# What Happens in Vegas Doesn't Always Stay in Vegas:

*The Dynamics of House Prices and Foreclosure Rates Across Space and Time*


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*paper and slides*

*The views expressed in this paper are those of the authors alone and do not reflect those of The Federal Deposit Insurance Corporation, the Office of the Comptroller of the Currency, and Freddie Mac.*

# Our Contribution

- Specify a Dynamic Spatial Simultaneous Equation System panel model at quarter/state level that
    - Allows simultaneous movement in house prices and foreclosure rates
    - Captures dynamics over time and space
- Identify instruments for house prices and foreclosure rates
- Show that at the state level, there is an amplification mechanism for foreclosure rates
    - Foreclosure shocks have a large and persistent impact on house prices
    - Shocks to housing markets propagate to nearby states
    - A one standard deviation increase in Nevada foreclosure rate leads to
        - 8% decline in Nevada real house prices after 8 quarters
        - 3% decline in California real house prices after 8 quarters

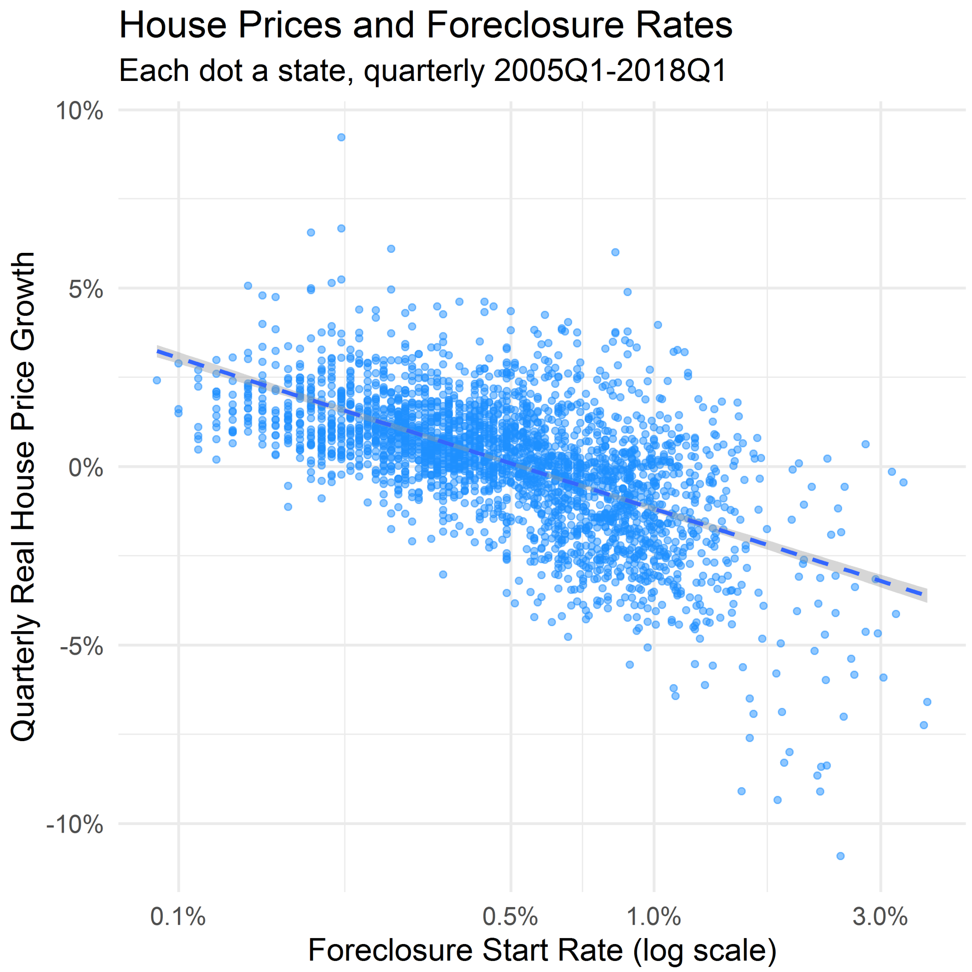
# (1) Introduction

# House prices and foreclosure rates are negatively correlated

Do high foreclosure rates cause lower house prices?

Or do lower house prices drive foreclosure rates up?

