Description of code and data for replicating the findings in the paper
"Changing supply elasticities and regional housing booms"

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1 Data

1.1 Publicly available data:

1. *GIS-data used to create Figure 4 in the paper and Figure B.1 in the supplementary Appendix:* To draw MSA (and State) polygons (before coloring them), we use the *maptile*-code written by Meru Bhanot and Michael Stepner. In the original code, 2013 GIS-data were used for CBSAs and 2010 GIS-data were used for US states. We updated these data to the 2019-editions. The raw data used to draw the maps are downloaded from the National Historical Geographic Information System (NHGIS). The downloaded datasets are *US_cbsa_2019* and *US_states_2019*. The full citations are:

   - *US_cbsa_2019*: Steven Manson, Jonathan Schroeder, David Van Riper, and Steven Ruggles. IPUMS National Historical Geographic Information System: Version 15.0 [*US_cbsa_2019*]. Minneapolis, MN: IPUMS. 2020.
     http://doi.org/10.18128/D050.V15.0
   - *US_states_2019*: Steven Manson, Jonathan Schroeder, David Van Riper, and Steven Ruggles. IPUMS National Historical Geographic Information System: Version 15.0 [*US_states_2019*]. Minneapolis, MN: IPUMS. 2020.
     http://doi.org/10.18128/D050.V15.0

   These data sets are based on the 2019 TIGER/Line files located at the webpages of the U.S. Census Bureau. The following terms of conditions apply to these data (taken from https://www.nhgis.org/ipums-nhgis-terms-use):

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- REDISTRIBUTION: YOU WILL NOT REDISTRIBUTE THE DATA WITHOUT PERMISSION. You may publish a subset of the data to meet journal requirements for accessing data related to a particular publication. Contact us for permission for any other redistribution; we will consider requests for free and commercial redistribution.

- CITATION: CITE THE NHGIS DATA APPROPRIATELY. For information on proper citation refer to citation and use. Publications and research reports making use of NHGIS should be added to our Bibliography

To improve the speed of map creation, we follow Meru Bhanot and Michael Stepner and simplify the maps via mapshaper.org using Visvalingam/weighted area to 0.2%, then repairing line intersections. This has no bearing on the results illustrated (Figure 4 and Figure B.1), but makes the size of the pdf-files smaller. Variable descriptions for the two datasets are given below.

- *US_cbsa_2019*: We use *shp* and *dbf* files including GIS coordinates for CBSA boundaries, as well as the following attributes:
  - GISJOIN - Unique identifier for joining to NHGIS tabular data
  - CSAFP - Current combined statistical area code, if applicable
  - CBSAFP -Current metropolitan statistical area/micropolitan statistical area code
  - GEOID - Metropolitan statistical area/micropolitan statistical area identifier, metropolitan statistical area/micropolitan statistical area code
  - NAME - Current metropolitan statistical area/micropolitan statistical area name
  - NAMELSAD - Current name and the translated legal/statistical description for metropolitan statistical area/micropolitan statistical area
  - LSAD - Current legal/statistical area description code for metropolitan statistical area/micropolitan statistical area
  - MEMI - Current metropolitan/micropolitan status indicator
  - MTFCC - MAF/TIGER feature class code
  - ALAND - Current land area (square meters)
  - AWATER - Current water area (square meters)
  - INTPTLAT - Current latitude of the internal point
  - INTPTLON - Current longitude of the internal point
- *US_states_2019*: We use the *shp* and *dbf* files including GIS coordingates for State boundaries, as well as the following attributes:
  - GISJOIN - Unique identifier for joining to NHGIS tabular data
  - REGION - Current Census region code
  - DIVISION - Current Census division code
  - STATEFP - Current state Federal Information Processing Series (FIPS) code

- STATENS - Current state GNIS code
- GEOID - State identifier; state FIPS code
- STUSPS - Current United States Postal Service state abbreviation
- NAME - Current state name
- LSAD - Current legal/statistical area description code for state
- MTFCC - MAF/TIGER feature class code
- FUNCSTAT - Current functional status
- ALAND - Current land area (square meters)
- AWATER - Current water area (square meters)
- INTPTLAT - Current latitude of the internal point
- INTPTLON - Current longitude of the internal point

2. *National level data:* The national level data are all publicly available and come from multiple sources. A description of each data series is provided below:

   - *ffs3m_shock*: Gertler and Karadi (2015) monetary policy shock, identified using changes in 3-month ahead contracts on Fed funds futures in a 30-minute window around FOMC announcement dates. Monthly observations of the monetary policy shock were downloaded in August 2016 from the replication codes of Gertler and Karadi (2015). We use their shocks until 2003q3, and – following their methodology– we update the series through 2019q4.
   https://www.openicpsr.org/openicpsr/project/114082/version/V1/view.
   Our quarterly observations correspond to taking the average of the monthly observations within each quarter

   - *ffr_sw*: Swanson (2021) federal funds rate surprise
   https://www.socsci.uci.edu/ swanson2/researchpublished.html

   - *fg_sw*: Swanson (2021) forward guidance surprise
   https://www.socsci.uci.edu/ swanson2/researchpublished.html

   - *lsap_sw*: Swanson (2021) large-scale asset purchase surprise
   https://www.socsci.uci.edu/ swanson2/researchpublished.html

   - *gazzani*: Federal funds rate surprise, aggregated to a quarterly frequency following Gazzani and Vicondoa (2020)

   - *us_cpi*: National CPI (Consumer Price Index for All Urban Consumers: All Items in U.S. City Average [CPIAUCSL] from U.S. Bureau of Labor Statistics, retrieved from FRED, Federal Reserve Bank of St. Louis;
   https://fred.stlouisfed.org/series/CPIAUCSL

   - *us_hpi*: National house price index from FHFA [USSTHPI], retrieved from FRED, Federal Reserve Bank of St. Louis;
   https://fred.stlouisfed.org/series/USSTHPI

   - *us_gs1*: One-year t-bill (FRED code: GS1)

   - *us_gs2*: Two-year t-bill, constant maturity rate (FRED code: GS2)

   - *us_ebp*: Excess bond premium (credit spread)
   https://www.federalreserve.gov/econresdata/notes/feds-notes/2016/files/ebp_csv.csv

3. *State-level data:*

   - *land_reg*: This is the model-inferred land-use regulation index of Herkenhoff et al. (2018)

   - *wage*: Wages and salaries in the construction sector. FRED code: XXWCON, in which XX stands for the state code. Constructed based on data from BEA and U.S. Census Bureau.

4. *MSA-level data:*

   - *unaval*: The land unavailability index captures housing supply geographical constraints. It is constructed using topographic maps measuring the proportion of land in a 50 km radius of the city center that is lost to steep slopes and water bodies, such as oceans, rivers, lakes and wetlands. Source: Saiz (2010)

   - *wrluri*: The Wharton Residential Land Use Regulatory Index captures regulatory restrictions in the housing market, i.e. measures the time and financial cost of acquiring building permits and constructing a new home. It refers to the principal component of 11 survey-based measures which is interpreted as the degree of stringency of local zoning laws. Source: Gyourko et al. (2008)

   - *prop_crime*: Counts of crimes per 100,000 inhabitants reported to the police for each police agency (cities, towns, and villages). It is broken down into two major types: violent crime, which includes offences of murder, forcible rape, robbery, and aggravated assault, and property crime, which includes offences of burglary, larceny-theft, and motor vehicle theft. Source: Uniform Crime Report Offenses Known to Law Enforcement dataset of the FBI

   - *fatal*: Mass shootings with at least four fatalities, constructed by Pappa et al. (2019). Updated through 2019 using the Mother Jones data base

1.2 Proprietary data:

We have also used a set of variables purchased from Moody's Analytics and downloaded in May 2020. All these data are at the MSA-level. These data are not included in the replication code, but can be purchased from Moody's Analytics. A list of variables is given below (_XXXX refers to short MSA-name in Moody's Analytics database):

- *permits*: Number of permits issues by local jurisdiction to proceed on a construction project. Calculated based on data from U.S. Census Burea (Moodys' Mnemonic: RHPN1M.IUSA_XXXX)

- *hpi*: FHFA House Price Index - New and existing buildings - All transactions (Moodys' Mnemonic: HOFHOPIQ.IUSA_XXXX)

- *pop*: Resident population based on data from U.S. Census Bureau (Moodys' Mnemonic: RFPOPQ.IUSA_XXXX)

- *pop_density*: Population per square mile based on data from U.S. Census Bureau. Annual data interpolated to quarterly frequency (Moodys' Mnemonic: POPDENSA.IUSA_XXXX)

