ONLINE APPENDIX
for
Asymmetric effects of monetary policy in regional housing markets*

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Abstract

This appendix provides additional results and robustness checks for "Asymmetric effects of monetary policy in regional housing markets".

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

Table A.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	0.60	6.87	-3.53
2	Los Angeles-Long Beach-Glendale CA	0.63	6.82	-3.53
3	Fort Lauderdale-Pompano Beach-Deerfield Beach FL	0.65	6.78	-3.53
4	San Francisco-Redwood City-South San Francisco CA	0.66	6.76	-3.53
5	San Diego-Carlsbad CA	0.67	6.75	-3.53
6	Oakland-Hayward-Berkeley CA	0.70	6.70	-3.53
7	Salt Lake City UT	0.75	6.63	-3.53
8	New York-Jersey City-White Plains NY-NJ	0.76	6.61	-3.53
9	San Jose-Sunnyvale-Santa Clara CA	0.76	6.61	-3.53
10	New Orleans-Metairie LA	0.81	6.53	-3.53
11	Chicago-Naperville-Arlington Heights IL	0.81	6.53	-3.53
12	Virginia Beach-Norfolk-Newport News VA-NC	0.82	6.52	-3.53
13	West Palm Beach-Boca Raton-Delray Beach FL	0.83	6.50	-3.53
14	Boston MA	0.86	6.45	-3.53
15	Seattle-Bellevue-Everett WA	0.88	6.41	-3.53
16	Riverside-San Bernardino-Ontario CA	0.94	6.32	-3.53
17	New Haven-Milford CT	0.98	6.27	-3.53
18	Tampa-St. Petersburg-Clearwater FL	1.00	6.23	-3.53
19	Cleveland-Elyria OH	1.02	6.19	-3.53
20	Milwaukee-Waukesha-West Allis WI	1.03	6.18	-3.53
21	Jacksonville FL	1.06	6.13	-3.53
22	Portland-Vancouver-Hillsboro OR-WA	1.07	6.12	-3.53
23	Orlando-Kissimmee-Sanford FL	1.12	6.04	-3.53
24	Newark NJ-PA	1.16	5.98	-3.53
25	Pittsburgh PA	1.20	5.90	-3.53
26	Baltimore-Columbia-Towson MD	1.23	5.85	-3.53
27	Detroit-Dearborn-Livonia MI	1.24	5.84	-3.53
28	Las Vegas-Henderson-Paradise NV	1.39	5.61	-3.53
29	Rochester NY	1.40	5.59	-3.53
30	Minneapolis-St. Paul-Bloomington MN-WI	1.45	5.52	-3.53
31	Hartford-West Hartford-East Hartford CT	1.50	5.44	-3.53
32	Denver-Aurora-Lakewood CO	1.53	5.39	-3.53
33	Washington-Arlington-Alexandria DC-VA-MD-WV	1.61	5.26	-3.53
34	Phoenix-Mesa-Scottsdale AZ	1.61	5.25	-3.53
35	Philadelphia PA	1.65	5.20	-3.53
36	Memphis TN-MS-AR	1.76	5.01	-3.53
37	Buffalo-Cheektowaga-Niagara Falls NY	1.83	4.91	-3.53
38	Raleigh NC	2.11	4.47	-3.53
39	Dallas-Plano-Irving TX	2.18	4.36	-3.53
40	Nashville-Davidson–Murfreesboro–Franklin TN	2.24	4.26	-3.53
41	Houston-The Woodlands-Sugar Land TX	2.30	4.16	-3.53
42	Louisville/Jefferson County KY-IN	2.34	4.10	-3.53
43	St. Louis MO-IL	2.36	4.07	-3.53
44	Grand Rapids-Wyoming MI	2.39	4.02	-3.53
45	Cincinnati OH-KY-IN	2.46	3.91	-3.53
46	Atlanta-Sandy Springs-Roswell GA	2.55	3.76	-3.53
47	Columbus OH	2.71	3.51	-3.53