*Why not both?*



## Lower house prices drive foreclosure rates higher

- Theory
    - Foster and Van Order (1984) option-based model
- Empirics
    - Bajari, Chu, Park (2008)
    - Foote, Gerardi, Willen (2008)
    - Guiso, Zingales (2013)

## Higher foreclosure rates drive house prices lower

- Foreclosure discount of 20% or more (own property)
    - Carroll, Clauretie, Neill(1997)
    - Clauretie and Daneshvary (2009)
    - Harding, Rosenblatt, Yao (2009)
- How about spillovers?
    - After controlling for simultaneity/reverse causality the foreclosure impact on nearby house prices declines to less than 2 percent
        - Campbell, Giglio, Pathak (2011)
        - Hartley (2014)
        - Gerardi, Rosenblatt, Willen (2015)

# Our results relative to two related contrasting studies

- Mian, Trebbi, Sufi (2015)

  1 standard deviation increase in foreclosure rate leads to 8-12% decline in house prices over nine quarters

- Calomiris, Longhofer, Miles (2013)

  1 standard deviation increase in foreclosure rate leads to 2.7% decline in house prices over nine quarters

- Our Result

  1 standard deviation increase in foreclosure rate leads to 7.7% decline in real house prices over nine quarters

# (2) Econometric Model

## Dynamic Spatial Simultaneous Equation System

*Paper also has Panel Vector Autoregression for benchmark/comparison*

# Dynamic Spatial Simultaneous Equation System

$$Y^*_{n2}(t)\Gamma = W_n Y^*_{n2}(t)\Psi + \sum_{j=1}^{p} Y^*_{n2}(t-j)P_j + X^*_n(t)\Pi + d' \otimes l_n + C + U^*_{n2}(t)$$

- $\Gamma$: simultaneous cross effects
- $\Psi$: contemporaneous spillover effects
- $P_j$: time lag effects
- $\Pi$: predetermined/exogenous variable effects
- $d' \otimes l_n$: state fixed effects
- $C$: constant (normalized so $\sum_{i=1}^{n} c_{1,i} = 0$)
- $U^*_{n2}(t)$: disturbance term

# Dynamic Spatial Simultaneous Equation System

We can write the DSSES as (Equation 10):

$$\Phi y^*_{n2}(t) = \mathcal{P} y^*_{n2}(t-1) + r^*(t) + u^*_{n2}(t)$$

$$\Phi = \begin{bmatrix} I_n - \psi_{11} W_n & \gamma_{12} I_n \\ \gamma_{21} I_n & I_n - \psi_{22} W_n \end{bmatrix}$$

$$\mathcal{P} = \begin{bmatrix} \rho_{11} I_n & \rho_{12} I_n \\ \rho_{21} I_n & \rho_{22} I_n \end{bmatrix}$$

- $y^*_{n2}(t)$ dependent variables
- $r^*(t)$ predetermined variables, intercept, fixed effects
- $u^*_{n2}(t)$ shocks

Inverting Equation 10 yields Equation 11

$$y^*_{n2}(t) = \Phi^{-1} \mathcal{P} y^*_{n2}(t-1) + \Phi^{-1} r^*(t) + \Phi^{-1} u^*_{n2}(t)$$

# (3) Data

# Data

- Our estimation window covers 2005Q1-2018Q1
    - 13.25 years (53 quarters)
- Dependent Variables
    - Quarterly log difference in Real (inflation-adjusted) house prices
        - FHFA All-Transactions House Price Index
        - Deflated by BLS- CPIU: All Items less Shelter
    - Log foreclosure start rate (% of loans starting foreclosure)
        - MBA National Delinquency Survey
- We require instruments for house prices and foreclosure rates.
- We also include additional controls to account for economic and general housing market conditions

