

# **Social Network and Propagation of Sentiment of Top Influencers**

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# Introduction

- Housing is the largest single asset in the portfolio of American households
- Incorporating social dynamics into economic models
  - explain asset price movements across various markets
- Social interactions are important in the real estate market
  - information inefficiencies, substantial financial implications, infrequent transactions and localized nuances
- Social networks serve as sources of information for individuals navigating complex financial decisions (Kuchler and Stroebel, 2021)

# Introduction

- “A key but underexploited intellectual building block of social economics and finance is **social transmission bias**, the systematic directional modification of ideas/ signals as they pass from person to person” – (Hirshleifer, 2020)
- “If we do not understand the epidemics of popular narratives, we do not fully understand changes in the economy and in economic behavior” – (Shiller, 2019)

My research aims to explore the complex relationship **between social dynamics and market outcomes** - by investigating the propagation of sentiment from one economic actor to another and their eventual influence on housing prices.

# Research Questions

- Does the sentiment of top influencers affect housing prices?
  - Pedersen (2022): Influencers with a large number of followers have a large impact on prices
- If so, through what transmission paths does this sentiment affect housing prices? Does the top influencer sentiment propagate to engaged connections who then subsequently affect housing prices?
- Is there social transmission bias when influencers' sentiment is disseminated to engaged connections?
  - i.e. Does sentiment get amplified when influencers' sentiment is disseminated to engaged connections?
  - Hirshleifer (2020) argues that social transmission bias occurs through **signal distortion** - Shift in the intensity of the information that is being transmitted

# Visualizing the propagation of sentiment



Top Influencer

Sentiment affects house prices



Influencer sentiment propagates to engaged connections

Social transmission bias



Engaged connections amplify influencer sentiment, generate hype and affects housing prices

Engaged connection: Twitter users who responded to top influencer in a conversation

# Hypothesis

**Q: Does the sentiment of top influencers affect prices?**

Null Hypothesis 1: The sentiment of top influencers do not affect prices.

**Q: If so, through what transmission paths does this sentiment affect housing prices? Does the top influencer sentiment propagate to engaged connections who then subsequently affect housing prices?**

Null Hypothesis 2: Sentiment of top influencers do not propagate to their engaged connections and do not affect housing prices.

• **Q: Is there social transmission bias when influencers sentiment is disseminated to engaged connections?**

Null Hypothesis 3: There is no social transmission bias.

# Contributions

- My paper differs from Soo (2019) which showed how newspaper sentiment affects housing prices in the real estate market
  - My paper **leverages the network structure** of Twitter data to show how **sentiment propagates from top influencers to their engaged connections** and how that impacts housing prices.
  - My paper investigates the incidence of **social transmission bias** when information propagates from one economic actor to another.
- My paper mainly contributes to the **growing social finance literature**
  - Bailey et al. (2018a), Shiller (2019), Hirshleifer (2020), Pedersen (2022)

To my knowledge, my paper is the first paper that leverages rich social media network data to investigate the propagation of sentiment by influencers and its impact on other economic agents and housing prices

## Key Findings

- The sentiment of top influencers who have a large number of followers increases prices by 1.8%.
- Top influencers' sentiment propagate to engaged connections
- Top influencers' sentiment is associated with a 22% increase in the sentiment of their engaged users 6 months later
- Preliminary evidence of social transmission bias

## Data

- 5.8 million tweets of 50 most populous cities in the US extracted using X's (formerly known as Twitter) API
  - Observe 39399 unique pairs of connections between the influencer and their engaged connections and 1.2 million tweets associated with those users
- Keywords for Tweets Extraction: “City real estate”, “City home price”, “City house price”
- Zillow Data: Zillow Home Value Index