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

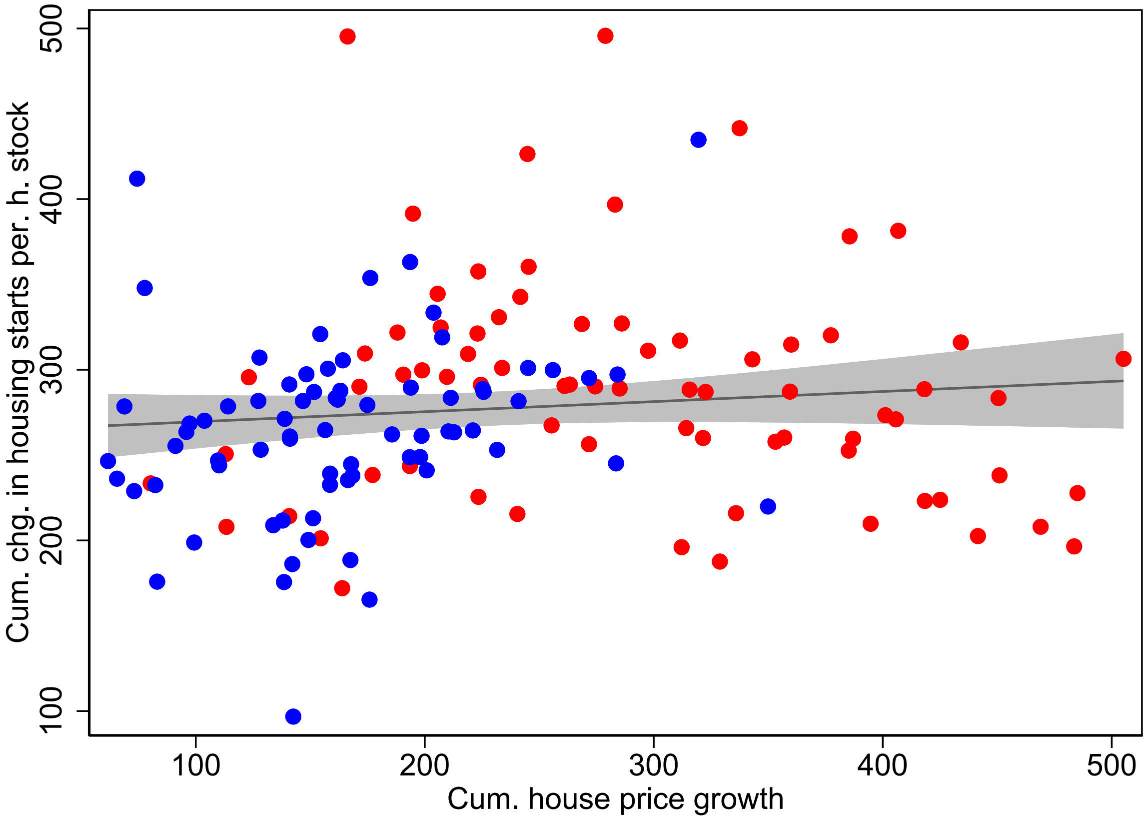
(*Continued from previous page*)

Rank	MSA name and state	Elasticity	Exp.	Contr
48	Fort Worth-Arlington TX	2.80	3.37	-3.53
49	San Antonio-New Braunfels TX	2.98	3.08	-3.53
50	Austin-Round Rock TX	3.00	3.05	-3.53
51	Charlotte-Concord-Gastonia NC-SC	3.09	2.91	-3.53
52	Greensboro-High Point NC	3.10	2.90	-3.53
53	Kansas City MO-KS	3.19	2.75	-3.53
54	Oklahoma City OK	3.29	2.59	-3.53
55	Indianapolis-Carmel-Anderson IN	4.00	1.46	-3.53

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.

