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ASYMMETRIC EFFECTS OF MONETARY POLICY  
IN REGIONAL HOUSING MARKETS

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Cities

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**ASYMMETRIC EFFECTS OF MONETARY POLICY  
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**ABSTRACT:** The responsiveness of house prices to monetary policy shocks depends on the nature of the shock – expansionary versus contractionary – and on local housing supply elasticities. These findings are established based on a panel of 263 US metropolitan areas. We test and find supporting evidence for the hypothesis that expansionary monetary policy shocks have a larger impact on house prices when supply elasticities are low. Our results also suggest that contractionary shocks are orthogonal to supply elasticities, as implied by downward rigidity of housing supply. A standard theoretical conjecture is that contractionary shocks have a greater impact on house prices than expansionary shocks, as long as supply is not perfectly inelastic. For areas with high housing supply elasticity, our results are in line with this conjecture. However, for areas with an inelastic housing supply, we find that expansionary shocks have a greater impact on house prices than contractionary shocks. We provide evidence that the direction of the asymmetry is related to a momentum effect that is more pronounced when house prices are increasing than when they are falling.

JEL Codes: E32, E43, E52, R21, R31

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# 1 Introduction

How do house prices respond to changes in the central bank policy rate? The answer is central to understanding the drivers of house price fluctuations. It is also important for the discussion of whether central banks should use the interest rate to enhance financial stability – particularly in order to quantify the potential trade-off between financial and real economic stability. Establishing the effect of monetary policy on house prices is far from trivial. First of all, the durability of housing entails that housing supply is rigid downwards (Glaeser and Gyourko, 2005), implying that an interest rate increase should, *ceteris paribus*, have a larger impact on house prices than a corresponding reduction in the interest rate. Secondly, it is well known that there are tremendous heterogeneities across regional housing markets (Ferreira and Gyourko, 2012), which means that changes in the policy rate could have differential effects across local areas within the same country. Somewhat surprisingly, the asymmetric effects of monetary policy across regional housing markets remain unexplored.

In this paper, we aim to fill this gap by exploring *(i)* Whether differences in city-specific housing supply elasticities matter for the responsiveness of house prices to exogenous monetary policy shocks and *(ii)* The extent of asymmetry in the response to expansionary and contractionary monetary policy shocks. We estimate impulse responses for house prices to monetary policy shocks using panel data and local projection methods (Jordà, 2005). Our sample covers 263 US Metropolitan Statistical Areas (MSAs) over the period 1983Q1-2007Q4.

Although house prices are not directly part of the central bank’s reaction function, they can affect the interest rate indirectly through their impact on consumption and employment (see e.g., Mian et al. (2013) and Mian and Sufi (2014)). To deal with potential reverse causality and to identify exogenous shifts in monetary policy, we make use of the narrative monetary policy shocks of Romer and Romer (2004).<sup>1</sup> To study regional varia-

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<sup>1</sup>We use an updated version of the Romer and Romer (2004) narrative shock series extending through 2007. To update the Romer and Romer shock, we use the code and data provided by Wieland and Yang (2016).

tions in the transmission of expansionary and contractionary monetary policy shocks to house prices, we interact the Romer and Romer shock with the housing supply elasticities calculated by Saiz (2010).

Our results are consistent with the view that expansionary monetary policy shocks have a considerably greater impact on house prices in markets with inelastic housing supply. For congested areas, such as Miami, Los Angeles and San Francisco, we estimate that house prices increase by almost seven percent two years after a monetary policy shock that lowers the interest rate by one percentage point. For areas with higher housing supply elasticity, such as Kansas City, Oklahoma City and Indianapolis, the same effect is estimated to be below three percent. In contrast, we find that the effect on house prices of a contractionary shock of similar magnitude is independent of housing supply elasticity. This is consistent with a downward rigidity of housing supply, which holds irrespective of local regulatory restrictions and topographical constraints. Finally, we find that whether expansionary or contractionary shocks have the strongest impact on house prices depends on local housing supply elasticities. For MSAs with low housing supply elasticities, expansionary monetary policy shocks are found to have a markedly larger effect on house prices than contractionary shocks. However, in areas with high housing supply elasticity, the effect of expansionary shocks is muted, leading to a stronger impact of contractionary shocks.

From the view of a standard supply-demand framework with durable housing contractionary shocks will always have a greater impact on house prices than expansionary shocks unless supply is perfectly inelastic. In light on this, our finding is “puzzling”. We present results suggesting that this “puzzle” can be explained by a momentum effect that is more pronounced when house prices are increasing.<sup>2</sup> Consequently, expansionary monetary policy shocks, which *ceteris paribus* lead to an increase in house prices, trigger a

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<sup>2</sup>Following the seminal paper by Case and Shiller (1989), momentum in house prices has been accepted as a key feature of the housing market, and Glaeser et al. (2014) listed predictability of house price changes by past house price changes as one of three stylized facts about the housing market. Consistent with this, we find strong evidence of a momentum effect in our sample. Moreover, we document that this momentum effect is particularly strong when house prices are increasing.

momentum effect that puts additional pressure on house prices. Since the initial response in house prices is greater when the elasticity of supply is low, this momentum effect will be more pronounced in congested areas. When house prices are falling, we find this momentum effect to be much weaker. As a result of this, the effect of expansionary shocks may be greater than, equal to, or smaller than the effect of contractionary shocks, depending on the elasticity of housing supply. For very inelastic areas, such as Miami, San Francisco and Los Angeles, we find that expansionary shocks have almost twice the effect on house prices relative to contractionary shocks. On the contrary, contractionary shocks are estimated to exercise a stronger impact on house prices in Kansas City, Oklahoma City and Indianapolis – areas with high housing supply elasticity. In the case of Indianapolis, the effect of contractionary shocks is three times as large as that of expansionary shocks.

There is a growing literature looking at the nexus between monetary policy and house prices (see e.g., Del Negro and Otrok (2007), Iacoviello (2005), Jarocinski and Smets (2008), Jordà et al. (2015) and Williams (2011, 2015)). These papers are, however, confined to studying aggregate effects on house prices, which masks the major heterogeneities existing across regional US housing markets.<sup>3</sup> For instance, while nominal house prices increased by more than 160 percent in some coastal areas of Florida and California from 2000 to 2006, they increased by less than 20 percent in inland open space areas of the Midwest. We add to this literature by documenting non-trivial heterogeneous responses to a common exogenous monetary policy shock across regional markets, as well as documenting an economically important and sizeable asymmetry in the response to expansionary and contractionary monetary policy shocks.

Another branch of the literature has attributed regional variations in the amplitude of boom-bust cycles in the housing market to heterogeneous supply side restrictions (see e.g., Green et al. (2005), Saiz (2010), Gyourko et al. (2008), Glaeser et al. (2008), Glaeser

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<sup>3</sup>One exception is Del Negro and Otrok (2007). They use a dynamic factor model on state level data to disentangle the relative importance of local and national shocks. They find that historically movements in house prices were mainly driven by local shocks. However, they highlight that the period 2001-2005 was different, as house prices during this period were mostly driven by national shocks. Although they also find the impact of common monetary policy shocks on house prices to be non-negligible, their estimates are fairly small in comparison with the magnitude of the house price increase over this five-year period.

(2009), Huang and Tang (2012) and Anundsen and Heebøll (2016)). This literature has shown that house price booms tend to be larger in markets with an inelastic housing supply. Our results add to this literature by documenting a substantial heterogeneity in the transmission of monetary policy shocks that depends on housing supply elasticities.

While our paper is the first to quantify the asymmetric effects of monetary policy on house prices, Tenreyro and Thwaites (2016), Barnichon and Matthes (2017) and Angrist et al. (2017) have documented an asymmetric effect of contractionary and expansionary monetary policy shocks on the real economy. In particular, these papers find that an interest rate reduction is less effective in stimulating the real economy than an increase in the interest rate is in curbing economic activity. Our results suggest that the opposite is true for house prices in many US metro areas.

These results have direct bearing on the discussion on the trade-offs faced by monetary policymakers when it comes to real economic stability and financial stability. Reducing the interest rate in order to stimulate the real economy may not be very effective, but at the same time it may contribute to amplifying the volatility of house prices – particularly so in supply inelastic areas. At the same time, an increase in the interest rate may have a large impact on the real economy without affecting house prices to the same extent as an expansionary monetary policy shock.

Our results are robust to various sensitivity checks. Controlling for differences in regional economic conditions, institutional and regulatory differences by adding Census Division-by-quarter fixed effects do not materially affect our results. Using a balanced panel of 147 MSAs, covering the full sample period in our estimation, does not alter our conclusions. Finally, our results are robust to calculating impulse responses for each MSA separately, allowing for complete heterogeneity in coefficients. In this case, the house prices responses to contractionary and expansionary shocks are grouped according to local housing supply elasticities using the mean group estimator of Pesaran and Smith (1995).

The rest of the paper is structured as follows. The next section motivates why hetero-

geneties and asymmetries may be of particular relevance in the housing markets. Section 3 presents the data we utilize and Section 4 documents our empirical findings on the heterogeneous and asymmetric effects of monetary policy. We outline possible mechanisms that could generate our findings in Section 5, whereas several robustness and sensitivity checks are carried out in Section 6. The final section concludes.

## 2 Monetary policy shocks in a model with durable housing

To motivate why heterogeneities and asymmetries in the response to monetary policy shocks may be of particular relevance in a housing market context, we consider a very simple motivating framework, where house prices in a given area are determined by the intersection of demand and supply.

We follow Glaeser et al. (2008) and distinguish between the existing stock of houses and the supply of houses in the market at a particular point in time. The number of houses available for sale in area  $i$  at time  $t$  is denoted  $S_{i,t}$ , which consists of a proportion,  $\psi$ , of the existing stock of houses,  $H_{i,t-1}$ , put up for sale by existing home owners<sup>4</sup> and new investments,  $I_{i,t}$ . Similar to Glaeser and Gyourko (2005), we assume that investments are zero whenever prices are below construction costs and that housing is a durable good. To capture these features, we postulate the following linear supply schedule:<sup>5</sup>

$$S_{i,t} = \begin{cases} \psi H_{i,t-1} & \text{if } PH_{i,t} \leq P_{i,t} \\ \psi H_{i,t-1} + \varphi_i (PH_{i,t} - P_{i,t}) & \text{if } PH_{i,t} > P_{i,t} \end{cases} \quad (1)$$

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<sup>4</sup>This can be motivated as in Glaeser et al. (2008), where each homeowner with a certain probability receives a Poisson-distributed shock. If they receive the shock, they have to sell. Otherwise, they stay in the house. With a continuum of homeowners, the number of sales will be deterministic and proportional to the existing stock of houses. The housing stock is in turn determined by a standard law-of-motion of capital accumulation, so that the stock at  $t$  is equal to the sum of the non-depreciated stock from  $t - 1$  and new investments.

<sup>5</sup>One could also motivate this by assuming that construction firms are idle when prices fall below construction costs, and that they otherwise maximize profits.



where  $PH_{i,t}$  measures house prices,  $P_{i,t}$  is the unit price of a composite input factor used to produce houses, while  $\varphi_i$  is an area-specific housing supply elasticity. With this setup, the supply curve is piecewise linear and kinked: only if the price exceeds the fixed cost of construction will supply increase. Hence, supply is assumed completely rigid downwards, motivated by the fact that housing is usually neither demolished nor dismantled (Glaeser and Gyourko (2005)).

We let housing demand be represented by a linear demand function:

$$D_{i,t} = v_0 r_t + v_1 Y_{i,t} + v_2 PH_{i,t} \quad (2)$$

where  $r_t$  is the interest rate, which is common across local markets, and  $Y_{i,t}$  is household income in area  $i$ .

To illustrate the conjectures of this skeleton model, assume that market  $i$  is characterized by house prices equal to construction costs at time 0 ( $PH_{i,0} = P_{i,0}$ ), which also implies that  $I_{i,0} = 0$  and hence that  $S_{i,0} = \psi H_{i,-1}$ . Then, market  $i$  is hit by an expansionary monetary policy shock at time 1. This will lead to a greater house price increase in supply inelastic markets. Figure 1 gives a visual illustration of this for the case of a market with high supply elasticity and a market with low supply elasticity. In this figure, the supply curve at time 0 is drawn with a kink at the equilibrium price, to reflect that houses are durable and that once they are built, they are usually not destroyed.