# Natural population growth as an I.V. for house prices

- To quantify the causal effect of house prices on foreclosures, we use the quarterly change in the growth rate of natural population as our instrument:

$$dnpopg_{i,t} = \Delta[(Births_{i,t} - Deaths_{i,t})/Population_{i,t-1}]$$

- Population growth reflects housing demand and is an important variable in many models of house prices
- When population growth increases, household formation rates tend to rise, driving up housing demand
- But migration patterns at least partially driven by employment, economic conditions
- Natural population growth captures lower frequency movements in population reflecting demographic profile of state and less likely to be correlated with contemporaneous shocks
- Requires that (with $u_{2i,t}$ state $i$'s foreclosure innovation in period $t$)

$$E[dnpopg_{i,t} \cdot u_{2i,t}] = 0$$

# ARM reset rate as an I.V. for foreclosures

- We focus on the loans experiencing a rate increase during their initial rate reset using Black Knight's McDash $1^{st}$ lien data
- ARM reset variable $ARM_{i,t}$
  - An ARM reset is flagged at the introductory expiration date or when the first principal and interest (P&I) payment amount changes, whichever comes first
  - Then, we compare the scheduled P&I payment from the current month with that of the previous month to identify whether the rate increases at the reset day
  - Compute the percent of outstanding loans in state $i$ that experience a payment shock that quarter = $ARM_{i,t}$
- Use $log(ARM_{i,t})$ as I.V.

This requires that (with $u_{1i,t}$ state $i$'s house price innovation in period $t$)

$$E[log(ARM_{i,t}) \cdot u_{1i,t}] = 0$$

*Results robust to using $log(ARM_{i,t-1})$ as an I.V.*

# Summary Statistics

dlrhpi: quarterly log difference in real house price index

lfcl: log foreclosure start rate

dnpopg: quarterly change in the growth rate of natural population ( $\Delta$ (births - deaths)/population)

log_arm: log of proportion of active loans experiencing positive payment shock due to ARM reset

dlemp_lag1: 1-quarter lag in quarterly log difference in nonfarm payroll employment

dlperm_lag1: 1-quarter lag in quarterly log difference in single-family building permits

dlpinc_lag1: 1-quarter lag in quarterly log difference in per capita income

Summary Statistics (2005Q1-2018Q1)

| var | mean | sd | min | max | n |
|---|---|---|---|---|---|
| **Dependent Variables** | | | | | |
| dlrhpi | 0.00 | 0.02 | -0.11 | 0.09 | 2544 |
| lfcl | -0.65 | 0.59 | -2.30 | 1.32 | 2544 |
| **I.V.s** | | | | | |
| dnpopg | 0.00 | 0.00 | -0.01 | 0.01 | 2544 |
| log_arm | -7.24 | 0.84 | -9.26 | -4.12 | 2544 |
| **Predetermined Variables** | | | | | |
| dlemp_lag1 | 0.00 | 0.01 | -0.07 | 0.03 | 2544 |
| dlperm_lag1 | -0.01 | 0.18 | -2.47 | 2.64 | 2544 |
| dlpinc_lag1 | 0.00 | 0.01 | -0.10 | 0.12 | 2544 |

# (4) Empirical Results

## Dynamic Spatial Simultaneous Equation System

*Paper also has Panel Vector Autoregression results*

# Dynamic Spatial Simultaneous Equation System Cross effects

DSSES Estimation: HPA equation

| | Beta 3SLS | Std Error | t value | Pvalue |
|---|---|---|---|---|
| HPA: FCLonHPA (current) | -0.054 | 0.005 | -11.194 | 0.000 |
| HPA: Spatial_lag | 0.444 | 0.038 | 11.831 | 0.000 |
| HPA: owntimelag1 | 0.228 | 0.046 | 4.934 | 0.000 |
| HPA: cross_FCLlag1 | 0.050 | 0.005 | 10.467 | 0.000 |
| HPA: Gamma1_dnpopg | 0.352 | 0.194 | 1.818 | 0.035 |
| HPA: Gamma1_dlemp_lag1 | 0.459 | 0.057 | 8.063 | 0.000 |
| HPA: Gamma1_dlpinc_lag1 | -0.085 | 0.021 | -4.133 | 0.000 |
| HPA: Gamma1_dlperm_lag1 | -0.002 | 0.001 | -1.755 | 0.040 |

DSSES Estimation: FCL equation

| | Beta 3SLS | Std Error | t value | Pvalue |
|---|---|---|---|---|
| FCL: HPAonFCL (current) | -6.684 | 0.730 | -9.161 | 0.000 |
| FCL: Spatial_lag | -0.044 | 0.028 | -1.539 | 0.062 |
| FCL: crossHPAlag1 | 1.212 | 0.742 | 1.634 | 0.051 |
| FCL: owntimelag1 | 0.932 | 0.035 | 27.002 | 0.000 |
| FCL: Gamma2_log_arm | 0.010 | 0.005 | 1.774 | 0.038 |
| FCL: Gamma2_dlemp_lag1 | 2.699 | 1.030 | 2.620 | 0.004 |
| FCL: Gamma2_dlpinc_lag1 | -0.689 | 0.326 | -2.110 | 0.017 |
| FCL: Gamma2_dlperm_lag1 | -0.076 | 0.020 | -3.900 | 0.000 |