House prices and housing supply

Figure A.1: Cumulative house price growth versus cumulative change in housing starts, 1983–2007. Elastic areas (blue dots) versus inelastic areas (red dots)



Note: The figure shows a scatter plot of cumulative house price growth over our sample period versus cumulative housing starts relative to the existing stock over our sample period. We have grouped the MSAs into two groups: Areas with supply elasticities above the median (blue) and areas with supply elasticities below the median (red).

Our supply-specification takes the following form:

$$\log(\text{Starts})_{i,t} = \alpha_i + \sum_{j=1}^{4} \rho_j \log(\text{Starts})_{i,t-j} + \beta^{Incr.} \Delta ph_{i,t}^{Incr.} + \beta^{Incr.,El.} \Delta ph_{i,t}^{Incr.} \times El.$$
$$+ \beta^{Decr.} \Delta ph_{i,t}^{Decr.} + \beta^{Decr.,El.} \Delta ph_{i,t}^{Decr.} \times El. + \boldsymbol{\gamma}' \boldsymbol{Z} \tag{A.1}$$

in which $\Delta ph_{i,t}^{Incr.}$ is calculated as $\Delta ph_{i,t}^{Incr.} = \Delta ph_{i,t}^{Incr.} \times I\left(\Delta ph_{i,t-1} > 0\right)$, and $I\left(\cdots\right)$ is an indicator variable taking the value 1 when the argument in the parenthesis holds, and zero otherwise. In a similar way, $\Delta ph_{i,t}^{Decr.}$ is calculated as $\Delta ph_{i,t}^{Decr.} = \Delta ph_{i,t}^{Incr.} \times I\left(\Delta ph_{i,t-1} \leq 0\right)$. The vector Z contains lags of house price growth in the two regimes, its interaction with the supply elasticity, lags of population growth, and lags of housing vacancies. We control for MSA fixed effects in the regressions.

Table A.2: Supply-side dynamics.

	(I)	(II)	(III)
Pos. HP. growth	0.77	0.73	0.54
	(0.20)	(0.19)	(0.19)
Pos. HP. growth	0.19	0.20	0.16
× El.	(0.07)	(0.07)	(0.07)
Neg. HP. growth	-1.47	-1.14	-0.83
	(0.38)	(0.38)	(0.38)
Neg. HP. growth	0.08	0.16	0.18
× El.	(0.18)	(0.18)	(0.18)
MSA FE	YES	YES	YES
Controls	NO	YES	YES
Time FE	NO	NO	YES

Note: The table shows the relationship between housing starts and house prices, where the effect depends on whether house prices are increasing or decreasing, and on the level of local area housing supply elasticities. The dependent variable is the logarithm of housing starts relative to the existing stock of houses. Results are based on estimating equation (A.1) using a fixed effect estimator, and the full data set covers a panel of 262 US MSAs (Pine Bluff is excluded due to being an outlier) over the period 1983q1–2007q4. Column (I) shows results when we only include house prices and lags of the dependent variable, together with MSA-fixed effects. In Column (II), we add controls for lags of population growth and housing vacancies. In Column (III), we also control for year-by-quarter fixed effects. We use Conley (1999, 2008) standard errors that are robust to both spatial correlation and autocorrelation, by employing the code developed by Hsiang (2010). We use the QGIS-software to calculate latitudes and longitudes of MSA centroids, and set the cut-off distance for the spatial correlation at 100 miles. The kernel that is used to weigh the spatial correlations decays linearly with distance in all directions. The standard errors are reported in absolute value in parenthesis below the point estimates. To calculate MSA centroids, we use 2019 TIGER/Line files for US CBSA's from https://www.census.gov/cgi-bin/geo/shapefiles/index.php.