As seen, a positive demand shock ( $D_0$  to  $D_1$ ) primarily leads to quantity adjustments in supply elastic markets, while the shock is mostly absorbed in terms of higher prices in inelastic markets. To ensure market clearing, the part of the adjustment that is taken by higher prices is larger the lower the supply elasticity. At the same time, the supply curve will now kink at point B instead of point A. Thus, the dotted part of the old supply curve is no longer relevant, since newly built houses are not destroyed, and a negative shock would lead to an adjustment along the vertical part of the supply curve.

In Figure 2, we show the effect of a contractionary monetary policy shock. Since sup-

ply is rigid downwards, this means that the demand curve shifts along the vertical part of the supply curve, independent of supply elasticity. The conjecture is that the drop in house prices following a contractionary monetary policy shock is independent of supply elasticity. Furthermore, the drop in prices following the contractionary shock is predicted to always be greater (in absolute value) than the increase in house prices following a similar sized expansionary shock – as long as supply is not completely inelastic, in which the supply curve would always be vertical. This asymmetry arises due to the durability of housing, and a similar conjecture comes out of the model of urban decline in Glaeser and Gyourko (2005). We summarize these conjectures below.<sup>6</sup>

**Conjecture # 1:** Expansionary shocks have a larger impact on house prices in markets with an inelastic housing supply.

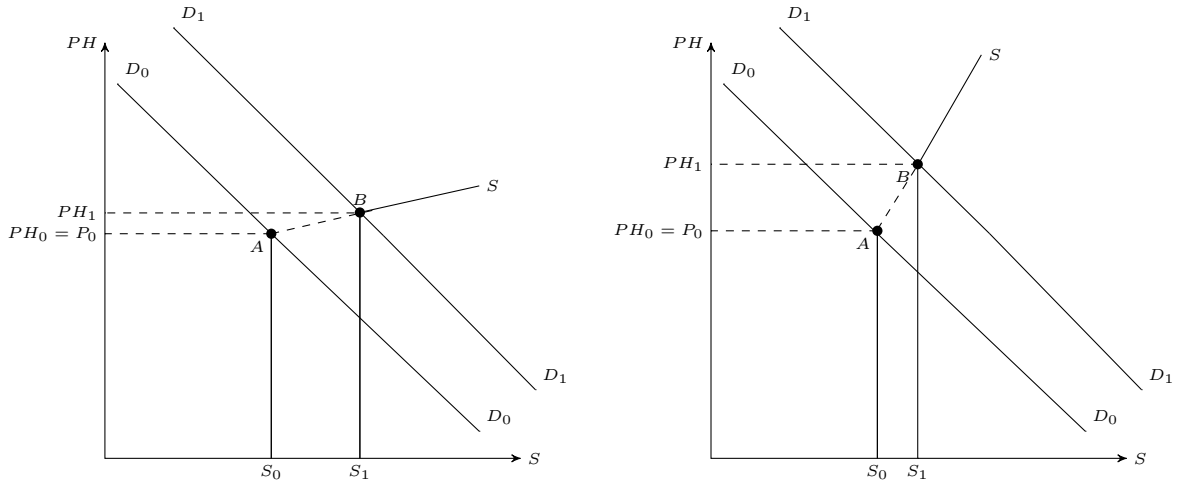
**Conjecture # 2:** The effect of contractionary monetary policy shocks is independent of supply elasticity.

**Conjecture # 3:** For any positive supply elasticity, contractionary shocks have a larger impact on house prices than expansionary shocks.

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<sup>6</sup>In Appendix A, we derive the analytical expressions giving rise to these conjectures.

Figure 1: Expansionary monetary policy shocks

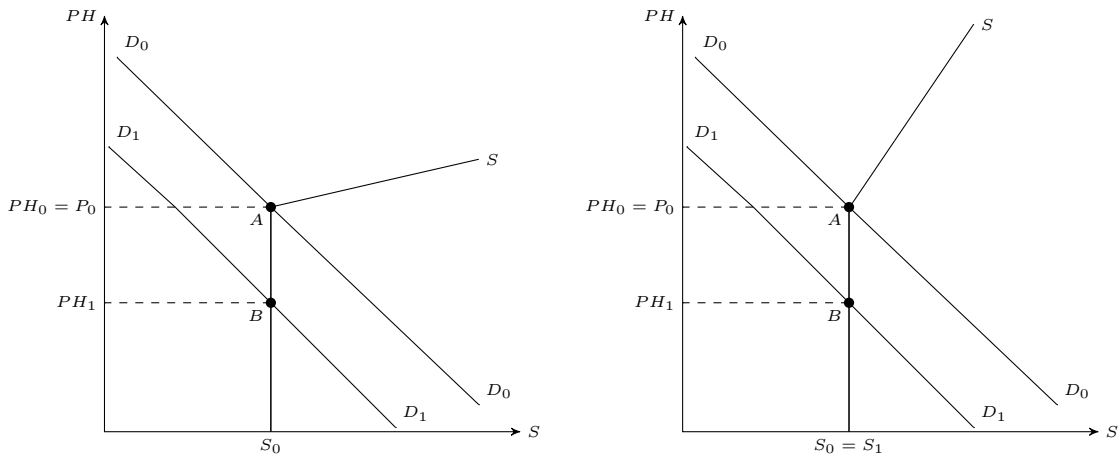


Market 1: High supply elasticity

Market 2: Low supply elasticity

**Note:**  $D_0$  is the original demand curve, while  $D_1$  is the demand curve after the interest rate reduction. The supply curve is given by  $S$ . The initial equilibrium is given by point  $A$ . The new equilibrium after the interest rate reduction is given at point  $B$ . The dotted part of the housing supply curve illustrates that housing supply is rigid downwards, so that the supply curve kinks at  $A$  before the shock and at  $B$  after the shock.

Figure 2: Contractionary monetary policy shocks



Market 1: High supply elasticity

Market 2: Low supply elasticity

**Note:**  $D_0$  is the original demand curve, while  $D_1$  is the demand curve after the interest rate increase. The supply curve is given by  $S$ . The initial equilibrium is given by point  $A$ . The new equilibrium after the interest rate increase is given at point  $B$ .

### 3 Data and descriptive statistics

Our data set includes 263 Metropolitan Statistical Areas (MSAs) in the United States, covering about 70 percent of the entire US population and all but two of the 50 US states (Hawaii and Alaska are not covered).<sup>7</sup> Following the Census Bureau, the US may be split into nine divisions: Pacific, Mountain, West South Central, West North Central, East North Central, East South Central, Middle Atlantic, New England and South Atlantic. Table 1 summarizes some information on the geographical dispersion of the MSAs covered by our sample across these divisions.

Table 1: Geographical distribution of MSAs in our sample

Census division	No. states	No. MSAs	Med. pop	Perc. pop.
Pacific	3	33	426	17
Mountain	8	21	289	7
West North Central	7	25	220	6
South West Central	4	33	390	12
East North Central	5	43	343	14
East South Central	4	18	402	5
New England	5	12	392	4
Middle Atlantic	3	25	427	14
South Atlantic	9	53	415	21
All	48	263	372	100

**Note:** The table summarizes the geographic distribution of the MSAs covered by our sample across US Census divisions. The table also shows median population in the MSAs in the different divisions, as well as the percentage of the total population covered by our sample of MSAs in each of the divisions. We use population data from 2007Q4.

The table shows that the MSAs are distributed across the entire country and that the median population size is broadly similar across census divisions. In addition to having a rich cross-sectional dimension, we also have a fairly long time series dimension for most of these areas. The sample runs through the period from 1983Q1 to 2007Q4

<sup>7</sup>Note that some of the MSAs belong to multiple states. The constraining factor in terms of MSA-coverage is the housing supply elasticities of Saiz (2010), which are available for 269 MSAs using the 1999 county-based MSA or NECMA definitions. The geographic data in Saiz (2010) are calculated using the principal city in the MSA, and we have matched those to the 2010 MSA definitions. For 6 MSAs, we were not able to match the Saiz data to the 2010 MSA definitions, as they are no longer the principal city in their new MSA.

( $T = 100$ ) for 147 of the areas, and 227 MSAs are covered by 1987Q1. We have full coverage for all MSAs from 1998Q1. For a majority of the MSAs, the sample covers both the recent housing cycle and the previous boom-bust cycle (Glaeser et al., 2008) in the period 1982–1996.

Several data sources have been used to compile our data set, and the rest of this section describes the different data we utilize in our empirical analysis.

### 3.1 Monetary policy shocks

To measure exogenous changes in monetary policy, we use the Romer and Romer (2004) narrative monetary policy shock series. Romer and Romer propose a novel procedure to identify monetary policy shocks. First, they use the narrative approach to extract measures of the change in the Fed’s target interest rate at each meeting of the Federal Open Market Committee (FOMC) between 1969 and 1996. They then regress this measure of policy changes on the Fed’s real-time forecasts of past, current, and future inflation, output growth, and unemployment. The residuals from this regression constitute their measure of monetary policy shocks.

The Romer and Romer series has been widely used to study the transmission of monetary policy shocks, see e.g. Coibion (2012), Ramey (2016), Tenreyro and Thwaites (2016), Coibion et al. (2017). We use an updated version of the Romer and Romer (2004) narrative shock series, using the codes and data provided by Wieland and Yang (2016). The updated shock series ends in 2007Q4. Thus, our analysis is confined to studying the transmission of conventional monetary policy shocks.<sup>8</sup> Moreover, Coibion (2012) showed that the effects of Romer and Romer identified monetary policy shocks on various variables are very sensitive to the inclusion of the period of non-borrowed

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<sup>8</sup>Due to the 5 year lag in the publication of the Greenbook forecasts, we could potentially have updated the Romer and Romer shock series until the end of 2011. However, there are two concerns with such an approach. First, when constructing the shocks, regressing the change in the Fed’s target interest rate on the Fed’s real-time forecasts of past, current, and future inflation, output growth, and unemployment would result in unreasonably large monetary policy shocks for the zero lower bound period. Second, such an approach would also imply that conventional and unconventional monetary policy shocks have similar effects on house prices.

reserves targeting, 1979–1982. We therefore follow Coibion (2012) and exclude the period of nonborrowed reserve targeting, starting our estimation in 1983Q1.<sup>9</sup>

### 3.2 Housing supply elasticities

To explore regional heterogeneities in the response to monetary policy shocks, we use the MSA-specific supply elasticities calculated by Saiz (2010). These elasticities are based on both topographical measures of undevelopable land, as outlined in Saiz (2010), as well as regulatory supply restrictions based on the Wharton Regulatory Land Use Index (WRLURI) developed by Gyourko et al. (2008). WRLURI measures MSA-level regulatory supply restrictions, including complications related to getting a building permit etc., whereas the topographical measure captures MSA-level geographical land availability constraints.

### 3.3 House prices and control variables

Our source for the house price data is the Federal Housing Finance Agency. We also control for local differences in households' disposable income per capita and migration. Both income and house prices are deflated by MSA-specific CPI indices. Data on local CPIs, income and migration were collected from Moody's Analytics' *Economy.com* webpage.

Several papers (e.g., Mian and Sufi (2009) and Favara and Imbs (2015)) have emphasized the role of lax lending standards as an explanation of regional differences in house prices. To control for this, we use the time-varying index of branching deregulation constructed by Rice and Strahan (2010). Favara and Imbs (2015) have used this index to show that an exogenous expansion in mortgage credit has significant effects on house prices. The index is constructed to capture regulatory changes governing geographic expansion for the US banking sector. Following the passage of the Interstate Banking and Branching Efficiency Act (IBBEA) in 1994, banks were allowed to operate across state

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<sup>9</sup>Note that, for consistency, the Romer and Romer shock is also estimated on a sample from 1983 to 2007.

borders without any formal authorization from state authorities. The Rice and Strahan (2010) index runs from 1994 to 2005 and takes values between 0 and 4. We follow Favara and Imbs (2015) and reverse the index, so that higher values refer to more deregulated states. As in Rice and Strahan (2010) and Favara and Imbs (2015), we assume that all states were fully restricted prior to 1994.

### **3.4 Descriptive statistics**

Table 2 summarizes average annual house price growth over the period 1983Q1 to 2007Q4 for the MSAs in our sample with a population exceeding one million. The table also shows the supply elasticity of Saiz (2010) for the same areas. It is clear that the areas with the highest annual house price growth have lower supply elasticity than the areas with low house price growth. The bottom part of the table shows summary statistics for both supply elasticity and average annual house price growth for all MSAs covered by our sample.

Table 2: House price growth and supply elasticities for MSAs with population above 1 million.