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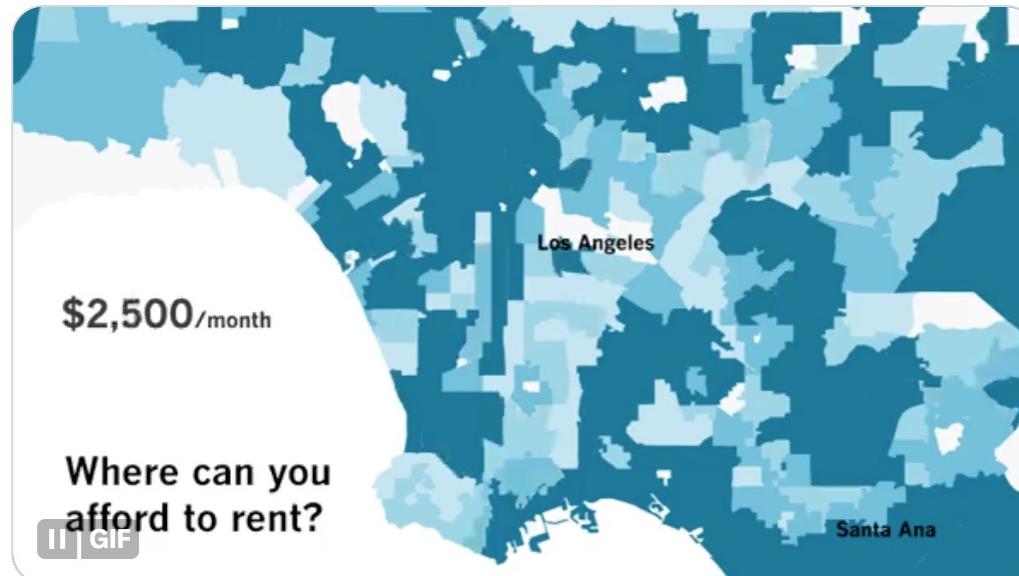
Post

← Post

Los Angeles Times

Los Angeles Times ✅ @latimes · Dec 3, 2017

Since 1980, rents in L.A. have gone up 55%. In that same time period, incomes have only risen by 13%. [lat.ms/2kiiuzH](https://lat.ms/2kiiuzH)



24

323

282



Christian Fulghum ☮

@zenkichi95

...

This is how we know there is a bubble in real estate prices. Same in Seattle.

8:52 PM · Dec 3, 2017



# Sample Tweets

## Positive Tweets

**Sentiment: 0.98** - WooHoo!!! Congrats to both my sellers and my buyers! This beautiful house has some new owners and my sellers have moved to New York. Congratulations and thank you so much for trusting me to help make all your Real Estate dreams a reality. realestate kellerwilliams sold

**Sentiment: 0.97** - We're excited to announce the sale of this amazing property on Biona Drive in Los Angeles. We're thrilled to have helped our clients build wealth through real estate, giving them the freedom to do what they love. <https://t.co/czuoiYRZv0lukejonesre> kwsiliconbeach LAhomeforsale

**Sentiment: 0.95** - PRICE REDUCED at this FANTASTIC opportunity to own in North Phoenix at "best of the tour" winning home!

## Negative Tweets

**Sentiment: -0.94** - Boston Luxury Condo Market Real Estate Search. Covid-19 has dealt a blow to New York's luxury real estate market that is worse than the 2008 financial crisis and the 9/11 terrorist attacks. The virus plowed into a market that was already scuffling

**Sentiment: -0.77** Southern California real estate is some of the priciest in the nation, and a huge swath of it is at risk of damage or destruction from the wildfires now tearing through the area. Just over 86,000 homes in Ventura and Los Angeles county are at some level of risk