Competition in the banking sector

Table A.3: Asymmetric and heterogeneous effects of monetary policy shocks on house prices. Controlling for banking competition.

	h=0	h=4	h=8	h=12
Exp MP shock	-0.37	6.45	11.99	10.46
	(0.41)	(1.37)	(2.51)	(3.55)
Exp MP shock	0.26	-1.49	-2.53	-2.42
× El.	(0.18)	(0.48)	(0.80)	(1.17)
Exp MP shock	0.03	-0.74	-0.88	-0.50
× HHI	(0.07)	(0.18)	(0.37)	(0.53)
Exp MP shock	-0.02	0.18	0.20	0.09
× HHI × El.	(0.03)	(0.06)	(0.11)	(0.17)
Contr MP shock	-0.46	-0.03	-3.42	-9.33
	(0.52)	(1.54)	(2.52)	(3.75)
Contr MP shock	0.32	0.01	0.75	1.47
× El.	(0.20)	(0.49)	(0.83)	(1.16)
Contr MP shock	0.06	-0.16	-0.12	0.51
× HHI	(0.10)	(0.19)	(0.30)	(0.45)
Contr MP shock	-0.03	-0.00	-0.05	-0.17
× HHI × El.	(0.04)	(0.06)	(0.10)	(0.13)
Observations	23212	22160	21108	20056
MSAs	263	263	263	263
R^2	0.268	0.463	0.499	0.516
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 and different levels of competition in the banking sector. 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 an augmented version of equation (1) 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. The specifications also include interaction between the monetary policy shocks and different levels of banking concentration, as measured through the Herfindahl-Hirchman Indices in Acolin, An and Wachter, 2018, as well as the triple interaction between the monetary shocks, supply elasticities and HHI. We also include HHI un-interacted and interacted with the supply elasticity. We use Conley (1999, 2008) standard errors that are robust to both spatial correlation and autocorrelation, by employing the code developed by Hsiang (2010). We use the QGIS-software to calculate latitudes and longitudes of MSA centroids, and set the cut-off distance for the spatial correlation at 100 miles. The kernel that is used to weigh the spatial correlations decays linearly with distance in all directions. The standard errors are reported in absolute value in parenthesis below the point estimates. To calculate MSA centroids, we use 2019 TIGER/Line files for US CBSA's from https://www.census.gov/cgi-bin/geo/shapefiles/index.php.

HFI-shocks in a LP-IV

Table A.4: Asymmetric and heterogeneous effects of monetary policy shocks on house prices when using HFI shocks in a LP-IV.

	h=0	h=4	h=8	h=12
Exp MP shock	1.46	3.94	3.76	8.18
	(0.18)	(0.71)	(1.28)	(1.61)
Exp MP shock	-0.17	-0.34	-0.34	-0.92
× El.	(0.06)	(0.20)	(0.33)	(0.42)
Contr MP shock	-0.54	2.65	-1.87	-1.18
	(0.30)	(1.36)	(2.28)	(2.44)
Contr MP shock	0.05	-0.93	-0.41	-0.47
× El.	(0.10)	(0.36)	(0.59)	(0.61)
Observations	16724	15672	14620	13568
MSAs	263	263	263	263
R^2	0.388	0.509	0.596	0.677
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 when using the HFI monetary policy shocks of Gertler and Karadi (2015) in a LP-IV model. 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 (1) 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. We use Conley (1999, 2008) standard errors that are robust to both spatial correlation and autocorrelation, by employing the code developed by Hsiang (2010). We use the QGIS-software to calculate latitudes and longitudes of MSA centroids, and set the cut-off distance for the spatial correlation at 100 miles. The kernel that is used to weigh the spatial correlations decays linearly with distance in all directions. The standard errors are reported in absolute value in parenthesis below the point estimates. To calculate MSA centroids, we use 2019 TIGER/Line files for US CBSA's from https://www.census.gov/cgi-bin/geo/shapefiles/index.php.