MSA	House price growth	Supply elasticity
<i>Top 5 MSAs with population &gt; 1,000,000:</i>		
San Francisco-Redwood City-South San Francisco, CA	8.21	0.66
San Jose-Sunnyvale-Santa Clara, CA	8.12	0.76
Los Angeles-Long Beach-Glendale, CA	7.75	0.63
New York-Jersey City-White Plains, NY-NJ	7.67	0.76
Oakland-Hayward-Berkeley, CA	7.51	0.70
<i>Bottom 5 MSAs with population &gt; 1,000,000:</i>		
Oklahoma City, OK	1.98	3.29
Houston-The Woodlands-Sugar Land, TX	2.26	2.30
Fort Worth-Arlington, TX	2.28	2.80
Dallas-Plano-Irving, TX	2.35	2.18
San Antonio-New Braunfels, TX	2.64	2.98
<i>Summary stats all MSAs:</i>		
10 <sup>th</sup> percentile	3.09	0.86
25 <sup>th</sup> percentile	3.91	1.21
Median	5.01	1.79
75 <sup>th</sup> percentile	6.24	2.59
90 <sup>th</sup> percentile	7.34	3.57
Mean	5.03	2.04
Standard deviation	1.53	1.04

**Note:** The table shows summary statistics for the supply elasticity of Saiz (2010) and for average annual growth in nominal house prices over the period 1983Q1-2007Q4. The upper part of the table shows average annual growth in house prices and supply elasticities for MSAs with a population exceeding 1 million. The first five are the MSAs with the highest average growth in house prices over this period. The next five are the MSAs with the lowest growth in house prices over the same period. The lower part of the table shows the distribution of average annual growth in nominal house prices and supply elasticity over the same period for all MSAs for which data are available for the full sample period.



## 4 Asymmetric effects of monetary policy shocks

The supply-demand framework with durable housing that we outlined in Section 2 suggests that expansionary monetary policy shocks should have a greater impact on house prices in areas with an inelastic housing supply, whereas the response to contractionary shocks should be similar across areas, due to the downward rigidity of housing supply. The model also suggests that contractionary shocks will have a greater impact on house prices than expansionary shocks.

To investigate the empirical relevance of these conjectures, we consider a reduced form version of the supply-demand model. In the reduced form, supply elasticity is interacted with all the variables appearing in the supply-demand model.

Our *modus operandi* is the local projection framework of Jordà (2005). We use this framework to estimate the cumulative percentage response to house prices  $h$  quarters after a monetary policy shock, for  $h = 0, 4, 8$  and 12. The advantage of using the local projection approach is that it allows us to study non-linear effects of monetary policy, which would be vastly complicated – and maybe even infeasible – in a standard VAR framework. In addition, our parameters of interest – the impulse-response functions of house prices following a monetary policy shock – are confined to one equation in the underlying VAR system, i.e., the house price equation.

### 4.1 Baseline specification

Our baseline empirical specification takes the following form:

$$\begin{aligned} ph_{i,t+h} - ph_{i,t-1} = & \alpha_i + \beta_h^{Exp.} RR_t^{Exp.} + \beta_h^{Exp.,El.} Elasticity_i \times RR_t^{Exp.} \\ & + \beta_h^{Contr.} RR_t^{Contr.} + \beta_h^{Contr.,El.} Elasticity_i \times RR_t^{Contr.} + \mathbf{\Gamma}' \mathbf{W}_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (3)$$

where  $ph_{i,t+h} - ph_{i,t-1}$  is the cumulative change in log house prices after  $h$  quarters,  $RR_t$

is the Romer and Romer (2004) shock,  $Elasticity_i$  is the time-invariant supply elasticities calculated by Saiz (2010), with a higher value indicating a more elastic housing supply.

We let  $RR_t^{Exp.}$  denote a variable measuring expansionary shocks, and it is calculated as  $RR_t^{Exp.} = RR_t \times I(RR_t \geq 0)$ , where  $I(RR_t \geq 0)$  is an indicator variable taking the value one for expansionary monetary policy shocks and a value of zero otherwise. Contractionary shocks are measured by  $RR_t^{Contr.} = RR_t \times (1 - I(RR_t \geq 0))$ .

With this notation,  $-\beta_h^{Exp.}$  is the cumulative effect on house prices after  $h$  quarters following an expansionary monetary policy shock, whereas  $\beta_h^{Contr.}$  measures the effect of a contractionary monetary policy shock after  $h$  quarters.

The vector  $\mathbf{W}_{i,t}$  contains a set of control variables, including lagged changes in log house prices, lagged values of the log change in disposable income per capita, lagged changes in net migration rates and the branching deregulation index used in Favara and Imbs (2015). For the lagged variables, we include four lags.

Regression results are displayed in Table 3. Consistent with *Conjecture I*, we find that expansionary monetary policy shocks lead to higher house prices, but that the effect is lower for areas with high housing supply elasticity. Supporting *Conjecture II*, we find that the effect of contractionary shocks have a negative impact on house prices, and that this effect is independent of housing supply elasticity.

Regarding *Conjecture III*, it is clear that the answer depends on housing supply elasticity. Figure 3 shows the responses in house prices to an expansionary monetary policy shock (upper panel) and to a contractionary monetary policy shock (lower panel) of one percentage point for the MSAs covered by our sample after two years ( $h = 8$ ).<sup>10</sup> The maps are constructed so that the color spectrum in the two panels have the same range in absolute value, with a darker color indicating a greater response in house prices.

We see that expansionary shocks have a greater effect than contractionary shocks in most areas. In particular, for very congested areas, such as San Francisco (CA) and Miami

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<sup>10</sup>For the contractionary shocks, the response in house prices for area  $i$  is calculated as  $\beta_h^{Contr.} + \beta_h^{Contr.,El.} Elasticity_i$ , whereas the response to house prices in area  $i$  following an expansionary shock is given by  $-(\beta_h^{Exp.} + \beta_h^{Exp.,El.} Elasticity_i)$ .

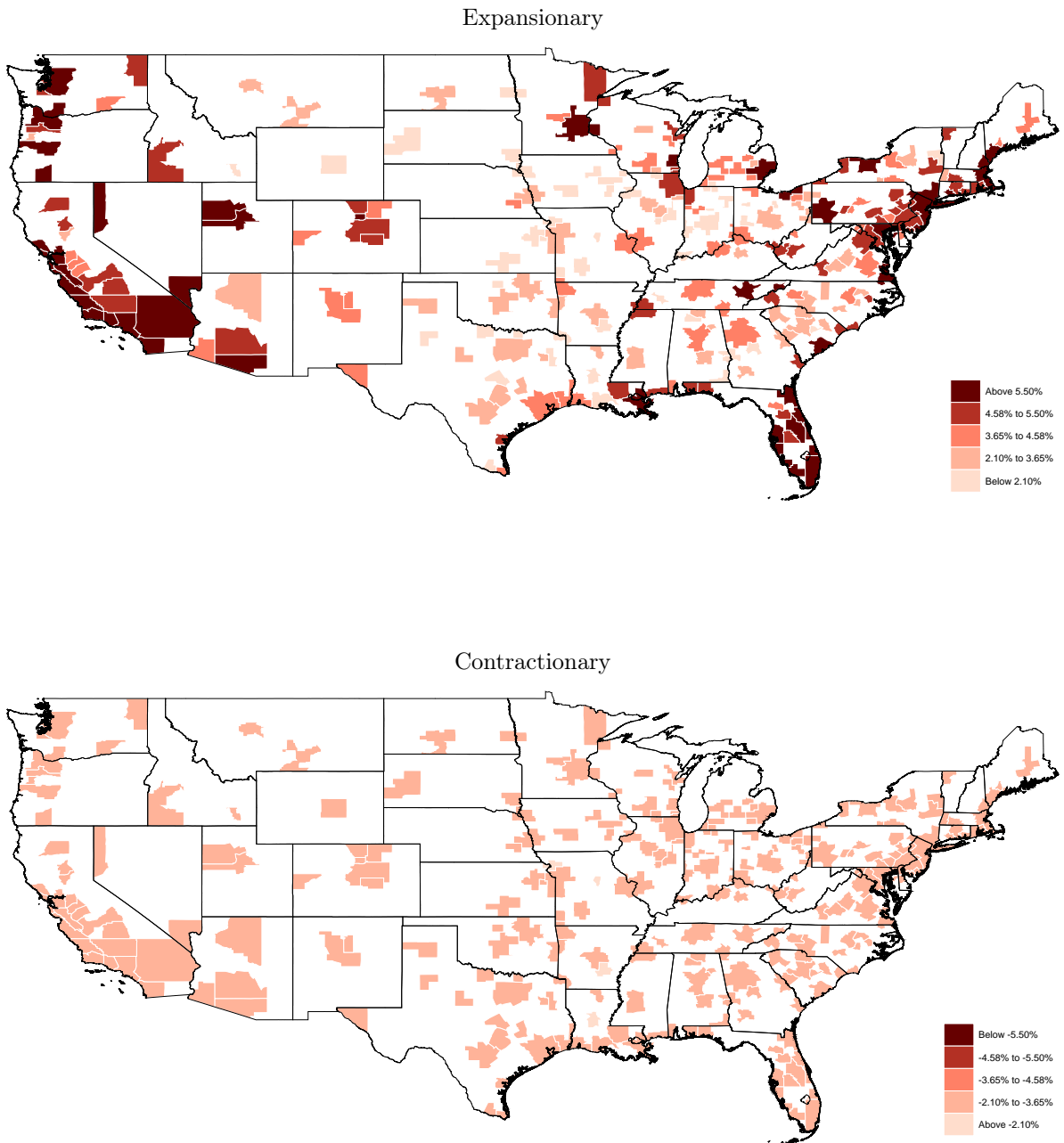
(FL), expansionary shocks have more than twice the impact on house prices relative to contractionary shocks, which is at odds with the simple demand-supply story. That said, it is also evident that there are several areas in which the effect of a contractionary shock exceeds that of an expansionary shock. Considering construction elastic areas, such as Dayton (OH) and Kansas City (MO), the effect of expansionary shocks is smaller than contractionary shocks. Table B.1 in Appendix B shows the effect of both contractionary and expansionary shocks after two years for MSAs with a population above one million. The areas are ranked according to their supply elasticity. The results in that table reveal that the effect of expansionary shocks is greater than the effect of contractionary shocks for most of the large MSAs included in our sample.

Table 3: Asymmetric and heterogeneous effects of monetary policy shocks on house prices.

Indep. Var.	<i>Dependent variable is <math>ph_{i,t+h} - ph_{i,t-1}</math></i>			
	h=0	h=4	h=8	h=12
Contr. MP shock	-0.08 (0.29)	-0.80 (0.67)	-3.53*** (1.16)	-6.29*** (1.77)
Contr. MP shock × Elasticity	0.12 (0.13)	-0.06 (0.23)	0.20 (0.38)	0.42 (0.54)
Exp. MP shock	-0.18 (0.22)	2.85*** (0.67)	7.81*** (1.01)	8.13*** (1.33)
Exp. MP shock × Elasticity	0.11 (0.08)	-0.59*** (0.23)	-1.59*** (0.33)	-2.07*** (0.46)
Observations	23,212	22,160	21,108	20,056
MSAs	263	263	263	263
R <sup>2</sup>	0.214	0.341	0.334	0.319
MSA FE	YES	YES	YES	YES
Controls	YES	YES	YES	YES

**Note:** The table shows the effect on house prices of contractionary and expansionary monetary policy shocks when accounting for different supply elasticities. The dependent variable is the cumulative log changes in the FHFA house price index at horizon  $h = 0, 4, 8$  and  $12$ . Results are based on estimating equation (3) using a fixed effect estimator, and the data set covers a panel of 263 US MSAs countries over the period 1983q1–2007q4. The specification allows the response in house prices to differ depending on the elasticity of supply, as calculated in Saiz (2010), and whether the monetary policy shock is expansionary or contractionary. Standard errors robust to heteroskedasticity and autocorrelation are reported in absolute value in parenthesis below the point estimates. The asterisks denote significance levels: \* = 10%, \*\* = 5% and \*\*\* = 1%.

Figure 3: Regional variation in the response to monetary policy shocks



**Note:** The effect of an expansionary and a contractionary monetary policy shock for MSAs with different housing supply elasticity after eight quarters.