## VADER Sentiment

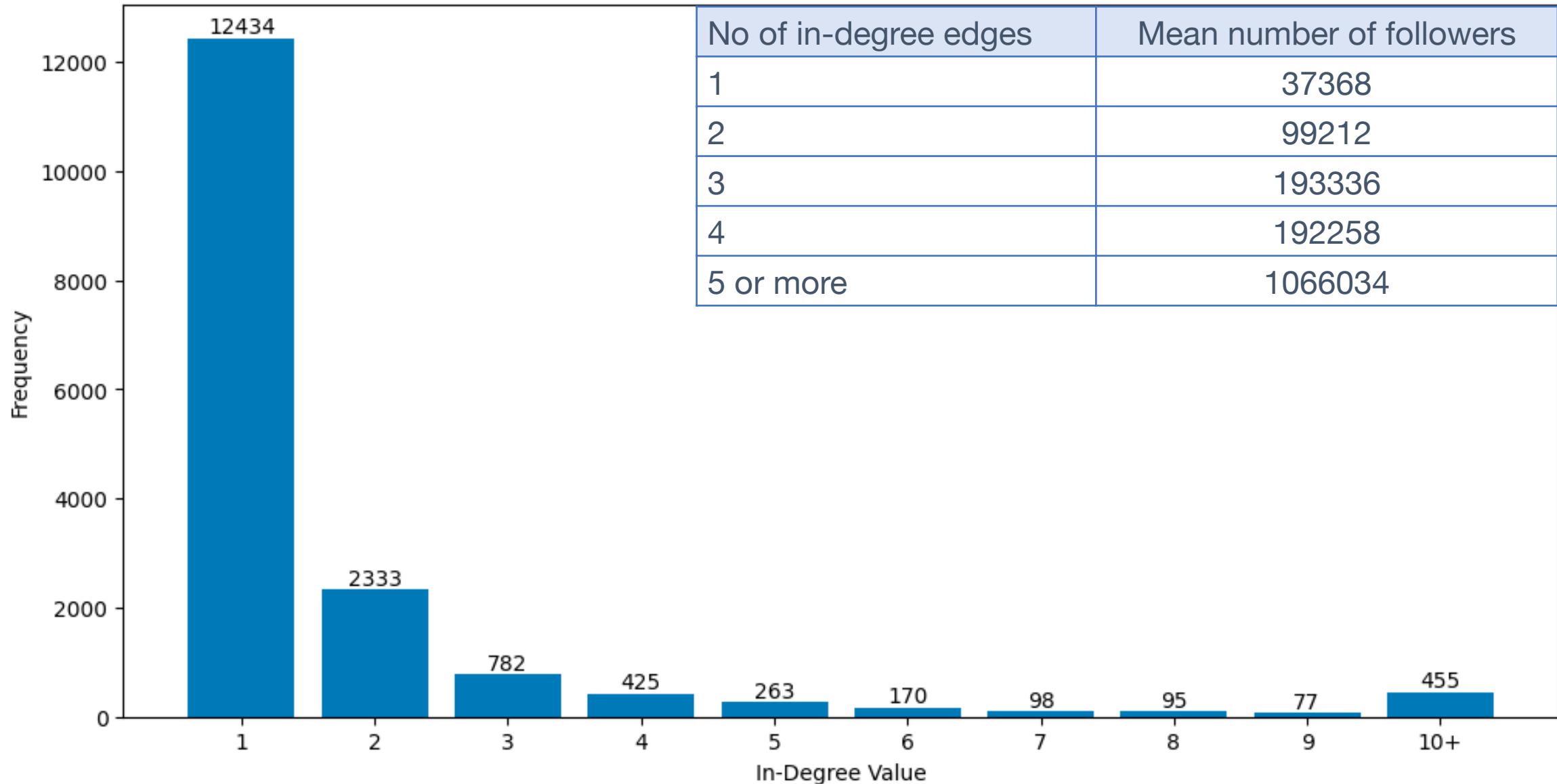
- VADER stands for Valence Aware Dictionary for Sentiment Reasoning
- Simple rule-based model for general sentiment analysis which is fine-tuned specifically for social media data
- Valence score for each word is a score that measures the sentiment intensity of words on a scale from  $-4$  to  $+4$ . For example, the word “okay” has a positive valence of  $0.9$ , “great” is  $3.1$ , whereas “horrible” is  $-2.5$ .
- VADER takes the following five heuristics into account:
  - Punctuation (I like it. Vs I like it!)
  - Capitalization (AMAZING vs amazing)
  - Modifiers (boosters vs dampeners) (sort of, kinda, etc)
  - Polarity shift due to use of conjunction
  - Negation - multiplying sentiment score with a negative value as negation would flip the polarity of the text

# The influencers in the network have significant number of followers

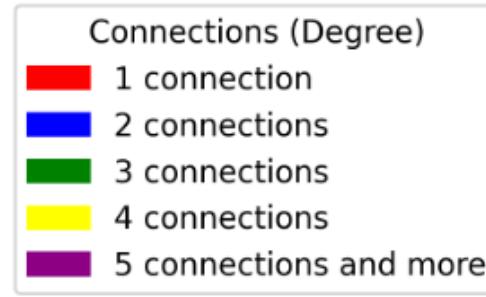
- 17132 total influencers
  - 1,094,664 tweets
  - Average follower count: 126,282
- 26366 engaged connections
  - 153,858 tweets
  - Average follower count: 2384