Alternative measure of supply elasticity

Table A.5: Asymmetric and heterogeneous effects of monetary policy shocks on house prices when using sensitivity measure of Guren et al. (2020).

	h=0	h=4	h=8	h=12
Exp MP shock	0.09	1.33	3.75	2.90
	(0.12)	(0.36)	(0.56)	(0.82)
Exp MP shock	-0.39	3.28	6.89	6.97
× Sens.	(0.25)	(1.19)	(1.78)	(2.05)
Contr MP shock	0.21	-0.92	-3.06	-5.10
	(0.15)	(0.45)	(0.71)	(1.00)
Contr MP shock	-0.59	-0.22	-0.28	-2.35
× Sens.	(0.33)	(1.14)	(1.55)	(2.24)
Observations	23046	22002	20958	19914
MSAs	261	261	261	261
R^2	0.266	0.473	0.510	0.534
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 for different values of the sensitivity measure in Guren et al. (2020) as an alternative measure of (the inverse of) 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 (1) 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 sensitivity measure (a proxy for the inverse of the supply elasticity) by Guren et al. (2020), and whether the monetary policy shock is expansionary or contractionary. We use Conley (1999, 2008) standard errors that are robust to both spatial correlation and autocorrelation, by employing the code developed by Hsiang (2010). We use the QGIS-software to calculate latitudes and longitudes of MSA centroids, and set the cut-off distance for the spatial correlation at 100 miles. The kernel that is used to weigh the spatial correlations decays linearly with distance in all directions. The standard errors are reported in absolute value in parenthesis below the point estimates. To calculate MSA centroids, we use 2019 TIGER/Line files for US CBSA's from https://www.census.gov/cgi-bin/geo/shapefiles/index.php.

Controlling for Census Division-by-quarter fixed effects

Table A.6: Asymmetric and heterogeneous effects of monetary policy shocks on house prices when controlling for Census Division-by-quarter fixed effects.

	h=0	h=4	h=8	h=12
Exp MP shock × El.	0.06	-0.55	-0.97	-1.12
	(0.10)	(0.20)	(0.32)	(0.44)
Contr MP shock	-0.04	-0.39	-0.24	0.23
× El.	(0.13)	(0.22)	(0.35)	(0.44)
Observations	23212	22160	21108	20056
MSAs	263	263	263	263
R^2	0.464	0.712	0.750	0.770
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 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 (1) 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. This means that the common effects of contractionary and expansionary shocks are soaked up by the fixed effects, which is why we only tabulate the interaction effects. We use Conley (1999, 2008) standard errors that are robust to both spatial correlation and autocorrelation, by employing the code developed by Hsiang (2010). We use the QGIS-software to calculate latitudes and longitudes of MSA centroids, and set the cut-off distance for the spatial correlation at 100 miles. The kernel that is used to weigh the spatial correlations decays linearly with distance in all directions. The standard errors are reported in absolute value in parenthesis below the point estimates.

Demographics

Table A.7: Asymmetric and heterogeneous effects of monetary policy shocks on house prices. Controlling for the fraction of young people.

	h=0	h=4	h=8	h=12
Exp MP shock	-0.25	2.69	7.39	7.47
	(0.23)	(0.82)	(1.33)	(1.87)
Exp MP shock × El.	0.14	-0.54	-1.42	-1.80
	(0.08)	(0.26)	(0.40)	(0.56)
Exp MP shock × Young	-1.14	-22.07	-20.60	1.29
	(4.93)	(17.55)	(26.37)	(35.10)
Exp MP shock × Young × El.	-1.01	7.57	6.26	-3.61
	(1.65)	(5.14)	(7.66)	(10.13)
Contr MP shock	-0.05	-0.79	-3.35	-6.12
	(0.30)	(1.01)	(1.66)	(2.39)
Contr MP shock × El.	0.10	-0.06	0.18	0.44
	(0.12)	(0.30)	(0.48)	(0.67)
Contr MP shock × Young	-5.05	-13.57	-0.41	33.97
	(5.82)	(16.72)	(25.66)	(38.07)
Contr MP shock × Young × El.	3.24	4.62	0.46	-12.17
	(2.03)	(4.54)	(7.01)	(10.34)
Observations	23141	22093	21045	19997
MSAs	262	262	262	262
R^2	0.266	0.473	0.513	0.532
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 and different demographics. 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 an augmented version of equation (1) using a fixed effect estimator, and the data set covers a panel of 262 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 the fraction of young people, the interaction between fraction of young and the monetary policy shocks, the interaction between the fraction of young and the supply elasticity, as well as the triple interaction between the fraction of young, the supply elasticity, and the monetary policy shocks. We also include double and triple interactions between the fraction of young and the control variables. The fraction of young is defined as the fraction of people in the age group 20–34 relative to the number of people aged above 20 years. We use Conley (1999, 2008) standard errors that are robust to both spatial correlation and autocorrelation, by employing the code developed by Hsiang (2010). We use the QGIS-software to calculate latitudes and longitudes of MSA centroids, and set the cut-off distance for the spatial correlation at 100 miles. The kernel that is used to weigh the spatial correlations decays linearly with distance in all directions. The standard errors are reported in absolute value in parenthesis below the point estimates. To calculate MSA centroids, we use 2019 TIGER/Line files for US CBSA's from https://www.census.gov/cgi-bin/geo/shapefiles/index.php.