## 4.2 Controlling for Census Division-by-quarter fixed effects

In our baseline specification, we control for state-specific changes in branching deregulation using the time-varying index of branching deregulation constructed by Rice and Strahan (2010). To control for other common regional shocks affecting geographically close MSAs, we add Census Division-by-quarter fixed effects to our baseline specification. These are dummies for all nine Census Divisions for all quarters spanned by our sample, and the modified specification takes the following form:

$$\begin{aligned}
 ph_{i,t+h} - ph_{i,t-1} = & \alpha_i + \eta_{k,t} + \beta_h^{Exp.,El.} Elasticity_i \times RR_t^{Exp.} + \beta_h^{Cont.,El.} Elasticity_i \times RR_t^{Contr} \\
 & + \mathbf{\Gamma} \mathbf{W}_t + \varepsilon_{i,t}
 \end{aligned} \tag{4}$$

where  $\eta_{k,t}$  is the Census Division-by-quarter fixed effects. Note that we cannot include the non-interacted variables for expansionary and contractionary monetary policy shocks in this case. This is because a linear combination of these two variables would be perfectly collinear with the linear combination of the Census Division-by-quarter fixed effects. This specification therefore does not allow us to draw any conclusion regarding the absolute response to expansionary and contractionary shocks. That said, we can still test the two conjectures that expansionary shocks have a more muted response in supply elastic areas and that the effect of contractionary shocks is independent of supply elasticity.

Results are reported in Table 4. Our results are robust to controlling for Census Division-by-quarter fixed effects. In particular, the interaction term between expansionary shocks and elasticity is highly significant at all horizons, except contemporaneously. This suggests that expansionary shocks have a greater impact on house prices the lower is the elasticity of supply. On the contrary, the interaction between contractionary shocks and elasticity is insignificant at all horizons. This adds support to our finding that the effect of contractionary shocks is independent of housing supply elasticity.

Table 4: Asymmetric and heterogeneous effects of monetary policy shocks on house prices when controlling for Census Division-by-quarter fixed effects.

Horizon	Expansionary shock	Contractionary shock	No. Obs.
0	0.06 (0.1)	-0.04 (0.12)	23,212
4	-0.55*** (0.21)	-0.39 (0.25)	22,160
8	-0.97*** (0.34)	-0.24 (0.36)	21,108
12	-1.12** (0.48)	0.23 (0.45)	20,056

**Note:** The table shows the effect on house prices of contractionary and expansionary monetary policy shocks when accounting for different supply elasticities and controlling for Census Division-by-quarter fixed effects. The dependent variable is the cumulative log changes in the FHFA house price index at horizon  $h = 0, 4, 8$  and  $12$ . Results are based on estimating equation (3) using a fixed effect estimator, and the data set covers a panel of 263 US MSAs over the period 1983Q1–2007Q4. The specification allows the response in house prices to differ depending on the elasticity of supply, as calculated in Saiz (2010), and whether the monetary policy shock is expansionary or contractionary. We also control for Census Division-by-quarter fixed effects. Standard errors robust to heteroskedasticity and autocorrelation are reported in absolute value in parenthesis below the point estimates. The asterisks denote significance levels: \* = 10%, \*\* = 5% and \*\*\* = 1%.

## 5 Momentum effects and asymmetric effects of monetary policy

Following the seminal article by Case and Shiller (1989), numerous studies have documented that aggregate house price changes are autocorrelated (see e.g., Cutler et al. (1991), Røed Larsen and Weum (2008), Head et al. (2014)). The momentum in house prices has been accepted as a key feature of the housing market, and Glaeser et al. (2014) listed predictability of house price changes by past house price changes as one of three stylized facts about the housing market.

Several reasons have been put forward to explain why this momentum effect occurs in the housing market, including variations in time-on-market due to search frictions (Head et al. (2014)), information frictions (Anenberg (2016)), extrapolative expectation formation (Case and Shiller (1987); Glaeser et al. (2008); Gelain and Lansing (2014); Glaeser and Nathanson (2017), Armona et al. (2016)), heterogeneous beliefs and the existence of

momentum traders (Piazzesi and Schneider (2009); Burnside et al. (2016)), as well as strategic complementarities (Guren (2017)).

We are agnostic about the exact source of the momentum effect, but the presence of momentum effects may be important to understand why expansionary monetary policy shocks can lead to a larger response in house prices than contractionary monetary policy shocks. A momentum effect that is symmetric over the housing cycle would contribute to further strengthening the conjecture that contractionary shocks hit harder than expansionary shocks. Any asymmetry in the momentum effect could, however, lead to different conclusions. In particular, a momentum effect that is more dominant in a booming market than in a falling market could lead to the opposite conjecture, namely that expansionary shocks have a greater impact on house prices than the contractionary shocks – which is consistent with the findings in this paper. If the momentum effect is more pronounced when house prices are increasing, positive demand shocks are amplified relatively more than negative demand shocks. Thus, even though the initial response to a negative demand shock is greater, the total effect of a positive demand shock may be greater.

To investigate whether there is evidence that the momentum effect is asymmetric, we estimate an AR(4)-model for house price growth, allowing the coefficients on lagged house price appreciation to have additional effect whenever house prices are increasing. Table 5 reports the sum of the AR-coefficients both for the case where we do not distinguish between periods of increasing and decreasing house prices, and for the case where we allow the momentum to differ depending on whether house prices are increasing or decreasing. These results support the notion of a momentum effect that is far more pronounced when house prices are increasing.



Table 5: Asymmetric momentum effects.

Momentum	0.57 (0.02)	0.31 (0.04)
Additional momentum when $\Delta ph_{i,t} > 0$		0.41 (0.05)
MSAs	263	263
Observations	23,212	23,212
Adj. $R^2$	0.18	0.20

**Note:** The table reports the sum of coefficients on lagged house price appreciation based on estimating an AR(4)-model for house price growth. The first column shows the case of symmetric coefficients, whereas the second column shows coefficients when we allow for an additional momentum effect when house prices are increasing.

## 5.1 Monetary policy shocks in a model with durable housing and asymmetry in the extrapolative expectation formation

While we are agnostic about the exact mechanism leading to a momentum effect, we shall concentrate on the case of extrapolative expectation formation. In particular, we shall investigate how an expectation rule that differs depending on whether house prices are increasing or falling affects the conjectures of the simple supply-demand model.

Assume that expectations affect demand, so that a modified version of the original demand curve takes the following form:

$$D_{i,t} = v_0 r_t + v_1 Y_{i,t} + v_2 PH_{i,t} + \eta E_t (PH_{i,t+1}) \quad (5)$$

Assume also that expectations about future house prices are determined in the following way:

$$E_t (PH_{i,t+1}) \leq \begin{cases} \kappa_1 PH_{i,t} & , \text{ when } PH_{i,t} > PH_{i,t-1}, \kappa_1 > 1 \\ \kappa_2 PH_{i,t} & , \text{ when } PH_{i,t} \leq PH_{i,t-1}, \kappa_2 < \kappa_1 \end{cases} \quad (6)$$

Without loss of generality, we shall assume that  $\kappa_2 = 0$ , which can be interpreted as expectations playing no role when house prices are falling. However, in a booming market,

people expect house prices to continue to increase in the future, which is captured by  $\kappa_1 > 1$ .

By inserting the expectation process in equation (6) into equation (5), we obtain a modified demand curve:

$$D_{i,t} = \begin{cases} v_0 r_t + v_1 Y_{i,t} + (v_2 + \eta \kappa_1) PH_{i,t} & , \text{ when } PH_{i,t} > PH_{i,t-1} \\ v_0 r_t + v_1 Y_{i,t} + v_2 PH_{i,t} & , \text{ when } PH_{i,t} \leq PH_{i,t-1} \end{cases} \quad (7)$$

Extending the supply-demand model to allow for asymmetric extrapolative expectations formation leads to some interesting mechanisms that are displayed in Figure 4 and Figure 5. We assume that we start out at point A, which also means that the demand curve will have a kink at this point.

In Figure 4, we illustrate the case of an expansionary monetary policy shock, shifting the demand curve out. The interest rate reduction leads to higher house prices and the new equilibrium is at point C. In the model without asymmetric extrapolative expectation formation, the new equilibrium would be at point B. In both models an expansionary monetary policy shock will have a greater impact in supply inelastic markets. However, in the model with asymmetric and extrapolative expectations formation, there will be an amplifying effect of the shock due to the price-to-price feedback loop (the movement from B to C). This effect is greater the lower is the elasticity of supply. Turning to Figure 5, we illustrate the effect of a contractionary monetary policy shock, leading to a downward shift in the housing demand curve. The effect of the interest rate increase is the same, irrespective of whether we allow for extrapolative expectation formation or not. Thus, the conjecture is still that the price drop is independent of supply elasticity.

Furthermore, for the elastic market, the effect of the contractionary shock is still greater than the effect of the expansionary shock. However, for the inelastic market, the interest rate reduction has a greater impact on house prices than the interest rate increase. Thus, this simple model extension suggests that depending on supply elasticity, an expansionary monetary policy shock may have a larger or smaller impact on house

prices than a contractionary monetary policy shock. We summarize the main conjectures from this model below.<sup>11</sup>

**Conjecture # 1:** Expansionary shocks have a larger impact on house prices in markets with an inelastic housing supply. The higher the parameter of extrapolation ( $\eta\kappa_1$ ), the greater is the response to an expansionary shock. The additional acceleration due to extrapolation is greater the lower is the elasticity of supply.

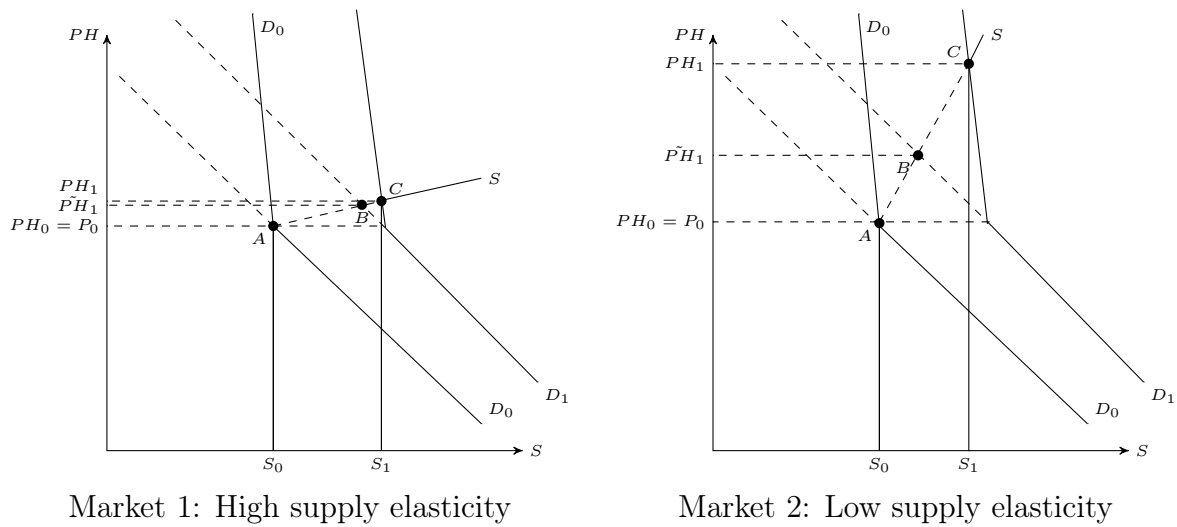
**Conjecture # 2:** The effect of contractionary monetary policy shocks is independent of supply elasticity.

**Conjecture # 3:** An expansionary shock will have a greater effect than the contractionary shock *if and only if*  $\varphi_i < \eta\kappa_1$ . Thus, there are positive elasticities for which expansionary shocks have a greater impact on house prices than contractionary shocks. Furthermore, the range of elasticities for which this holds increases in  $\eta\kappa_1$ .

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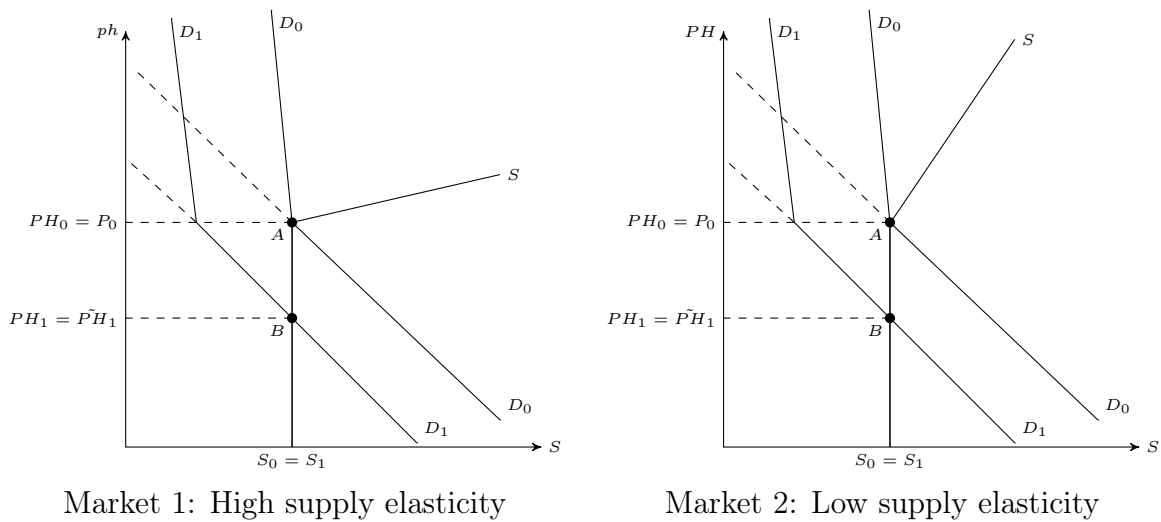
<sup>11</sup>In Appendix A, we derive the analytical expressions giving rise to these conjectures.