Follower Counts	Influencers	Engaged Connections
Mean	126,282	2384
Standard Deviation	1,227,458	14,780
25th Percentile	1131	117
50th Percentile	4315	423
75th Percentile	23128	1446
99th Percentile	2,020,818	31,195

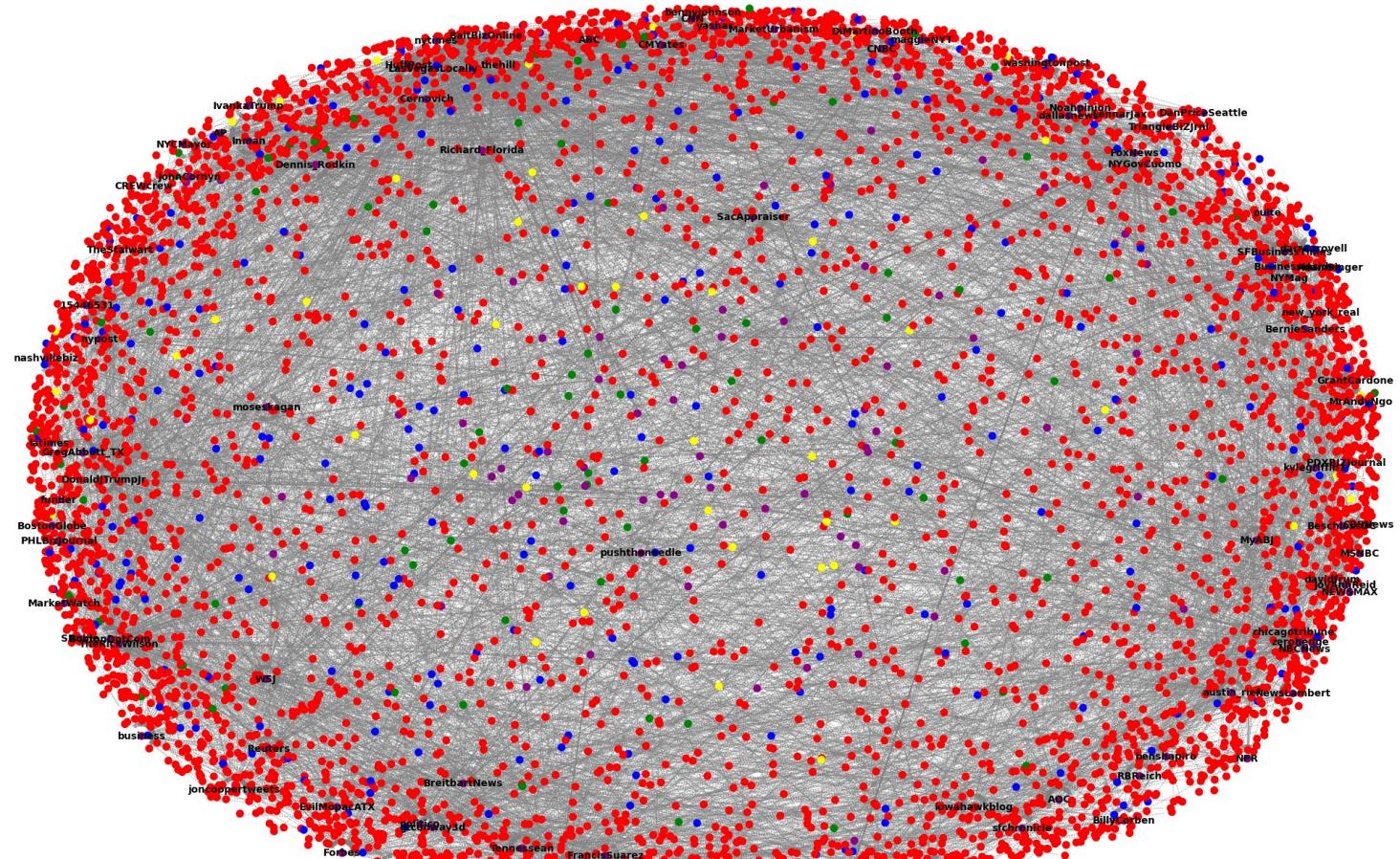
# Distribution of In-degree values of the influencers