# Dynamic Spatial Simultaneous Equation System Spatial lag

DSSES Estimation: HPA equation

| | Beta 3SLS | Std Error | t value | Pvalue |
|---|---|---|---|---|
| HPA: FCLonHPA (current) | -0.054 | 0.005 | -11.194 | 0.000 |
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| FCL: Gamma2_dlperm_lag1 | -0.076 | 0.020 | -3.900 | 0.000 |

# Dynamic Spatial Simultaneous Equation System Time lag

DSSES Estimation: HPA equation

| | Beta 3SLS | Std Error | t value | Pvalue |
|---|---|---|---|---|
| HPA: FCLonHPA (current) | -0.054 | 0.005 | -11.194 | 0.000 |
| HPA: Spatial_lag | 0.444 | 0.038 | 11.831 | 0.000 |
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# Dynamic Spatial Simultaneous Equation System I.V.

DSSES Estimation: HPA equation

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| FCL: Gamma2_dlperm_lag1 | -0.076 | 0.020 | -3.900 | 0.000 |

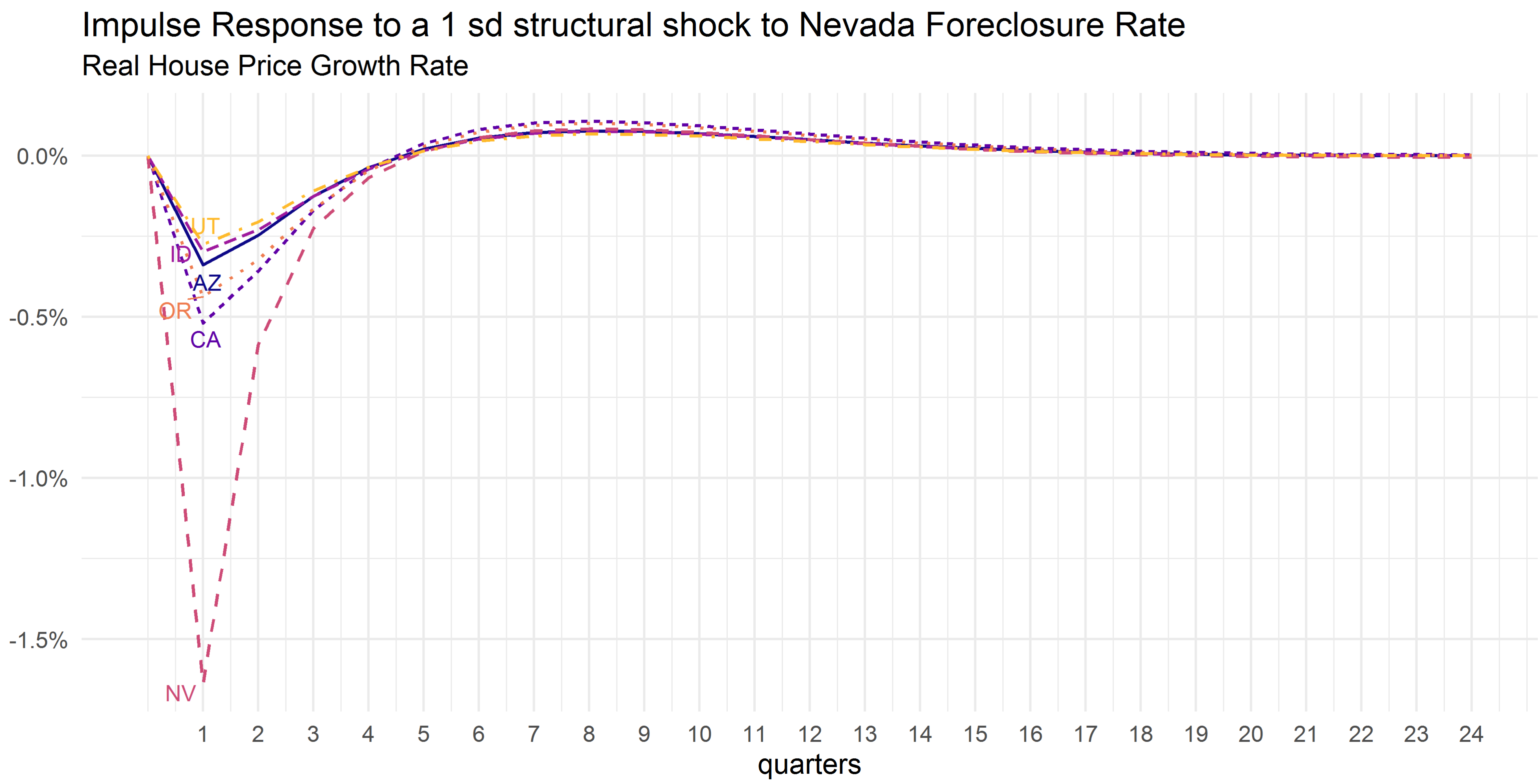
# Dynamic Spatial Simultaneous Equation System