Figure 4: Expansionary monetary policy shocks with momentum effects



**Note:**  $D_0$  is the original demand curve, while  $D_1$  is the demand curve after the interest rate reduction. The supply curve is given by  $S$ . The initial equilibrium is given by point A. The new equilibrium after the interest rate reduction is given at point C. The dotted part of the housing supply curve illustrates that housing supply is rigid downwards. The dotted part of the demand curves illustrates how the demand curve would look in the case where there is no momentum effect. Point B shows the equilibrium that would prevail in the absence of a price-to-price feedback loop.

Figure 5: Contractionary monetary policy shocks with momentum effects



**Note:**  $D_0$  is the original demand curve, while  $D_1$  is the demand curve after the interest rate increase. The supply curve is given by  $S$ . The initial equilibrium is given by point A. The new equilibrium after the interest rate increase is given at point B. The dotted part of the demand curves illustrates how the demand curve would look in the case where there is no momentum effect.

## 5.2 Empirical evidence of asymmetry in extrapolative expectation formation

We use data from Case et al. (2012), which measures house price expectations based on a series of surveys of homebuyers in four metropolitan areas over the period 2003–2012. Consistent with their finding, we see that the data provide strong evidence that house price expectations for the coming year are explained by current house price appreciation. In fact, a regression of house price expectations on current house prices yields an  $R^2$  close to 0.8.

Figure 6 shows a scatter plot of the Case et al. (2012) data, where we distinguish between periods of increasing (Panel 1) and falling (Panel 2) house prices. The figure shows a remarkable asymmetry in expectation formation. In periods of positive house price appreciation, there is strong evidence that homebuyers expect prices to continue to increase in the future. However, when house prices are falling, the effect of an expectation that house prices will continue to fall is far less pronounced. The survey data therefore suggest that current house prices are much better at predicting house price expectations in periods of increasing house prices than in periods of falling house prices, with a  $R^2$  that is almost twice as large.

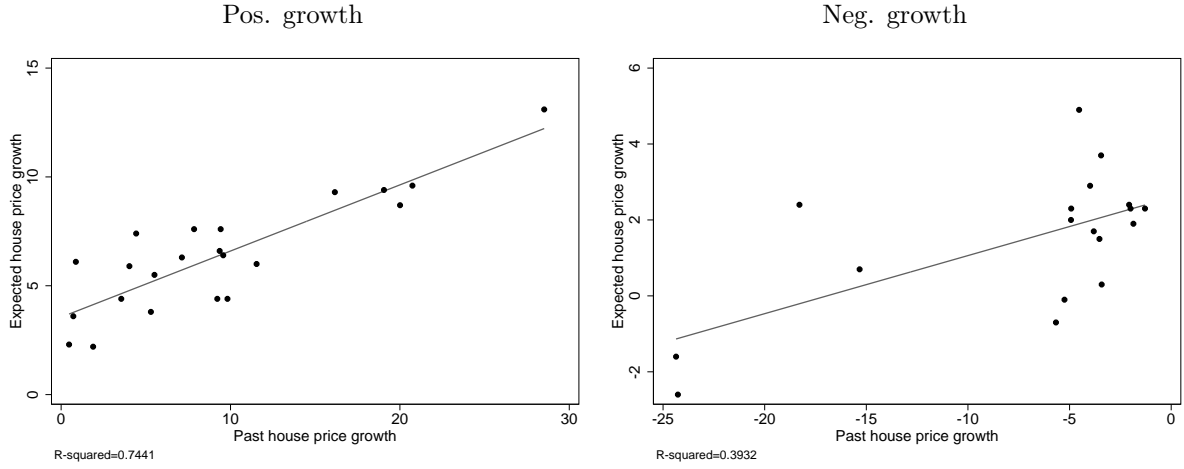
To formally address the asymmetries in expectation formation, we estimate the following model by OLS:

$$E_{i,t}(\Delta ph_{i,t+1}) = \alpha_i + \beta^+ I(\Delta ph_{i,t} \geq 0) \Delta ph_{i,t} + \beta^- I(\Delta ph_{i,t} < 0) \Delta ph_{i,t} + u_{i,t} \quad (8)$$

with  $E_{i,t}(\Delta ph_{i,t})$  denoting the expected increase in house prices at time  $t$  over the next 12 months and  $\Delta ph_{i,t}$  measuring the annual price increase at time  $t$ .

The results reported in Table 6 provide strong evidence of asymmetry in expectation formation, which is consistent with our finding of a momentum effect that is more important when house prices are increasing. In particular, the extrapolation of current house

Figure 6: Survey evidence on asymmetric expectations.



**Note:** The two figures show scatter plots of house price expectations and positive and negative house price growth, respectively. Data are taken from Case et al. (2012) and measure house price expectations based on a series of surveys of homebuyers in four metropolitan areas over the period 2003–2012

Table 6: Asymmetric expectation formation.

Indep. Var.	<i>Dep. Var.: <math>E_{i,t}(\Delta ph_{i,t+1})</math></i>	
	(I)	(II)
Current house price growth	0.27*** (0.02)	0.18*** (0.04)
Current house price growth when $\Delta ph_{i,t} > 0$		0.16** (0.07)
Observations	40	40
R <sup>2</sup>	0.84	0.86

**Note:** The table shows results from estimating equation (8). That is, regressing expected house prices on current house prices and allowing for an additional effect when house prices increase. We report the sum of the coefficients,  $\sum_{j=0}^4 \beta_j^+$  and  $\sum_{j=0}^4 \beta_j^-$ , respectively. Standard errors are clustered by MSA and reported in absolute value in parenthesis below the point estimates. The asterisks denote significance levels: \* = 10%, \*\* = 5% and \*\*\* = 1%.

price growth is more pronounced in periods of increasing house prices. The presence of such asymmetries can explain why expansionary shocks are found to have a greater impact on house prices than contractionary shocks in most MSAs.

## 6 Robustness and sensitivity checks

### 6.1 MSA-by-MSA analysis

In our baseline model, we account for heterogeneity through the intercept term (MSA-specific fixed effects). While the panel approach has some advantages, a drawback is that only the intercept is allowed to vary along the cross-sectional dimension. As has been highlighted by e.g., Pesaran and Smith (1995); Im et al. (2003); Pesaran et al. (1999); Phillips and Moon (2000), the pooling assumption of equal slope coefficients may often be disputed as well. To investigate whether our results are sensitive to this assumption, we have estimated separate models for each MSA. For MSA  $i$ , we estimate the following specification:

$$ph_{i,t+h} - ph_{i,t-1} = \alpha_i + \beta_{i,h}^{Exp.} RR_t^{Exp.} + \beta_{i,h}^{Cont.} RR_t^{Cont.} + \mathbf{\Gamma}_i \mathbf{W}_{i,t} + \varepsilon_{i,t} \quad (9)$$

With  $N$  MSAs and  $H$  horizons, this gives us two  $N \times H$  matrices of the response to contractionary and expansionary shocks. We then group the MSAs into five equally sized groups, depending on their supply elasticity. For each group, we calculate the mean group estimator of Pesaran and Smith (1995). Thus, the mean group estimators for quintile  $q$  at horizon  $h$  are given by:

$$\beta_{q,h}^{Exp.} = \frac{1}{N_q} \sum_{j \in q} \beta_{j,h}^{Exp.}$$

$$\beta_{q,h}^{Cont.} = \frac{1}{N_q} \sum_{j \in q} \beta_{j,h}^{Cont.}$$

None of our conclusions is materially affected by this alternative econometric approach, and results are summarized in Table B.2 in Appendix B.

## 6.2 Balanced panel

In our baseline results, reported in 4, we use an unbalanced panel. For 147 of the areas, we have data for the full period, whereas the starting point for the rest of the MSAs varies. To explore sensitivity to this, we repeated our analysis on a balanced panel for the full data sample (1983Q1-2007Q4), covering 147 MSAs. Our results are not affected by this, see Table B.3 in Appendix B.

## 6.3 Asymmetric momentum and supply elasticities

We have also explored whether the momentum effect depends on supply elasticity. To this end, we estimate MSA-specific models allowing for a different effect of lagged house prices in a booming market. We then collected the sum of coefficients for the common momentum term and the sum of coefficients for the additional momentum term in a booming market for each MSA. We then regressed these variables on supply elasticity. Results from this exercise are summarized in Table B.4 in Appendix B.

The intercepts are highly significant in both specifications, suggesting that the result of an additional momentum effect in a booming market is maintained in the cross section. Second, the additional momentum effect is, if anything, somewhat stronger in markets with low supply elasticity. Thus, allowing for MSA-specific momentum effect would further strengthen our argument that asymmetries in the momentum effect could cause expansionary shocks to have a greater impact on house prices than contractionary shocks.

## 7 Conclusion

We have analyzed the effects of contractionary and expansionary monetary policy shocks in regional housing markets. Consistent with theory, we find that expansionary shocks have a substantially greater impact on house prices in markets with an inelastic housing supply. We also find that, due to the durability of housing, the effect of a contractionary shock is independent of the elasticity of housing supply. Finally, our results indicate that



for most elasticities, the effect of an expansionary shock is greater (in absolute value) than the effect of a contractionary shock. Our results suggest that this is related to a momentum effect that is more important when house prices are increasing than when they are falling, and that this may be attributed to an asymmetric and extrapolative expectation formation.

These results have direct bearing on the discussion on the trade-offs faced by monetary policymakers when it comes to real economic stability and financial stability. As documented in Tenreyro and Thwaites (2016), Barnichon and Matthes (2017) and Angrist et al. (2017), a reduction in the interest rate is less effective in stimulating the real economy than an interest rate increase is in dampening economic activity. In contrast, our results suggest that an interest rate reduction contribute to amplifying the volatility of house prices – particularly so in supply inelastic areas. At the same time, an increase in the interest rate does not affect house prices to the same extent as an expansionary monetary policy shock.

Finally, as pointed out by Nakamura and Steinsson (2018), estimates based on cross-sectional identification are powerful in order to discriminate between alternative theoretical views. Our findings call for theoretical models that incorporate an asymmetric transmission of housing demand shocks and that account for state-dependent momentum effects in the housing market.

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# A Analytical expressions for conjectures from baseline and extended supply-demand models

## Baseline model

### Boom

In a booming market, the equilibrium house price and housing quantity are given by equating supply and demand in the regime where investments respond to the deviation between house prices and construction costs:

$$PH_{i,t} = \frac{1}{\varphi_i - v_2} (v_0 r_t + v_1 Y_{i,t} - \psi H_{i,t-1} + \varphi_i P_{i,t})$$
$$S = \frac{\varphi_i}{\varphi_i - v_2} (v_0 r_t + v_1 Y_{i,t} + v_2 P_{i,t}) - \frac{v_2 \psi}{\varphi_i - v_2} H_{i,t-1}$$

It follows from this that the response in house prices and quantity to an interest rate reduction are given by:

$$-\frac{\partial PH_{i,t}}{\partial r_t} = -\frac{v_0}{\varphi_i - v_2} > 0$$
$$-\frac{\partial S_{i,t}}{\partial r_t} = -\frac{\varphi v_0}{\varphi_i - v_2} > 0$$

Thus, a lower interest rate contributes to higher house prices and a larger supply. Furthermore, the higher is elasticity of supply, the larger is the quantity reaction and the lower is the house price reaction.

