 percent significance levels.

Results-II

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Dynamic Spatial Durbin Models: with Demand-Shifters

	USA (341 MSAs)	Region-1 (33 MSAs)	Region-2 (57 MSAs)	Region-3 (52 MSAs)	Region-4 (65 MSAs)
	(1)	(2)	(3)	(4)	(5)
Spatial regressor	0.812***	0.629***	0.741***	0.767***	0.494***
*W**House Price Growth	(100.60)	(18.23)	(35.89)	(40.34)	(16.672)
Space-time regressor:	0.182	0.367	0.311	-1.468**	0.487
*W**House Price Growth (lag1)	(0.75)	(0.41)	(0.47)	(-2.11)	(1.22)
House Price Growth (lag1)	-0.006	-0.365	-0.219	-0.793**	0.085
	(-0.05)	(-0.93)	(-0.68)	(-2.18)	(0.43)
Per Capita Income Growth	0.387***	0.432***	0.347***	0.387***	0.311***
	(12.66)	(3.41)	(4.12)	(5.06)	(4.69)
*W** Per Capita Income Growth	0.248***	0.621**	0.465***	0.294**	0.421***
	(4.02)	(2.47)	(2.63)	(2.09)	(2.87)
Population Growth	0.104***	-0.002	0.076	0.228***	0.081**
	(5.71)	(-0.04)	(1.38)	(4.05)	(2.086)
*W** Population Growth	0.117***	0.071	0.072	0.301***	-0.042
	(3.67)	(0.58)	(0.73)	(3.44)	(-0.61)
Model Description	MSA & Time Fixed Effects	MSA & Time Fixed Effects	MSA & Time Fixed Effects	MSA & Time Fixed Effects	MSA & Time Fixed Effects
N	6,820	660	1,140	1,040	1,300
σ^2	7.336	16.228	5.326	7.269	3.696

Note: All variables are specified in percentage change. *t* statistic is reported within the parentheses. '***', '**', and '*' denote 1 percent, 5 percent and 10 percent significance levels.

Results-III

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Dynamic Spatial Durbin Models: with Demand-Shifters

	USA (341 MSAs)	Region-1 (33 MSAs)	Region-2 (57 MSAs)	Region-3 (52 MSAs)	Region-4 (65 MSAs)
	(1)	(2)	(3)	(4)	(5)
Direct effect: Per Capita Income Growth	0.554*** (14.55)	0.618*** (4.34)	0.564*** (5.02)	0.597*** (5.91)	0.394*** (5.61)
Indirect or Spillover effect: Per Capita Income Growth	2.823*** (8.57)	2.252*** (3.63)	2.556*** (3.90)	2.345*** (4.21)	1.072*** (3.91)
Total effect: Per Capita Income Growth	3.378*** (9.52)	2.871*** (4.09)	3.121*** (4.24)	2.943*** (4.68)	1.466*** (4.66)
Direct effect: Population Growth	0.164*** (8.52)	0.011 (0.16)	0.115* (1.81)	0.398*** (6.07)	0.079** (2.09)
Indirect or Spillover effect: Population Growth	1.019*** (7.15)	0.163 (0.565)	0.458 (1.353)	1.883*** (5.64)	0.001 (0.08)
Total effect: Population Growth	1.184*** (7.79)	0.174 (0.54)	0.573 (1.53)	2.281*** (6.12)	0.081 (0.61)

Note: All variables are specified in percentage change. *t* statistic is reported within the parentheses. '***', '**', and '*' denote 1 percent, 5 percent and 10 percent significance levels.

Results-IV

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Dynamic Spatial Durbin Models: with Demand-Shifters

	Simple SDM (Normal Years)	Simple SDM (Recession/ Boom Years)	SDM with demand shifters (Normal Years)	SDM with demand shifters (Recession/ Boom Years)
	(1)	(2)	(3)	(4)
Spatial regressor	0.767***	0.859***	0.732***	0.837***
*W**House Price Growth	(55.39)	(93.07)	(49.038)	(83.89)
Space-time regressor:	0.761*	0.376	0.543	0.028
*W**House Price Growth (lag1)	(1.92)	(1.16)	(1.36)	(0.08)
House Price Growth (lag1)	0.065	0.095	-0.031	-0.009
	(0.37)	(0.62)	(-0.18)	(-0.06)
Per Capita Income Growth			0.378***	0.367***
			(8.63)	(8.43)
*W** Per Capita Income Growth			0.436***	0.186**
			(4.59)	(2.17)
Population Growth			0.061**	0.094***
			(2.44)	(3.56)
*W** Population Growth			0.007	0.163***
			(0.17)	(3.63)
Model Description	MSA & Time Fixed Effects	MSA & Time Fixed Effects	MSA & Time Fixed Effects	MSA & Time Fixed Effects
N	3,069	3,751	3,069	3,751
σ^2	5.076	9.173	4.964	8.958

Concluding remarks

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- Simple spatial panel models show highly significant coefficients on spatial regressor showing high degree of spatial dependence.
- Four regions show noticeable difference in spatial effects.
- To further explore robustness of these results, we incorporate demand shifters (population growth and per capita income growth) and also a supply shifter (permit growth) in explaining house price variation. Results for the permit variable is lot less robust – possibly due to frequent cancellations.
- The most remarkable result is the significance of income growth variable at various levels. The spatially dependent income variable is also significant across all regions. Although the space-time covariance has been incorporated, the results are not significant.

Concluding remarks

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- We also compute the direct (=own), indirect (=spill-over) and the total effects. Income growth shows much more prominent spatial patterns.

- During the time period that we have studied, the US experienced two recessions and the early 90s saw the US recession around 1991 with subsequent slowdown.

- We test spatial patterns across normal and recession/boom years. The income growth results holds well across all time periods. The computation of direct, indirect and total effects show similar patterns.

- Regional housing market dynamics should be considered when housing policies are made and policies are implemented.