# Network Graph of Top 100 Influencers Based on Number of In-degree Edges

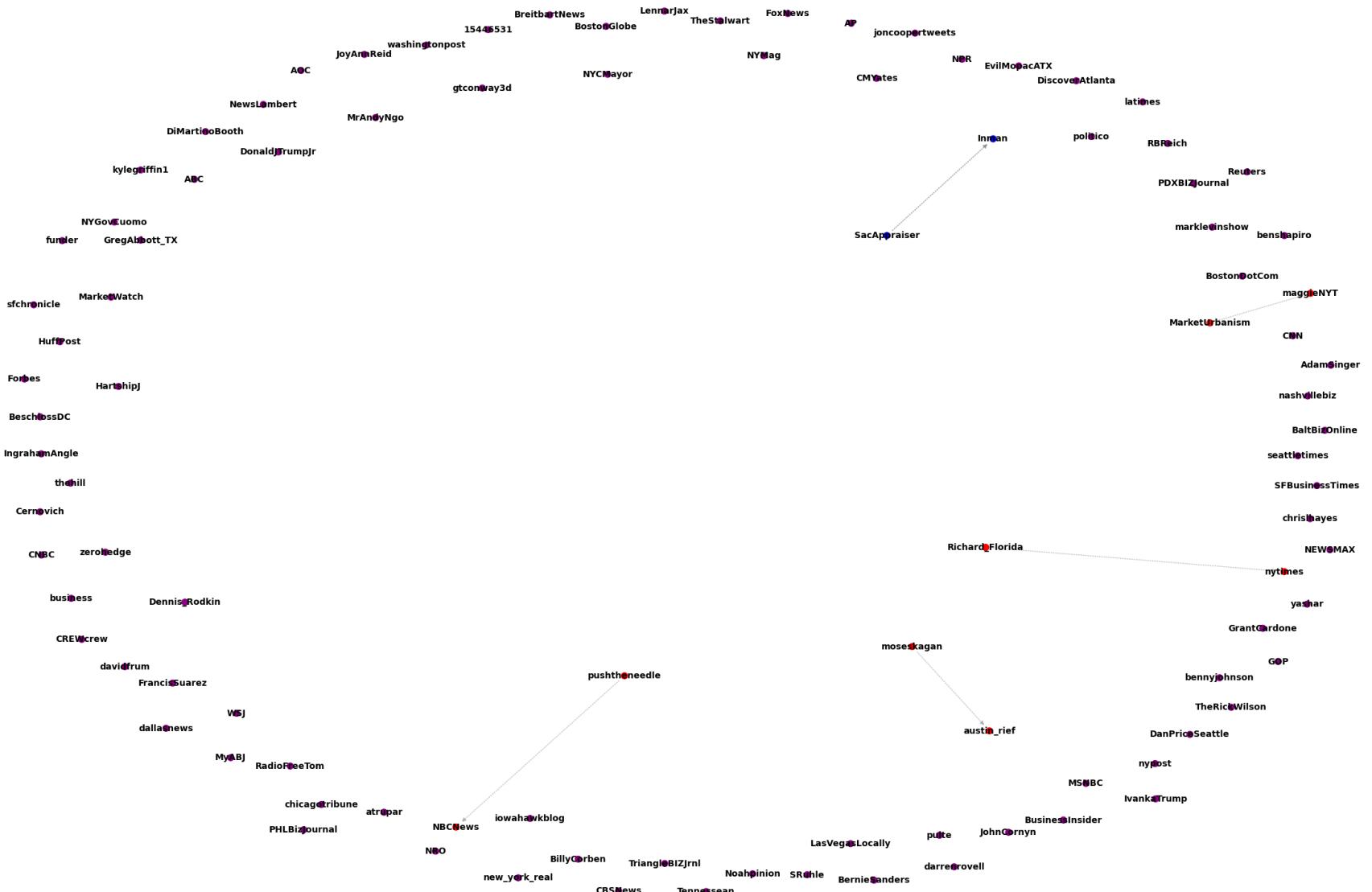


Number of inward edges (in-degree)	
Mean	58
Standard Deviation	41
25th Percentile	35
50th Percentile	44
75th Percentile	64
99th Percentile	186



## Top Influencers Almost Never Respond to Each Other

Twitter Network Graph (Top 100 Nodes)