## Bust

In a falling market, the equilibrium house price and housing quantity are given by equating supply and demand in the regime where investments are zero:

$$PH_{i,t} = -\frac{1}{v_2} (v_0 r_t + v_1 Y_{i,t} - \psi H_{i,t-1})$$
$$S = \psi H_{i,t-1}$$

The response in house prices and quantity to an interest rate increase is therefore given by:

$$\frac{\partial PH_{i,t}}{\partial r_t} = -\frac{v_0}{v_2} < 0$$
$$\frac{\partial S_{i,t}}{\partial r_t} = 0$$

Thus, a higher interest rate leads to lower house prices, but no change in quantity. Furthermore, the price response in the bust is independent of supply elasticity, since supply is perfectly downwardly rigid in all markets during a bust.

Finally, the boom response in house prices (in absolute value) is greater than the bust response *if and only if*:

$$\frac{v_0}{\varphi_i - v_2} < -\frac{v_0}{v_2}$$
$$\frac{1}{\varphi_i - v_2} > -\frac{1}{v_2}$$
$$-v_2 > \varphi_i - v_2$$
$$\varphi_i < 0$$



which is logically impossible for any positive supply elasticity. Thus, a simple demand-supply framework suggests that the price response following a contractionary monetary policy shock will be greater than the price response to an expansionary monetary policy shock for any positive supply elasticity.

## Model with asymmetry in expectation formation

### Boom

In a booming market, the reduced form house price and housing quantity equations in the period of a shock is given by:

$$PH_{i,t} = \frac{1}{\varphi_i - v_2 - \eta\kappa_1} (v_0 r_t + v_1 Y_{i,t} - \psi H_{i,t-1} + \varphi_i P_{i,t})$$

$$S = \frac{\varphi_i}{\varphi_i - v_2 - \eta\kappa_1} (v_0 r_t + v_1 Y_{i,t} + (v_2 + \eta\kappa_1) P_{i,t}) - \frac{(v_2 + \eta\kappa_1)\psi}{\varphi_i - v_2} H_{i,t-1}$$

It follows from this that the response in house prices and quantity following an interest rate reduction are given by:

$$-\frac{\partial PH_{i,t}}{\partial r_t} = -\frac{v_0}{\varphi_i - v_2 - \eta\kappa_1} > 0$$

$$-\frac{\partial S_{i,t}}{\partial r_t} = -\frac{\varphi v_0}{\varphi_i - v_2 - \eta\kappa_1} > 0$$

These are similar to the results in the model without extrapolative house price expectations when  $\kappa_1 = 0$ , but the higher  $\kappa_1$  is, the greater is the price response – and more so the lower the elasticity of supply is.

## Bust

In a bust, the reduced form house price and housing quantity equations are still given by:

$$PH_{i,t} = -\frac{1}{v_2} (v_0 r_t + v_1 Y_{i,t} - \psi H_{i,t-1})$$
$$S = \psi H_{i,t-1}$$

It follows from this that the response in house prices and quantity following an interest rate increase is given by:

$$\frac{\partial PH_{i,t}}{\partial r_t} = -\frac{v_0}{v_2} < 0$$
$$\frac{\partial S_{i,t}}{\partial r_t} = 0$$

Thus, the price response in the bust is independent of supply elasticity, since supply is perfectly downwardly rigid in all markets during a bust.

From this, it follows that the boom response in house prices (in absolute value) is greater than the bust response *if and only if*:

$$\frac{v_0}{\varphi_i - v_2 - \eta\kappa_1} < -\frac{v_0}{v_2}$$
$$\frac{1}{\varphi_i - v_2 - \eta\kappa_1} > -\frac{1}{v_2}$$
$$-v_2 > \varphi_i - v_2 - \eta\kappa_1$$
$$\varphi_i < \eta\kappa_1$$

Thus, there are positive supply elasticities for which the response to an expansionary

shock is greater than the response to a contractionary shock. Furthermore, the greater the price-to-price feedback loop, as measured by  $\eta\kappa_1$ , the greater is the range of elasticities for which this is true.

## B Tables and figures

### Effect of expansionary and contractionary monetary policy shocks in the largest MSAs

Table B.1: Effect of contractionary and expansionary monetary policy shocks  
after two years, MSAs with population > 1 million

Rank	MSA name and state	Elasticity	Exp.	Contr.
1	Miami-Miami Beach-Kendall FL	0.6	6.87	-3.41
2	Los Angeles-Long Beach-Glendale CA	0.63	6.82	-3.4
3	Fort Lauderdale-Pompano Beach-Deerfield Beach FL	0.65	6.78	-3.4
4	San Francisco-Redwood City-South San Francisco CA	0.66	6.76	-3.39
5	San Diego-Carlsbad CA	0.67	6.75	-3.39
6	Oakland-Hayward-Berkeley CA	0.7	6.7	-3.39
7	Salt Lake City UT	0.75	6.63	-3.38
8	New York-Jersey City-White Plains NY-NJ	0.76	6.61	-3.37
9	San Jose-Sunnyvale-Santa Clara CA	0.76	6.61	-3.37
10	New Orleans-Metairie LA	0.81	6.53	-3.36
11	Chicago-Naperville-Arlington Heights IL	0.81	6.53	-3.36
12	Virginia Beach-Norfolk-Newport News VA-NC	0.82	6.52	-3.36
13	West Palm Beach-Boca Raton-Delray Beach FL	0.83	6.5	-3.36
14	Boston MA	0.86	6.45	-3.35
15	Seattle-Bellevue-Everett WA	0.88	6.41	-3.35
16	Riverside-San Bernardino-Ontario CA	0.94	6.32	-3.34
17	New Haven-Milford CT	0.98	6.27	-3.33
18	Tampa-St. Petersburg-Clearwater FL	1	6.23	-3.33
19	Cleveland-Elyria OH	1.02	6.19	-3.32
20	Milwaukee-Waukesha-West Allis WI	1.03	6.18	-3.32
21	Jacksonville FL	1.06	6.13	-3.31
22	Portland-Vancouver-Hillsboro OR-WA	1.07	6.12	-3.31
23	Orlando-Kissimmee-Sanford FL	1.12	6.04	-3.3
24	Newark NJ-PA	1.16	5.98	-3.29
25	Pittsburgh PA	1.2	5.9	-3.28
26	Baltimore-Columbia-Towson MD	1.23	5.85	-3.28
27	Detroit-Dearborn-Livonia MI	1.24	5.84	-3.28
28	Las Vegas-Henderson-Paradise NV	1.39	5.61	-3.25
29	Rochester NY	1.4	5.59	-3.24
30	Minneapolis-St. Paul-Bloomington MN-WI	1.45	5.52	-3.24
31	Hartford-West Hartford-East Hartford CT	1.5	5.44	-3.23
32	Denver-Aurora-Lakewood CO	1.53	5.39	-3.22

*Continued on next page*

Table B.1 Effect of contractionary and expansionary monetary policy shocks after two years, MSAs with population > 1 million

(Continued from previous page)

Rank	MSA name and state	Elasticity	Exp.	Contr
33	Washington-Arlington-Alexandria DC-VA-MD-WV	1.61	5.26	-3.2
34	Phoenix-Mesa-Scottsdale AZ	1.61	5.25	-3.2
35	Philadelphia PA	1.65	5.2	-3.19
36	Memphis TN-MS-AR	1.76	5.01	-3.17
37	Buffalo-Cheektowaga-Niagara Falls NY	1.83	4.91	-3.16
38	Raleigh NC	2.11	4.47	-3.1
39	Dallas-Plano-Irving TX	2.18	4.36	-3.09
40	Nashville-Davidson-Murfreesboro-Franklin TN	2.24	4.26	-3.07
41	Houston-The Woodlands-Sugar Land TX	2.3	4.16	-3.06
42	Louisville/Jefferson County KY-IN	2.34	4.1	-3.05
43	St. Louis MO-IL	2.36	4.07	-3.05
44	Grand Rapids-Wyoming MI	2.39	4.02	-3.04
45	Cincinnati OH-KY-IN	2.46	3.91	-3.03
46	Atlanta-Sandy Springs-Roswell GA	2.55	3.76	-3.01
47	Columbus OH	2.71	3.51	-2.98
48	Fort Worth-Arlington TX	2.8	3.37	-2.96
49	San Antonio-New Braunfels TX	2.98	3.08	-2.92
50	Austin-Round Rock TX	3	3.05	-2.92
51	Charlotte-Concord-Gastonia NC-SC	3.09	2.91	-2.9
52	Greensboro-High Point NC	3.1	2.9	-2.9
53	Kansas City MO-KS	3.19	2.75	-2.88
54	Oklahoma City OK	3.29	2.59	-2.86
55	Indianapolis-Carmel-Anderson IN	4	1.46	-2.72

**Note:** This table reports estimated effects of a contractionary monetary policy shock for all MSAs in our sample with a population above one million. The calculations are based on results reported in Table 3.

## Results from MSA-by-MSA analysis

Table B.2: Asymmetric effects of monetary policy, grouping by quartiles.

Horizon	<i>Expansionary shock:</i>				
	Q1	Q2	Q3	Q4	Q5
0	0.148 (0.196)	0.085 (0.18)	0.489 (0.296)	0.602 (0.235)	0.22 (0.234)
4	4.019 (0.587)	2.12 (0.581)	1.594 (0.669)	0.806 (0.609)	1.582 (0.492)
8	8.801 (0.914)	5.656 (0.897)	3.732 (0.915)	2.652 (0.898)	2.255 (0.661)
12	9.392 (1.269)	6.565 (1.244)	3.12 (1.205)	2.398 (1.344)	0.656 (0.93)
Horizon	<i>Contractionary shock:</i>				
	Q1	Q2	Q3	Q4	Q5
0	-0.057 (0.195)	0.337 (0.278)	0.196 (0.335)	0.691 (0.356)	0.668 (0.418)
4	-0.578 (0.711)	0.292 (0.763)	-0.269 (0.703)	-1.165 (0.721)	0.146 (0.617)
8	-2.855 (1.03)	-2.247 (1.068)	-1.842 (1.098)	-2.773 (1.017)	-0.719 (0.937)
12	-3.561 (1.478)	-4.635 (1.396)	-4.002 (1.251)	-3.762 (1.261)	-2.614 (1.109)

**Note:** The table shows mean estimates of the effect of contractionary and expansionary shocks at different horizons when we group the areas into quartiles depending on their housing supply elasticity. The underlying model for each MSA allows for full heterogeneity in all coefficients and is estimated using the mean group estimator of Pesaran and Smith (1995).

## Results from balanced panel

Table B.3: Asymmetric and heterogeneous effects of monetary policy shocks on house prices using a balanced panel.

Indep. Var.	<i>Dependent variable is <math>ph_{i,t+h} - ph_{i,t-1}</math></i>			
	h=0	h=4	h=8	h=12
Contr. MP shock	0.22 (0.44)	-0.08 (1.02)	-2.92* (1.72)	-6.08** (2.63)
Contr. MP shock × Elasticity	-0.11 (0.24)	-0.81* (0.44)	-0.69 (0.70)	-0.21 (0.99)
Exp. MP shock	-0.17 (0.32)	4.00*** (0.95)	9.68*** (1.45)	11.08*** (1.94)
Exp. MP shock × Elasticity	0.09 (0.16)	-1.32*** (0.40)	-2.65*** (0.60)	-3.81*** (0.84)
Observations	13,961	13,373	12,785	12,197
MSAs	147	147	147	147
R <sup>2</sup>	0.303	0.403	0.369	0.344
MSA FE	YES	YES	YES	YES
Controls	YES	YES	YES	YES

**Note:** The table shows the effect on house prices of contractionary and expansionary monetary policy shocks when accounting for different supply elasticities. The dependent variable is the cumulative log changes in the FHFA house price index at horizon  $h = 0, 4, 8$  and  $12$ . Results are based on estimating equation 3 using a fixed effect estimator and the data set covers a balanced panel of the 147 MSAs for which we have data over the full period 1983q1–2007q4. The specification allows the response in house prices to differ depending on the elasticity of supply, as calculated in Saiz (2010), and whether the monetary policy shock is expansionary or contractionary. Standard errors robust to heteroskedasticity and autocorrelation are reported in absolute value in parenthesis below the point estimates. The asterisks denote significance levels: \* = 10%, \*\* = 5% and \*\*\* = 1%.

## Allowing for heterogeneity in momentum effects

Table B.4: Asymmetric momentum, MSA-by-MSA.

	Momentum	Additional momentum when $\Delta ph_{i,t} > 0$
Constant	0.53 (0.07)	0.33 (0.07)
Elasticity	-0.12 (0.02)	-0.06 (0.02)
Observations	263	263
Adj. $R^2$	0.09	0.02

**Note:** The table shows how the momentum effect and the additional momentum effect in a booming market are related to housing supply elasticity. The results are based on a two-stage analysis, where we first estimate an AR(4)-model for house price appreciation, allowing the AR-parameters to be different when house prices are increasing, for each MSA in the data set. We then calculate the sum of coefficients on the two momentum terms and regress them on housing supply elasticity. The first column displays results for the common momentum effect, whereas the second column shows results for the additional momentum effect in a booming market.