- Given the coefficients we can plug into Equation 11:

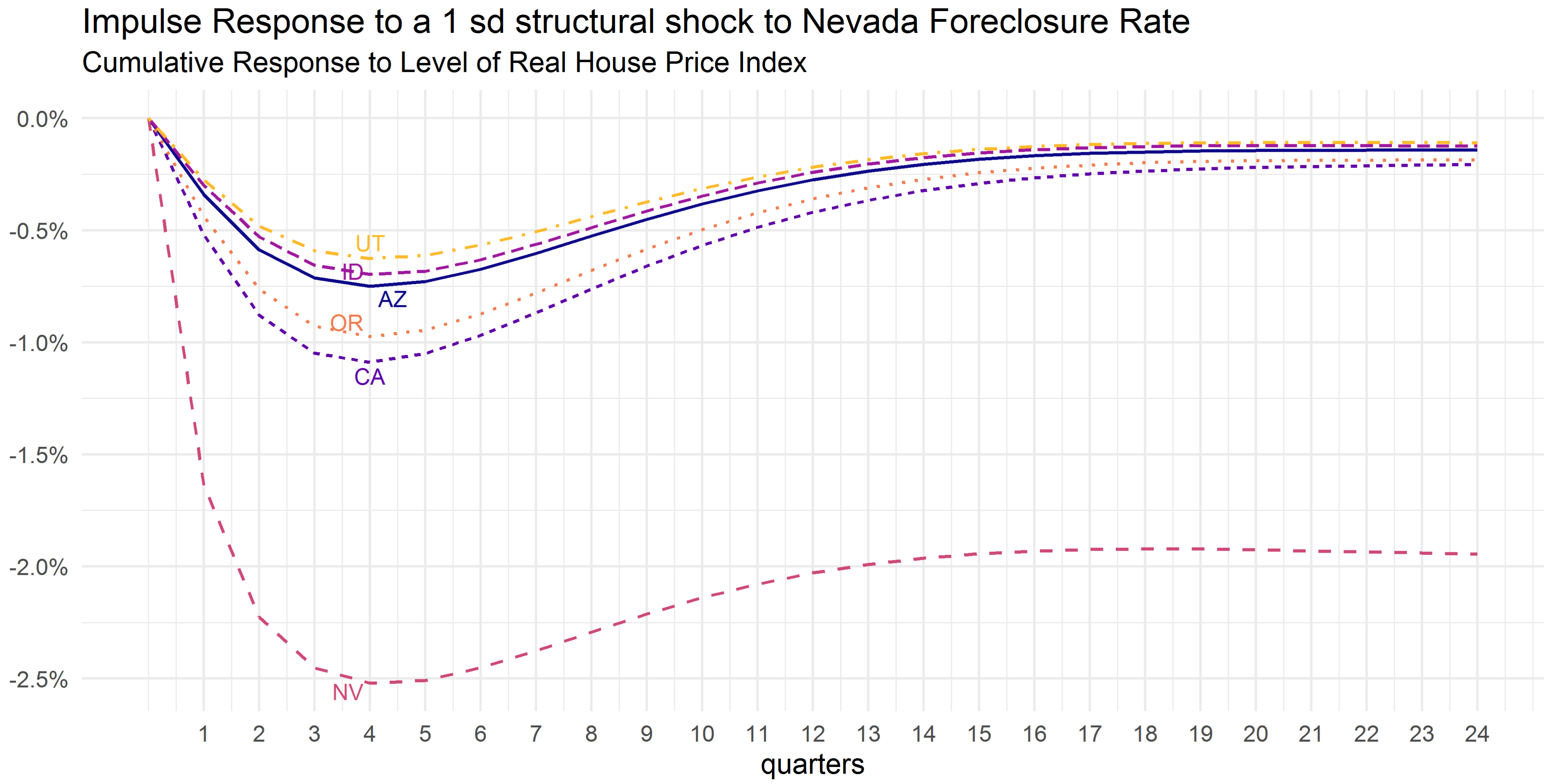
$$y^*_{n2}(t) = \Phi^{-1}\mathcal{P}y^*_{n2}(t-1) + \Phi^{-1}r^*(t) + \Phi^{-1}u^*_{n2}(t)$$