**Q: Does the sentiment of top influencers affect prices?**

# Finding: The $\Delta$ sentiment of top influencers has a positive effect on $\Delta$ housing index

$$\Delta sentiment\_engaged\_connections_{i,t} = \Delta sentiment\_top\_influencers_{i,t} + \Delta sentiment\_top\_influencers_{i,t-1} + \beta \Delta housing\_index_{i,t-1} + \gamma X_{i,t} + \epsilon_{i,t}$$

VARIABLES	(1) $\Delta$ housing index
$\Delta$ sentiment top influencer	0.0305*** (2.684)
1y lag $\Delta$ sentiment top influencer	0.0175*** (2.822)
1y lag $\Delta$ housing index	0.213*** (5.718)
Constant	-0.0707*** (-3.089)
Observations	5128
Year FE	YES
City FE	YES
Adjusted R-squared	0.614

Robust t-statistics in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1



**Q: If so, through what transmission paths does this sentiment affect housing prices? Does the top influencer sentiment propagate to engaged connections who then subsequently affect housing prices?**

# Strong correlation when regressing $\Delta$ sentiment engaged connections on $\Delta$ sentiment top influencers

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VARIABLES	$\Delta$ sentiment engaged connections
$\Delta$ sentiment top influencers	0.0297** (2.150)
1 year lag $\Delta$ sentiment engaged connections	-0.322*** (-8.218)
Constant	0.0180 (1.041)
Observations	2939
Year FE	YES
Adjusted R-squared	0.233

t-statistics in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

# No significant correlation when regressing $\Delta$ sentiment top influencers on $\Delta$ sentiment engaged connections

VARIABLES	$\Delta$ sentiment top influencers
$\Delta$ sentiment engaged connections	0.121 (1.278)
1 year lag $\Delta$ sentiment top influencers	-0.580*** (-6.815)
Constant	-0.0437 (-0.952)
Observations	3248
Year FE	YES
Adjusted R-squared	0.291

Robust t-statistics in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## IV Strategy

$$\Delta \text{sentiment\_top\_influencers}_{i,t} = \beta^{FS} \Delta \text{housing\_index}_{i,t} + \gamma X_{i,t} + \epsilon_{i,t}$$

$$\Delta \text{sentiment\_engaged\_connections}_{i,t}^{OC} = \beta^{IV} \widehat{\Delta \text{sentiment\_top\_influencers}}_{i,t-2} + \gamma X_{i,t} + \epsilon_{i,t}$$

Potential Identification issues:

- Exclusion restriction is violated if the change in housing index of in the influencer's city affect the change in sentiment of engaged connections independent of the influencer

# Visualizing the IV Strategy

Housing index increase in city A



Sentiment of top influencer increases in city A



Top Influencer

Sentiment of engaged connection increases in other cities (not City A)



Engaged Connection



# First Stage Regression

VARIABLES	(1) Δsentiment top influencer
Δhousing index	0.277*** (2.813)
1Q lag Δsentiment top influencer	-0.363*** (-14.66)
Constant	0.0404 (1.105)
Observations	2,382
Year FE	YES
City FE	YES
R-squared	0.177

Robust t-statistics in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## Second Stage Regression

VARIABLES	(1) $\Delta Sentiment\_Engaged\_Connections^{OC}$
Lag 2Q $\Delta Sentiment\widehat{TopInfluencer}$	0.220*** (2.712)
Constant	0.0575** (2.402)
Observations	1,230
Year FE	YES
R-squared	0.155

Robust t-statistics in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## Conclusion and Next Steps

- A 1% change in top influencers' sentiment is associated with a 1.8% increase in housing prices a year later
- Top influencers' sentiment propagates to their engaged connections
- Top influencers' sentiment is associated with a 22% increase in the sentiment of their engaged users 2Q later
- Preliminary evidence of social transmission bias
- Further research questions to explore:
  - What narratives are disseminated within the network by the influencers, and can the analysis of these narratives help us understand how psychological biases, such as selection bias/ self-enhancing bias (Hirshleifer, 2020; Shiller, 2020)?
  - What role do real estate agents, brokers, and other intermediaries play in facilitating the spread of sentiment and information within social networks, and how does this influence housing market outcomes?

Thank you