- *dom_mig*: Difference between domestic immigration and outmigration relative to total population based on data from U.S. Census Bureau (Moodys' Mnemonic: RNMDQ.IUSAin_XXXX)

- *int_mig*: Difference between international immigration and outmigration relative to total population based on data from U.S. Census Bureau (Moodys' Mnemonic: XHVACHQ.IUSA_XXXX)

- *home_vacant*: Homeowner vacancy rate based on data from U.S. Census Bureau (Moodys' Mnemonic: POPDENSA.IUSA_XXXX)

- *cpi*: Consumer price index (Urban Consumer) - All Items, based on data from BLS (Moodys' Mnemonic: RCPIUM.IUSA_XXXX)

- *rinc/ninc*: Real/nominal personal disposable income (Moodys' Mnemonic: RYPDPI\$Q.IUSA_XX

- *ur*: The number of unemployed persons relative to total labor force. Based on data from BLS. (Moodys' Mnemonic: LBR.IUSA_XXXX)

- *nfp* Total nonfarm employment based on data from BLS (Moodys' Mnemonic: ET.IUSA_XXXX)

- *mort_org*: New mortgages (USD) approved by mortgage broker or loan officer from HMDA (Moodys' Mnemonic: RMOF14TQ.IUSA_XXXX)

- *pop_wa*: Working age (15-64) population in ths. based on data from U.S. Census Bureau (Moodys' Mnemonic: RPOP1519Q.IUSA_XXXX + RPOP2024Q.IUSA_XXXX + RPOP2529Q.IUSA_XXXX + RPOP3034Q.IUSA_XXXX + RPOP3539Q.IUSA_XXXX + RPOP4044Q.IUSA_XXXX + RPOP4549Q.IUSA_XXXX + RPOP5054Q.IUSA_XXXX + RPOP5559Q.IUSA_XXXX + RPOP6064Q.IUSA_XXXX)

- *dep_ratio*: Sum of population below 15 and older than 64 relative to *pop_wa* (Moodys' Mnemonic for numerator: RPOP0004Q.IUSA_XXXX + RPOP0590Q.IUSA_XXXX + RPOP1014Q.IUSA_XXXX + RPOP65GQ.IUSA_XXXX)

- *fem*: Female population (in ths.) based on data from U.S. Census Bureau (Moodys' Mnemonic: POPFA.IUSA_XXXX)

- *male*: Male population (in ths.) based on data from U.S. Census Bureau (Moodys' Mnemonic: POPMA.IUSA_XXXX)

- *black*: Black population (in ths.) based on data from U.S. Census Bureau (Moodys' Mnemonic: POPBA.IUSA_XXXX)

- *hispanic*: Hispanic population (in ths.) based on data from U.S. Census Bureau (Moodys' Mnemonic: POPHA.IUSA_XXXX)

1.3 Data used for descriptive figures

Data used for drawing Figure 1, Figure 2, Figure A.1, Figure A.2, Figure A.3, Figure A.4, Figure C.7, Figure C.8, Figure C.9, Figure C.10, and Figure C.11 are described below:

- *Figure 2*:

  - *Real HPI*: FHFA house price index deflated by consumer price index all urban consumers (FRED codes: USSTHPI and CPIAUCSL)
  - *HPI to income per capita*: FHFA house price index divided by disposable personal income per capita (FRED codes: USSTHPI and A229RCO)
  - *Building permits as % of housing stock*: Building permits divided by seasonally adjusted total units of US housing inventory (FRED code: PERMIT; Datastream code: USHIN...P)
  - *Housing starts as % of housing stock*: Housing starts divided by seasonally adjusted total units of US housing inventory (FRED code: HOUST; Datastream code: USHIN...P)

- *Figure A.1*:

  - *Real disposable income*: Real disposable personal income (FRED codes: DSPIC96)
  - *Real consumption*: real personal consumption expenditures (FRED codes: PCECC96)

- *Figure A.2*:

  - *Median sales prices of new homes*: non-seasonally adjusted median existing home price of single-family and condos (Datastream code: USHSMEDEA)
  - *Median sales prices of new homes*: non-seasonally adjusted median sales price of new houses sold (FRED code: MSPNHSUS)

- *Figure A.3*:

  - *HPI to income per capita ratio*: hpi divided by ninc times pop
  - *Building permits as % of housing stock*: Number of permits based on data from U.S. Census Burea (Moodys' Mnemonic: RHPN1M.IUSA_XXXX) divided by the housing stock based Decennial Census, American Community Survey, Census Estimates (Moodys' Mnemonic: RHSTKQ.IUSA_XXXX)

- *Figure A.4*:

  - *Building permits - single-family (% of housing stock)*: new private housing units authorized by building permits in structures with 1 unit divided by seasonally adjusted total units of US housing inventory (FRED code: PERMIT1; Datastream code: USHIN...P)
  - *Building permits - multi-family (% of housing stock)*: new private housing units authorized by building permits in structures with 2 to 5 units divided by seasonally adjusted total units of US housing inventory (FRED code: PERMIT24 + PERMIT5; Datastream code: USHIN...P)

- *Figure C.7*:

  - *Housing stock per capita*: seasonally adjusted total units of US housing inventory divided by number of households (Datastream codes: USHIN...P and USHH...P)

  - *Months' supply*: monthly supply of houses (FRED code: MSACSR)

- *Figure C.8*:

  - *New homes available for sale/ households*: new one-family homes for sale divided by number of households (FRED code: HNFSEPUSSA; Datastream code: USHH...P)

  - *Existing homes available for sale/ households*: existing one-family homes available for sale divided by number of households (Datastream codes: USHSALEEP and USHH...P)

- *Figure C.9*:

  - *Homeowner vacancy rate*: Vacant owner-occupied units as a percentage of total housing stock (FRED code: RHVRUSQ156N; Datastream code: USHIN...P)

  - *Rental vacancy rate*: Vacant rental units as a percentage of total housing stock (FRED code: RRVRUSQ156N; Datastream code: USHIN...P)

- *Figure C.10*:

  - *New foreclosures*: new foreclosures as a % of total loans (HAVER codes: USL14F@MBAMTG)

  - *Delinquency rates*: all mortgages past due (over 30 days) as a % of total loans (HAVER codes: USL14@MBAMTG)

- *Figure C.11*:

  - *Share of construction employment*: number of employees in construction as a share of total non-farm employment (FRED codes: USCONS and PAYEMS)

  - *Number of construction workers per housing start*: number of employees in construction divided by total number of housing starts (FRED codes: USCONS and HOUST)

1.4 Data identifiers

- *time*: Year-quarter of the observation

- *year*: Year of the observation

- *quarter*: Quarter of the observation

- *msa*: CBSA code from the US Census Bureau

- *msa_name*: Name of CBSA along with the states it belongs to

- *name*: Name of the MSA

- *main_state*: Some MSAs belong to multiple MSAs. The main state is the state in which the largest proportion of the MSA-population lives

- *msa_num*: Identifier for MSA. Created based on CBSA code

2   Software requirements

All calculations have been done using Stata 16.1. The following packages are needed to replicate the findings (automatically installed in the main replication files):

- *asrol*

- *estout*

- *labutil*

- *listtab*

- *maptile*

- *matmap*

- *nbercycles*

- *shp2dta*

- *spmap*

- *unique*

- *ols_spatial_HAC.ado* (provided)

- *cbsa2019_maptile.ado* (provided)

- *reshape_us_CBSA.ado* (provided)

- *reshape_us_CBSAstateoutline.ado* (provided)

3   Folder structure

The main folder, *Replication*, for replicating the paper consists of the following sub-folders:

1. *Codes*: This sub-folder includes all do-files needed to replicate the results in the paper and in the supplementary Appendix. The structure of the folder is as following:

(a) The folder *For SE and maps* contains the do-file *Map.do* which is called on to construct the polygons of the maps that are used to generate Figure 4 in the paper and Figure B.1 in the supplementary Appendix. This code is written by Meru Bhanot and Michael Stepner and can be downloaded from here In addition, the folder contains the ado-file *ols_spatial_HAC.ado*, written by Solomon Hsiang. The code was used in the paper by Hsiang (2010) to calculate Conley (1999, 2008) standard errors that are robust to both spatial correlation and autocorrelation. This code is called in our estimations in order to calculate standard errors using the MSA-centroids to calculate distances between MSAs

(b) The folder *Paper* contains all do-files needed to replicate all tables and figures reported in the published paper. While the underlying sub-codes are stored in the folders *Figures* and *Tables*, the code *main_paper.do* is the master code and the only code that needs to be run in order to replicate all our results