- Short-run Response to a 1 sd shock (average of all 48 states):
  - 1 sd house price shock after 1 quarter
    - increases house prices 2%
    - decreases the foreclosure rate 13%
  - 1 sd foreclosure shock after 1 quarter
    - decreases house prices 1.6%
    - increases the foreclosure rate 27%
- The long-run cumulative response in the level of house prices to a 1 sd
  - house price shock is a 2.6% increase in house prices
  - foreclosure shock is a 2.0% decrease in house prices

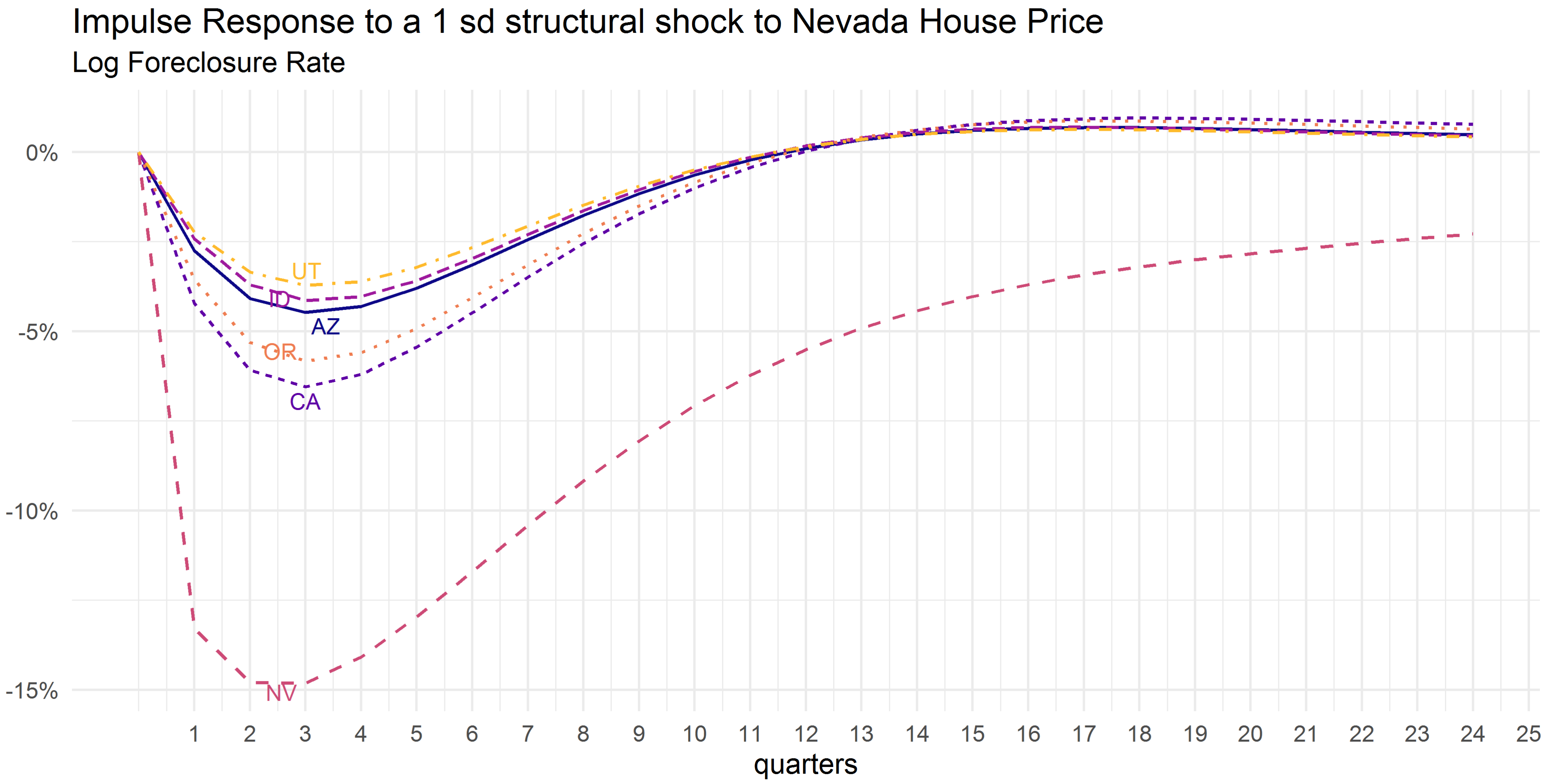
# Dynamic Spatial Simultaneous Equation System