2013

- 2013/1, **Sánchez-Vidal, M.; González-Val, R.; Viladecans-Marsal, E.:** "Sequential city growth in the US: does age matter?"
- 2013/2, **Hortas Rico, M.:** "Sprawl, blight and the role of urban containment policies. Evidence from US cities"
- 2013/3, **Lampón, J.F.; Cabanelas-Lorenzo, P.; Lago-Peñas, S.:** "Why firms relocate their production overseas? The answer lies inside: corporate, logistic and technological determinants"
- 2013/4, **Montolio, D.; Planells, S.:** "Does tourism boost criminal activity? Evidence from a top touristic country"
- 2013/5, **García-López, M.A.; Holl, A.; Viladecans-Marsal, E.:** "Suburbanization and highways: when the Romans, the Bourbons and the first cars still shape Spanish cities"
- 2013/6, **Bosch, N.; Espasa, M.; Montolio, D.:** "Should large Spanish municipalities be financially compensated? Costs and benefits of being a capital/central municipality"
- 2013/7, **Escardíbul, J.O.; Mora, T.:** "Teacher gender and student performance in mathematics. Evidence from Catalonia"
- 2013/8, **Arqué-Castells, P.; Viladecans-Marsal, E.:** "Banking towards development: evidence from the Spanish banking expansion plan"
- 2013/9, **Asensio, J.; Gómez-Lobo, A.; Matas, A.:** "How effective are policies to reduce gasoline consumption? Evaluating a quasi-natural experiment in Spain"
- 2013/10, **Jofre-Monseny, J.:** "The effects of unemployment benefits on migration in lagging regions"
- 2013/11, **Segarra, A.; García-Quevedo, J.; Teruel, M.:** "Financial constraints and the failure of innovation projects"
- 2013/12, **Jerrim, J.; Choi, A.:** "The mathematics skills of school children: How does England compare to the high performing East Asian jurisdictions?"
- 2013/13, **González-Val, R.; Tirado-Fabregat, D.A.; Viladecans-Marsal, E.:** "Market potential and city growth: Spain 1860-1960"
- 2013/14, **Lundqvist, H.:** "Is it worth it? On the returns to holding political office"
- 2013/15, **Ahlfeldt, G.M.; Maennig, W.:** "Homevoters vs. leasevoters: a spatial analysis of airport effects"
- 2013/16, **Lampón, J.F.; Lago-Peñas, S.:** "Factors behind international relocation and changes in production geography in the European automobile components industry"
- 2013/17, **Guío, J.M.; Choi, A.:** "Evolution of the school failure risk during the 2000 decade in Spain: analysis of Pisa results with a two-level logistic mode"
- 2013/18, **Dahlby, B.; Rodden, J.:** "A political economy model of the vertical fiscal gap and vertical fiscal imbalances in a federation"
- 2013/19, **Acacia, F.; Cubel, M.:** "Strategic voting and happiness"
- 2013/20, **Hellerstein, J.K.; Kutzbach, M.J.; Neumark, D.:** "Do labor market networks have an important spatial dimension?"
- 2013/21, **Pellegrino, G.; Savona, M.:** "Is money all? Financing versus knowledge and demand constraints to innovation"
- 2013/22, **Lin, J.:** "Regional resilience"
- 2013/23, **Costa-Campi, M.T.; Duch-Brown, N.; García-Quevedo, J.:** "R&D drivers and obstacles to innovation in the energy industry"
- 2013/24, **Huisman, R.; Stradnic, V.; Westgaard, S.:** "Renewable energy and electricity prices: indirect empirical evidence from hydro power"
- 2013/25, **Dargaud, E.; Mantovani, A.; Reggiani, C.:** "The fight against cartels: a transatlantic perspective"
- 2013/26, **Lambertini, L.; Mantovani, A.:** "Feedback equilibria in a dynamic renewable resource oligopoly: pre-emption, voracity and exhaustion"
- 2013/27, **Feld, L.P.; Kalb, A.; Moessinger, M.D.; Osterloh, S.:** "Sovereign bond market reactions to fiscal rules and no-bailout clauses – the Swiss experience"
- 2013/28, **Hilber, C.A.L.; Vermeulen, W.:** "The impact of supply constraints on house prices in England"
- 2013/29, **Revelli, F.:** "Tax limits and local democracy"
- 2013/30, **Wang, R.; Wang, W.:** "Dress-up contest: a dark side of fiscal decentralization"
- 2013/31, **Dargaud, E.; Mantovani, A.; Reggiani, C.:** "The fight against cartels: a transatlantic perspective"
- 2013/32, **Saarimaa, T.; Tukiainen, J.:** "Local representation and strategic voting: evidence from electoral boundary reforms"
- 2013/33, **Agasisti, T.; Murtinu, S.:** "Are we wasting public money? No! The effects of grants on Italian university students' performances"
- 2013/34, **Flacher, D.; Harari-Kermadec, H.; Moulin, L.:** "Financing higher education: a contributory scheme"
- 2013/35, **Carozzi, F.; Repetto, L.:** "Sending the pork home: birth town bias in transfers to Italian municipalities"
- 2013/36, **Coad, A.; Frankish, J.S.; Roberts, R.G.; Storey, D.J.:** "New venture survival and growth: Does the fog lift?"
- 2013/37, **Giulietti, M.; Grossi, L.; Waterson, M.:** "Revenues from storage in a competitive electricity market: Empirical evidence from Great Britain"

## 2014

- 2014/1, **Montolio, D.; Planells-Struse, S.:** "When police patrols matter. The effect of police proximity on citizens' crime risk perception"
- 2014/2, **García-López, M.A.; Solé-Ollé, A.; Viladecans-Marsal, E.:** "Do land use policies follow road construction?"
- 2014/3, **Piolatto, A.; Rablen, M.D.:** "Prospect theory and tax evasion: a reconsideration of the Yitzhaki puzzle"
- 2014/4, **Cuberes, D.; González-Val, R.:** "The effect of the Spanish Reconquest on Iberian Cities"
- 2014/5, **Durán-Cabré, J.M.; Esteller-Moré, E.:** "Tax professionals' view of the Spanish tax system: efficiency, equity and tax planning"
- 2014/6, **Cubel, M.; Sanchez-Pages, S.:** "Difference-form group contests"
- 2014/7, **Del Rey, E.; Racionero, M.:** "Choosing the type of income-contingent loan: risk-sharing versus risk-pooling"
- 2014/8, **Torregrosa Hetland, S.:** "A fiscal revolution? Progressivity in the Spanish tax system, 1960-1990"
- 2014/9, **Piolatto, A.:** "Itemised deductions: a device to reduce tax evasion"
- 2014/10, **Costa, M.T.; García-Quevedo, J.; Segarra, A.:** "Energy efficiency determinants: an empirical analysis of Spanish innovative firms"
- 2014/11, **García-Quevedo, J.; Pellegrino, G.; Savona, M.:** "Reviving demand-pull perspectives: the effect of demand uncertainty and stagnancy on R&D strategy"
- 2014/12, **Calero, J.; Escardíbul, J.O.:** "Barriers to non-formal professional training in Spain in periods of economic growth and crisis. An analysis with special attention to the effect of the previous human capital of workers"
- 2014/13, **Cubel, M.; Sanchez-Pages, S.:** "Gender differences and stereotypes in the beauty"
- 2014/14, **Piolatto, A.; Schuett, F.:** "Media competition and electoral politics"
- 2014/15, **Montolio, D.; Trillas, F.; Trujillo-Baute, E.:** "Regulatory environment and firm performance in EU telecommunications services"
- 2014/16, **Lopez-Rodriguez, J.; Martinez, D.:** "Beyond the R&D effects on innovation: the contribution of non-R&D activities to TFP growth in the EU"
- 2014/17, **González-Val, R.:** "Cross-sectional growth in US cities from 1990 to 2000"
- 2014/18, **Vona, F.; Nicolli, F.:** "Energy market liberalization and renewable energy policies in OECD countries"
- 2014/19, **Curto-Grau, M.:** "Voters' responsiveness to public employment policies"
- 2014/20, **Duro, J.A.; Teixidó-Figueras, J.; Padilla, E.:** "The causal factors of international inequality in CO<sub>2</sub> emissions per capita: a regression-based inequality decomposition analysis"
- 2014/21, **Fleten, S.E.; Huisman, R.; Kilic, M.; Pennings, E.; Westgaard, S.:** "Electricity futures prices: time varying sensitivity to fundamentals"
- 2014/22, **Afcha, S.; García-Quevedo, J.:** "The impact of R&D subsidies on R&D employment composition"
- 2014/23, **Mir-Artigues, P.; del Río, P.:** "Combining tariffs, investment subsidies and soft loans in a renewable electricity deployment policy"
- 2014/24, **Romero-Jordán, D.; del Río, P.; Peñasco, C.:** "Household electricity demand in Spanish regions. Public policy implications"
- 2014/25, **Salinas, P.:** "The effect of decentralization on educational outcomes: real autonomy matters!"
- 2014/26, **Solé-Ollé, A.; Sorribas-Navarro, P.:** "Does corruption erode trust in government? Evidence from a recent surge of local scandals in Spain"
- 2014/27, **Costas-Pérez, E.:** "Political corruption and voter turnout: mobilization or disaffection?"
- 2014/28, **Cubel, M.; Nuevo-Chiquero, A.; Sanchez-Pages, S.; Vidal-Fernandez, M.:** "Do personality traits affect productivity? Evidence from the LAB"
- 2014/29, **Teresa Costa, M.T.; Trujillo-Baute, E.:** "Retail price effects of feed-in tariff regulation"
- 2014/30, **Kilic, M.; Trujillo-Baute, E.:** "The stabilizing effect of hydro reservoir levels on intraday power prices under wind forecast errors"
- 2014/31, **Costa-Campí, M.T.; Duch-Brown, N.:** "The diffusion of patented oil and gas technology with environmental uses: a forward patent citation analysis"
- 2014/32, **Ramos, R.; Sanromá, E.; Simón, H.:** "Public-private sector wage differentials by type of contract: evidence from Spain"
- 2014/33, **Backus, P.; Esteller-Moré, A.:** "Is income redistribution a form of insurance, a public good or both?"
- 2014/34, **Huisman, R.; Trujillo-Baute, E.:** "Costs of power supply flexibility: the indirect impact of a Spanish policy change"
- 2014/35, **Jerrim, J.; Choi, A.; Simancas Rodríguez, R.:** "Two-sample two-stage least squares (TSTSLS) estimates of earnings mobility: how consistent are they?"
- 2014/36, **Mantovani, A.; Tarola, O.; Vergari, C.:** "Hedonic quality, social norms, and environmental campaigns"
- 2014/37, **Ferraresi, M.; Galmarini, U.; Rizzo, L.:** "Local infrastructures and externalities: Does the size matter?"
- 2014/38, **Ferraresi, M.; Rizzo, L.; Zanardi, A.:** "Policy outcomes of single and double-ballot elections"