Greenbook forecasts

Table A.8: Asymmetric and heterogeneous effects of monetary policy shocks on house prices. Controlling for Greenbook forecasts.

	h=0	h=4	h=8	h=12
Exp MP shock	-0.35	2.23	7.15	7.15
	(0.23)	(0.75)	(1.26)	(1.85)
Exp MP shock	0.11	-0.65	-1.63	-2.18
× El.	(0.09)	(0.24)	(0.39)	(0.55)
Contr MP shock	-0.12	-0.04	-2.07	-5.86
	(0.30)	(0.99)	(1.62)	(2.33)
Contr MP shock	0.15	-0.07	0.39	0.89
× El.	(0.11)	(0.29)	(0.47)	(0.65)
Observations	23212	22160	21108	20056
MSAs	263	263	263	263
R^2	0.289	0.504	0.536	0.555
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 and controlling for Greenbook forecasts. 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 (1) 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. Greenbook forecasts are added as controls. We add the nowcast, the 1-quarter ahead, and the 2-quarters ahead forecasts for GDP, inflation and unemployment rates. We use Conley (1999, 2008) standard errors that are robust to both spatial correlation and autocorrelation, by employing the code developed by Hsiang (2010). We use the QGIS-software to calculate latitudes and longitudes of MSA centroids, and set the cut-off distance for the spatial correlation at 100 miles. The kernel that is used to weigh the spatial correlations decays linearly with distance in all directions. The standard errors are reported in absolute value in parenthesis below the point estimates. To calculate MSA centroids, we use 2019 TIGER/Line files for US CBSA's from https://www.census.gov/cgi-bin/geo/shapefiles/index.php.

Controlling for non-linearities

Table A.9: Asymmetric and heterogeneous effects of monetary policy shocks on house prices. Controlling for non-linear effects of monetary policy depending on the size of the shock.

	h=0	h=4	h=8	h=12
Exp MP shock	-0.51	6.67	12.01	10.66
	(0.28)	(1.14)	(1.94)	(2.44)
Exp MP shock	0.12	-1.37	-2.64	-2.37
× El.	(0.09)	(0.33)	(0.55)	(0.68)
Contr MP shock	-0.35	-1.33	-4.67	-7.01
	(0.30)	(1.05)	(1.74)	(2.50)
Contr MP shock	0.16	0.02	0.38	0.35
× El.	(0.12)	(0.31)	(0.51)	(0.71)
Observations	23212	22160	21108	20056
MSAs	263	263	263	263
R^2	0.266	0.464	0.498	0.515
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 and potential non-linear effects of monetary policy shocks. 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 (1) 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 follow Tenreyro and Thwaites (2016) and add the third power of the monetary policy shock as well as its interaction with the supply elasticity to control for potential non-linear effects. We use Conley (1999, 2008) standard errors that are robust to both spatial correlation and autocorrelation, by employing the code developed by Hsiang (2010). We use the QGIS-software to calculate latitudes and longitudes of MSA centroids, and set the cut-off distance for the spatial correlation at 100 miles. The kernel that is used to weigh the spatial correlations decays linearly with distance in all directions. The standard errors are reported in absolute value in parenthesis below the point estimates. To calculate MSA centroids, we use 2019 TIGER/Line files for US CBSA's from https://www.census.gov/cgi-bin/geo/shapefiles/index.php.