# Dynamic Spatial Simultaneous Equation System



# Dynamic Spatial Simultaneous Equation System



Impulse response functions for 1 std structural shock ( $u_{1i,t}$, $u_{2i,t}$) to Nevada (NV)

$std(log(fcl)) = 0.59$ in data, need 3.47 (=0.59/0.17) sd structural shock to increase fcl rate 1 sd after 8 quarters

Cumulative House Price to House Price Shock

| horizon | AZ | CA | ID | NV | OR | UT |
|---|---|---|---|---|---|---|
| 4 | 0.011 | 0.016 | 0.010 | 0.032 | 0.014 | 0.009 |
| 8 | 0.009 | 0.014 | 0.009 | 0.031 | 0.012 | 0.008 |
| 24 | 0.006 | 0.008 | 0.005 | 0.026 | 0.007 | 0.005 |

Foreclosure to House Price Shock

| horizon | AZ | CA | ID | NV | OR | UT |
|---|---|---|---|---|---|---|
| 4 | -0.043 | -0.062 | -0.040 | -0.141 | -0.056 | -0.036 |
| 8 | -0.018 | -0.026 | -0.016 | -0.092 | -0.023 | -0.015 |
| 24 | 0.005 | 0.008 | 0.004 | -0.023 | 0.006 | 0.004 |

Cumulative House Price to Foreclosure Shock

| horizon | AZ | CA | ID | NV | OR | UT |
|---|---|---|---|---|---|---|
| 4 | -0.007 | -0.011 | -0.007 | -0.025 | -0.010 | -0.006 |
| 8 | -0.005 | -0.008 | -0.005 | -0.023 | -0.007 | -0.004 |
| 24 | -0.001 | -0.002 | -0.001 | -0.019 | -0.002 | -0.001 |

Foreclosure to Foreclosure Shock

| horizon | AZ | CA | ID | NV | OR | UT |
|---|---|---|---|---|---|---|
| 4 | 0.024 | 0.034 | 0.023 | 0.244 | 0.032 | 0.021 |
| 8 | -0.001 | -0.004 | -0.001 | 0.170 | -0.001 | -0.001 |
| 24 | -0.013 | -0.021 | -0.012 | 0.056 | -0.017 | -0.011 |

A shock that increase NV foreclosure rates 1 sd:

- Results in 8% (=3.47 x -2.3%) decrease in NV house prices after 8 quarters
- Results in 3% (=3.47 x -0.8%) decrease in CA house prices after 8 quarters

# (5) Conclusion

- Specified a Dynamic Spatial Simultaneous Equation System panel model at quarter/state level that
    - Allows simultaneous movement in house prices and foreclosure rates
    - Captures dynamics over time and space
- Identified instruments for house prices and foreclosure rates
- Showed that at the state level, there is am amplification mechanism for foreclosure rates
    - Foreclosure shocks have a large and persistent impact on house prices
    - Shocks to housing markets propagate to nearby states
    - A one standard deviation increase in Nevada foreclosure rate leads to
        - 8% decline in Nevada real house prices after 8 quarters
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