2015

- 2015/1, **Foremny, D.; Freier, R.; Moessinger, M-D.; Yeter, M.:** "Overlapping political budget cycles in the legislative and the executive"
- 2015/2, **Colombo, L.; Galmarini, U.:** "Optimality and distortionary lobbying: regulating tobacco consumption"
- 2015/3, **Pellegrino, G.:** "Barriers to innovation: Can firm age help lower them?"
- 2015/4, **Hémet, C.:** "Diversity and employment prospects: neighbors matter!"
- 2015/5, **Cubel, M.; Sanchez-Pages, S.:** "An axiomatization of difference-form contest success functions"
- 2015/6, **Choi, A.; Jerrim, J.:** "The use (and misuse) of Pisa in guiding policy reform: the case of Spain"
- 2015/7, **Durán-Cabré, J.M.; Esteller-Moré, A.; Salvadori, L.:** "Empirical evidence on tax cooperation between sub-central administrations"
- 2015/8, **Batalla-Bejerano, J.; Trujillo-Baute, E.:** "Analysing the sensitivity of electricity system operational costs to deviations in supply and demand"
- 2015/9, **Salvadori, L.:** "Does tax enforcement counteract the negative effects of terrorism? A case study of the Basque Country"
- 2015/10, **Montolio, D.; Planells-Struse, S.:** "How time shapes crime: the temporal impacts of football matches on crime"
- 2015/11, **Piolatto, A.:** "Online booking and information: competition and welfare consequences of review aggregators"
- 2015/12, **Boffa, F.; Pingali, V.; Sala, F.:** "Strategic investment in merchant transmission: the impact of capacity utilization rules"
- 2015/13, **Slemrod, J.:** "Tax administration and tax systems"
- 2015/14, **Arqué-Castells, P.; Cartaxo, R.M.; García-Quevedo, J.; Mira Godinho, M.:** "How inventor royalty shares affect patenting and income in Portugal and Spain"
- 2015/15, **Montolio, D.; Planells-Struse, S.:** "Measuring the negative externalities of a private leisure activity: hooligans and pickpockets around the stadium"
- 2015/16, **Batalla-Bejerano, J.; Costa-Campi, M.T.; Trujillo-Baute, E.:** "Unexpected consequences of liberalisation: metering, losses, load profiles and cost settlement in Spain's electricity system"
- 2015/17, **Batalla-Bejerano, J.; Trujillo-Baute, E.:** "Impacts of intermittent renewable generation on electricity system costs"
- 2015/18, **Costa-Campi, M.T.; Paniagua, J.; Trujillo-Baute, E.:** "Are energy market integrations a green light for FDI?"
- 2015/19, **Jofre-Monseny, J.; Sánchez-Vidal, M.; Viladecans-Marsal, E.:** "Big plant closures and agglomeration economies"
- 2015/20, **García-López, M.A.; Hémet, C.; Viladecans-Marsal, E.:** "How does transportation shape intrametropolitan growth? An answer from the regional express rail"
- 2015/21, **Esteller-Moré, A.; Galmarini, U.; Rizzo, L.:** "Fiscal equalization under political pressures"
- 2015/22, **Escardíbul, J.O.; Afcha, S.:** "Determinants of doctorate holders' job satisfaction. An analysis by employment sector and type of satisfaction in Spain"
- 2015/23, **Aidt, T.; Asatryan, Z.; Badalyan, L.; Heinemann, F.:** "Vote buying or (political) business (cycles) as usual?"
- 2015/24, **Albæk, K.:** "A test of the 'lose it or use it' hypothesis in labour markets around the world"
- 2015/25, **Angelucci, C.; Russo, A.:** "Petty corruption and citizen feedback"
- 2015/26, **Moriconi, S.; Picard, P.M.; Zanaj, S.:** "Commodity taxation and regulatory competition"
- 2015/27, **Brekke, K.R.; Garcia Pires, A.J.; Schindler, D.; Schjelderup, G.:** "Capital taxation and imperfect competition: ACE vs. CBIT"
- 2015/28, **Redonda, A.:** "Market structure, the functional form of demand and the sensitivity of the vertical reaction function"
- 2015/29, **Ramos, R.; Sanromá, E.; Simón, H.:** "An analysis of wage differentials between full-and part-time workers in Spain"
- 2015/30, **García-López, M.A.; Pasidis, I.; Viladecans-Marsal, E.:** "Express delivery to the suburbs the effects of transportation in Europe's heterogeneous cities"
- 2015/31, **Torregrosa, S.:** "Bypassing progressive taxation: fraud and base erosion in the Spanish income tax (1970-2001)"
- 2015/32, **Choi, H.; Choi, A.:** "When one door closes: the impact of the hagwon curfew on the consumption of private tutoring in the republic of Korea"
- 2015/33, **Escardíbul, J.O.; Helmy, N.:** "Decentralisation and school autonomy impact on the quality of education: the case of two MENA countries"
- 2015/34, **González-Val, R.; Marcén, M.:** "Divorce and the business cycle: a cross-country analysis"

- 2015/35, Calero, J.; Choi, A.: "The distribution of skills among the European adult population and unemployment: a comparative approach"
- 2015/36, Mediavilla, M.; Zancajo, A.: "Is there real freedom of school choice? An analysis from Chile"
- 2015/37, Daniele, G.: "Strike one to educate one hundred: organized crime, political selection and politicians' ability"
- 2015/38, González-Val, R.; Marcén, M.: "Regional unemployment, marriage, and divorce"
- 2015/39, Foremny, D.; Jofre-Monseny, J.; Solé-Ollé, A.: "'Hold that ghost': using notches to identify manipulation of population-based grants"
- 2015/40, Mancebón, M.J.; Ximénez-de-Embún, D.P.; Mediavilla, M.; Gómez-Sancho, J.M.: "Does educational management model matter? New evidence for Spain by a quasiexperimental approach"
- 2015/41, Daniele, G.; Geys, B.: "Exposing politicians' ties to criminal organizations: the effects of local government dissolutions on electoral outcomes in Southern Italian municipalities"
- 2015/42, Ooghe, E.: "Wage policies, employment, and redistributive efficiency"

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 2016
 

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- 2016/1, Galletta, S.: "Law enforcement, municipal budgets and spillover effects: evidence from a quasi-experiment in Italy"
- 2016/2, Flatley, L.; Giulletti, M.; Grossi, L.; Trujillo-Baute, E.; Waterson, M.: "Analysing the potential economic value of energy storage"
- 2016/3, Calero, J.; Murillo Huertas, I.P.; Raymond Bara, J.L.: "Education, age and skills: an analysis using the PIAAC survey"
- 2016/4, Costa-Campi, M.T.; Daví-Arderius, D.; Trujillo-Baute, E.: "The economic impact of electricity losses"
- 2016/5, Falck, O.; Heimisch, A.; Wiederhold, S.: "Returns to ICT skills"
- 2016/6, Halmenschlager, C.; Mantovani, A.: "On the private and social desirability of mixed bundling in complementary markets with cost savings"
- 2016/7, Choi, A.; Gil, M.; Mediavilla, M.; Valbuena, J.: "Double toil and trouble: grade retention and academic performance"
- 2016/8, González-Val, R.: "Historical urban growth in Europe (1300–1800)"
- 2016/9, Guio, J.; Choi, A.; Escardíbul, J.O.: "Labor markets, academic performance and the risk of school dropout: evidence for Spain"
- 2016/10, Bianchini, S.; Pellegrino, G.; Tamagni, F.: "Innovation strategies and firm growth"
- 2016/11, Jofre-Monseny, J.; Silva, J.L.; Vázquez-Grenno, J.: "Local labor market effects of public employment"
- 2016/12, Sanchez-Vidal, M.: "Small shops for sale! The effects of big-box openings on grocery stores"
- 2016/13, Costa-Campi, M.T.; García-Quevedo, J.; Martínez-Ros, E.: "What are the determinants of investment in environmental R&D?"
- 2016/14, García-López, M.A.; Hémet, C.; Viladecans-Marsal, E.: "Next train to the polycentric city: The effect of railroads on subcenter formation"
- 2016/15, Matas, A.; Raymond, J.L.; Dominguez, A.: "Changes in fuel economy: An analysis of the Spanish car market"
- 2016/16, Leme, A.; Escardíbul, J.O.: "The effect of a specialized versus a general upper secondary school curriculum on students' performance and inequality. A difference-in-differences cross country comparison"
- 2016/17, Scandurra, R.I.; Calero, J.: "Modelling adult skills in OECD countries"
- 2016/18, Fernández-Gutiérrez, M.; Calero, J.: "Leisure and education: insights from a time-use analysis"
- 2016/19, Del Rio, P.; Mir-Artigues, P.; Trujillo-Baute, E.: "Analysing the impact of renewable energy regulation on retail electricity prices"
- 2016/20, Taltavull de la Paz, P.; Juárez, F.; Monllor, P.: "Fuel Poverty: Evidence from housing perspective"
- 2016/21, Ferraresi, M.; Galmarini, U.; Rizzo, L.; Zanardi, A.: "Switch towards tax centralization in Italy: A wake up for the local political budget cycle"
- 2016/22, Ferraresi, M.; Migali, G.; Nordi, F.; Rizzo, L.: "Spatial interaction in local expenditures among Italian municipalities: evidence from Italy 2001–2011"
- 2016/23, Daví-Arderius, D.; Sanin, M.E.; Trujillo-Baute, E.: "CO2 content of electricity losses"
- 2016/24, Arqué-Castells, P.; Viladecans-Marsal, E.: "Banking the unbanked: Evidence from the Spanish banking expansion plan"
- 2016/25 Choi, Á.; Gil, M.; Mediavilla, M.; Valbuena, J.: "The evolution of educational inequalities in Spain: Dynamic evidence from repeated cross-sections"
- 2016/26, Brutti, Z.: "Cities drifting apart: Heterogeneous outcomes of decentralizing public education"
- 2016/27, Backus, P.; Cubel, M.; Guid, M.; Sánchez-Pages, S.; Lopez Manas, E.: "Gender, competition and performance: evidence from real tournaments"
- 2016/28, Costa-Campi, M.T.; Duch-Brown, N.; García-Quevedo, J.: "Innovation strategies of energy firms"
- 2016/29, Daniele, G.; Dipoppa, G.: "Mafia, elections and violence against politicians"

2016/30, Di Cosmo, V.; Malaguzzi Valeri, L.: “Wind, storage, interconnection and the cost of electricity”

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**2017**

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2017/1, González Pampillón, N.; Jofre-Monseny, J.; Viladecans-Marsal, E.: “Can urban renewal policies reverse neighborhood ethnic dynamics?”

2017/2, Gómez San Román, T.: “Integration of DERs on power systems: challenges and opportunities”

2017/3, Bianchini, S.; Pellegrino, G.: “Innovation persistence and employment dynamics”

2017/4, Curto-Grau, M.; Solé-Ollé, A.; Sorribas-Navarro, P.: “Does electoral competition curb party favoritism?”

2017/5, Solé-Ollé, A.; Viladecans-Marsal, E.: “Housing booms and busts and local fiscal policy”

2017/6, Esteller, A.; Piolatto, A.; Rablen, M.D.: “Taxing high-income earners: Tax avoidance and mobility”

2017/7, Combes, P.P.; Duranton, G.; Gobillon, L.: “The production function for housing: Evidence from France”

2017/8, Nepal, R.; Cram, L.; Jamasb, T.; Sen, A.: “Small systems, big targets: power sector reforms and renewable energy development in small electricity systems”

2017/9, Carozzi, F.; Repetto, L.: “Distributive politics inside the city? The political economy of Spain’s plan E”

2017/10, Neisser, C.: “The elasticity of taxable income: A meta-regression analysis”

2017/11, Baker, E.; Bosetti, V.; Salo, A.: “Finding common ground when experts disagree: robust portfolio decision analysis”

2017/12, Murillo, I.P.; Raymond, J.L.; Calero, J.: “Efficiency in the transformation of schooling into competences: A cross-country analysis using PIAAC data”

2017/13, Ferrer-Esteban, G.; Mediavilla, M.: “The more educated, the more engaged? An analysis of social capital and education”

2017/14, Sanchis-Guarner, R.: “Decomposing the impact of immigration on house prices”

2017/15, Schwab, T.; Todtenhaupt, M.: “Spillover from the haven: Cross-border externalities of patent box regimes within multinational firms”

2017/16, Chacón, M.; Jensen, J.: “The institutional determinants of Southern secession”

2017/17, Gancia, G.; Ponzetto, G.A.M.; Ventura, J.: “Globalization and political structure”

2017/18, González-Val, R.: “City size distribution and space”

2017/19, García-Quevedo, J.; Mas-Verdú, F.; Pellegrino, G.: “What firms don’t know can hurt them: Overcoming a lack of information on technology”

2017/20, Costa-Campi, M.T.; García-Quevedo, J.: “Why do manufacturing industries invest in energy R&D?”

2017/21, Costa-Campi, M.T.; García-Quevedo, J.; Trujillo-Baute, E.: “Electricity regulation and economic growth”

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**2018**

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2018/1, Boadway, R.; Pestieau, P.: “The tenuous case for an annual wealth tax”

2018/2, García-López, M.Á.: “All roads lead to Rome ... and to sprawl? Evidence from European cities”

2018/3, Daniele, G.; Galletta, S.; Geys, B.: “Abandon ship? Party brands and politicians’ responses to a political scandal”

2018/4, Cavalcanti, F.; Daniele, G.; Galletta, S.: “Popularity shocks and political selection”

2018/5, Naval, J.; Silva, J. I.; Vázquez-Grenno, J.: “Employment effects of on-the-job human capital acquisition”

2018/6, Agrawal, D. R.; Foremny, D.: “Relocation of the rich: migration in response to top tax rate changes from Spanish reforms”

2018/7, García-Quevedo, J.; Kesidou, E.; Martínez-Ros, E.: “Inter-industry differences in organisational eco-innovation: a panel data study”