MSA-by-MSA analysis

For MSA i, we estimate the following specification:

$$ph_{i,t+h} - ph_{i,t-1} = \alpha_i + \beta_{i,h}^{Exp.} RR_t^{Exp.} + \beta_{i,h}^{Cont.} RR_t^{Cont.} + \mathbf{\Gamma}_i \boldsymbol{W}_{i,t} + \varepsilon_{i,t} \tag{A.2}$$

With N MSAs and H horizons, this gives us two $N \times H$ matrices of the response to contractionary and expansionary shocks. Thus, the mean group estimators for quintile q at horizon h are given by:

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

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

Table A.10: Asymmetric effects of monetary policy, grouping by quartiles.

	Expansionary shock:				
Horizon	Q1	Q2	Q3	Q4	Q5
0	0.15	0.08	0.49	0.60	0.22
	(0.20)	(0.18)	(0.30)	(0.24)	(0.23)
4	4.02	2.12	1.59	0.81	1.58
	(0.59)	(0.58)	(0.67)	(0.61)	(0.49)
8	8.80	5.66	3.73	2.65	2.26
	(0.91)	(0.90)	(0.91)	(0.90)	(0.66)
12	9.39	6.57	3.12	2.40	0.66
	(1.27)	(1.24)	(1.20)	(1.34)	(0.93)
	Contractionary shock:				
Horizon	Q1	Q2	Q3	Q4	Q5
0	-0.06	0.34	0.20	0.69	0.67
	(0.20)	(0.28)	(0.34)	(0.36)	(0.42)
4	-0.58	0.29	-0.27	-1.16	0.15
	(0.71)	(0.76)	(0.70)	(0.72)	(0.62)
8	-2.85	-2.25	-1.84	-2.77	-0.72
	(1.03)	(1.07)	(1.10)	(1.02)	(0.94)
12	-3.56	-4.63	-4.00	-3.76	-2.61
	(1.48)	(1.40)	(1.25)	(1.26)	(1.11)

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 numbers in parentheses are (absolute) standard errors. 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).

Balanced panel

Table A.11: Asymmetric and heterogeneous effects of monetary policy shocks on house prices using a balanced panel.

	h=0	h=4	h=8	h=12
Exp MP shock	-0.17	4.00	9.68	11.08
	(0.33)	(1.14)	(1.88)	(2.63)
Exp MP shock	0.09	-1.32	-2.65	-3.81
× El.	(0.16)	(0.45)	(0.71)	(1.00)
Contr MP shock	0.22	-0.08	-2.92	-6.08
	(0.44)	(1.44)	(2.39)	(3.49)
Contr MP shock	-0.11	-0.81	-0.69	-0.21
× El.	(0.22)	(0.54)	(0.86)	(1.21)
Observations	13961	13373	12785	12197
MSAs	147	147	147	147
R^2	0.352	0.504	0.512	0.514
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 (1) 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. We use Conley (1999, 2008) standard errors that are robust to both spatial correlation and autocorrelation, by employing the code developed by Hsiang (2010). We use the QGIS-software to calculate latitudes and longitudes of MSA centroids, and set the cut-off distance for the spatial correlation at 100 miles. The kernel that is used to weigh the spatial correlations decays linearly with distance in all directions. The standard errors are reported in absolute value in parenthesis below the point estimates. To calculate MSA centroids, we use 2019 TIGER/Line files for US CBSA's from https://www.census.gov/cgi-bin/geo/shapefiles/index.php.

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