(c) The folder *Appendix* contains all do-files needed to replicate all tables and figures reported in the supplementary Appendix. While the underlying sub-codes are stored in the folders *Figures* and *Tables*, the code *main_appendix.do* is the master code and the only code that needs to be run in order to replicate all our results

2. *Data*: This sub-folder contains all raw and constructed data and is organized as follows:

(a) *Maps*: These are all the files needed to construct the maps of the US, including shape-files

(b) *RawData*: Raw data used in the paper

(c) *ConstructedData*: All datasets that are constructed by running the codes. These datasets will be constructed when running the code(s)

3. *Figures* This is where figures are stored (both for the paper and for the supplementary Appendix). All figures are stored automatically, and are saved in pdf-format

4. *Tables* The codes automatically generates LATEX-tables, which are stored in this folder

4   Code structure

All codes needed to replicate our results are stored in the folder *Codes*. Auxiliary codes used for generating maps and calculating standard errors are stored in the sub-folder *For SE and maps*. The structure of the codes is as follows:

1. Paper: All codes to replicate tables and figures in the paper are stored in the folder *Paper*:

   - By changing the global path on line 10 in *main_paper.do*, all results in the paper are replicated. This master code runs a set of sub-codes that separately

reproduces each table and figure, which can also be run one-by-one (after running the first 18 lines of *main_paper.do*. The underlying codes for generating tables and figures are stored in the folders *Tables* and *Figures*, respectively. Figures are automatically saved in pdf-format, whereas tables are outputted to LATEXformat. A description of all codes below:

- *Data_Transformations.do*: This code does all the data transformations and preparations needed to replicate results before Section 6
- *Data_Transformations LP.do*: This code does additional data transformations and preparations needed to replicate results in Section 6
- *Table 1.do*: Replicates Table 1
- *Table 2.do*: Replicates Table 2
- *Table 3.do*: Replicates Table 3. This code calls on *ols_spatial_HAC.ado*
- *Table 4.do*: Replicates Table 4
- *Figure 3.do*: Replicates Figure 3
- *Figure 4.do*: Replicates Figure 4. This code calls on *Map.do* in order to get the shape of the map
- *Figure 5.do*: Replicates Figure 5
- *Table A.1.do*: Replicates Table A.1 in the Appendix contained in the paper

- Figure 1 and Figure 2 are created in Excel. They are shown in the file "FiguresExcel.xlsx", which calls on the data file "DataFigures.xlsx"

2. Supplementary Appendix: All codes to replicate tables and figures in the supplementary Appendix are stored in the folder *In Appendix*:

- By changing the global path on line 10 in *main_appendix.do*, all results in the supplementary Appendix are replicated. This master code runs a set of sub-codes that separately reproduces each table and figure, which can also be run one-by-one (after running the first 18 lines of *main_appendix.do*. The underlying codes for generating tables and figures are stored in the folders *Tables* and *Figures*, respectively. Figures are automatically saved in pdf-format, whereas tables are outputted to LATEXformat. A description of all codes below:

  - *Data_Transformations.do*: This code does all the data transformations and preparations
  - *Table A1, Table A2, and Table A3.do*: Replicates Table A.1, Table A.2, and Table A.3
  - *Table B1 and Table B2.do*: Replicates both Table B.1 and Table B.2
  - *Table D1 and Figure D2.do*: Replicates both Table D.1 and Figure D.2
  - *Figure B.1.do*: Replicates Figure B.1. This code calls on *Map.do* in order to get the shape of the map
  - *Figure C.1.do*: Replicates Figure C.1
  - *Figure C.2.do*: Replicates Figure C.2
  - *Figure C.3.do*: Replicates Figure C.3

- *Figure C.4.do*: Replicates Figure C.4
- *Figure C.5.do*: Replicates Figure C.5
- *Figure C.6.do*: Replicates Figure C.6
- *Figure D.3.do*: Replicates Figure D.3
- *Figure D.4.do*: Replicates Figure D.4
- *Figure D.5.do*: Replicates Figure D.5

- Figure A.1, Figure A.2, Figure A.3, Figure A.4, Figure C.7, Figure C.8, Figure C.9, Figure C.10, and Figure C.11 are created in Excel. They are shown in the file "FiguresExcel.xlsx", which calls on the data file "DataFigures.xlsx"

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