



Outshine to Outbid:
Weather-Induced Sentiments on
Housing Market

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Philadelphia in Good Weather

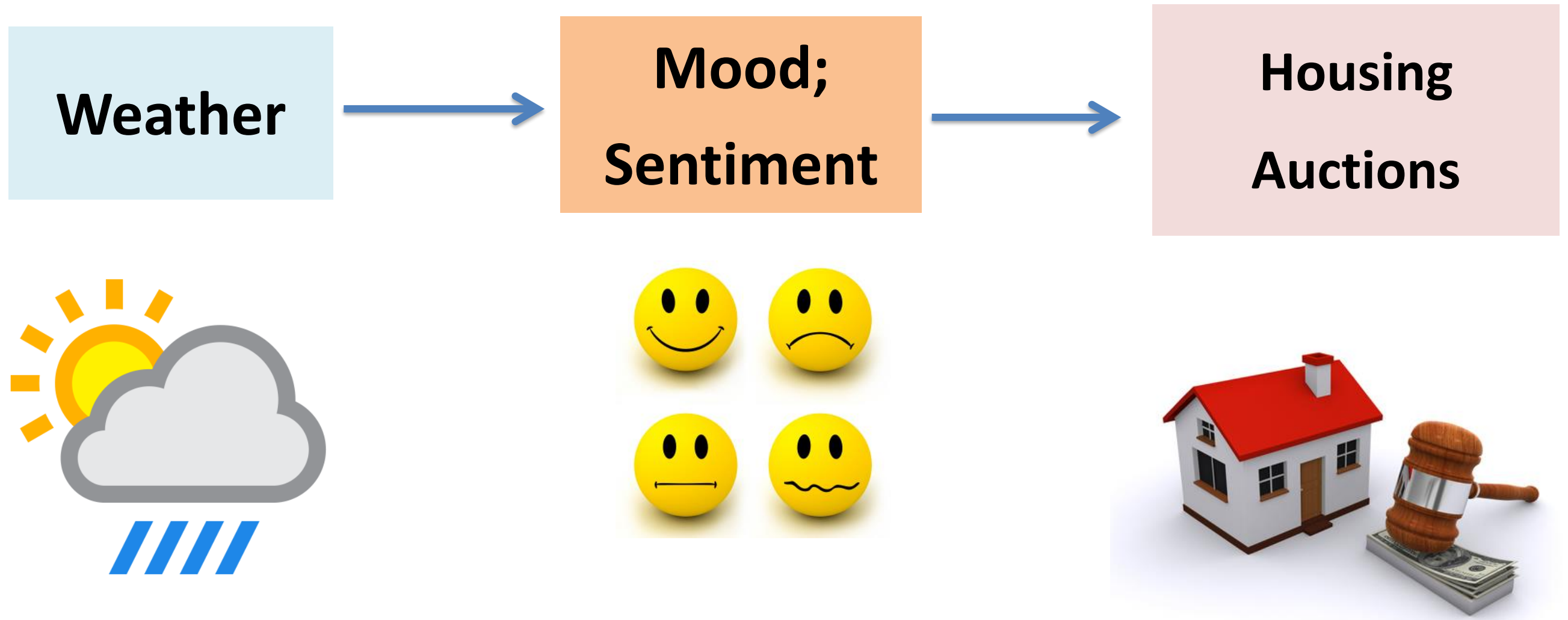


Philadelphia in Bad Weather



Research Question

Weather Induced Sentiment on Housing Auctions



Housing Auctions

Good weather



Auction Fever; Overbidding

Housing Auctions

Bad weather



Dampened interests; Less Hype; Lower excitement

Housing Auctions Process in Sydney

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Before Auction Day

- 1) Seller chooses the auction day at least **one month prior**.
Auction date is usually set on **Saturday**.
- 1) Potential buyers can inspect property up to and including auction date.

On the Auction Day

- 1) At the beginning, the auctioneer **introduces the property** and **makes an announcement** detailing the state rules;
- 2) The auctioneer will then **ask for an opening bid**, setting the increment amount by which all bids must rise, such as in \$5,000 increments;
- 3) Once the reserve price has been reached the property is considered to be “**on the market**”.
- 4) The auction is considered **complete** when the highest bid is reached.
- 5) The house will be **sold** to the highest bidder; **Sign Contract**.



Rules in Housing Auctions

- A reserve price must be set by the seller in writing before auction day
- The highest bidder has the first right to negotiate if a property fails to reach its reserve price.
- Auctions are **unconditional** and do not have a **cooling-off period**.
- Winning buyer must pay an upfront deposit (amount pre-determined by seller), and contracts signed **immediately** after an auction sale.
- Auction fee is a **fixed flat fee**, whether auction happens or not.

The Housing Auction Process



James Pratt from McGrath facilitates this hotly contested property auction in Manly, Sydney in Oct 2013.
https://www.youtube.com/watch?v=Bc009e_nW8k

Weather, Sentiment and Housing Prices



4 Sentiment Measures:

Rain,

Temperature,

Sunshine

Survey-based sentiment

Related Work

Weather and ...



- Stocks** - Hirshleifer and Shumway (JF 2003), Goetzmann et al (RFS 2014)
- Loan approvals** - Cortés et al (JFE 2016)
- Car purchases** – Busse et al. (QJE 2015)

Auction Fever

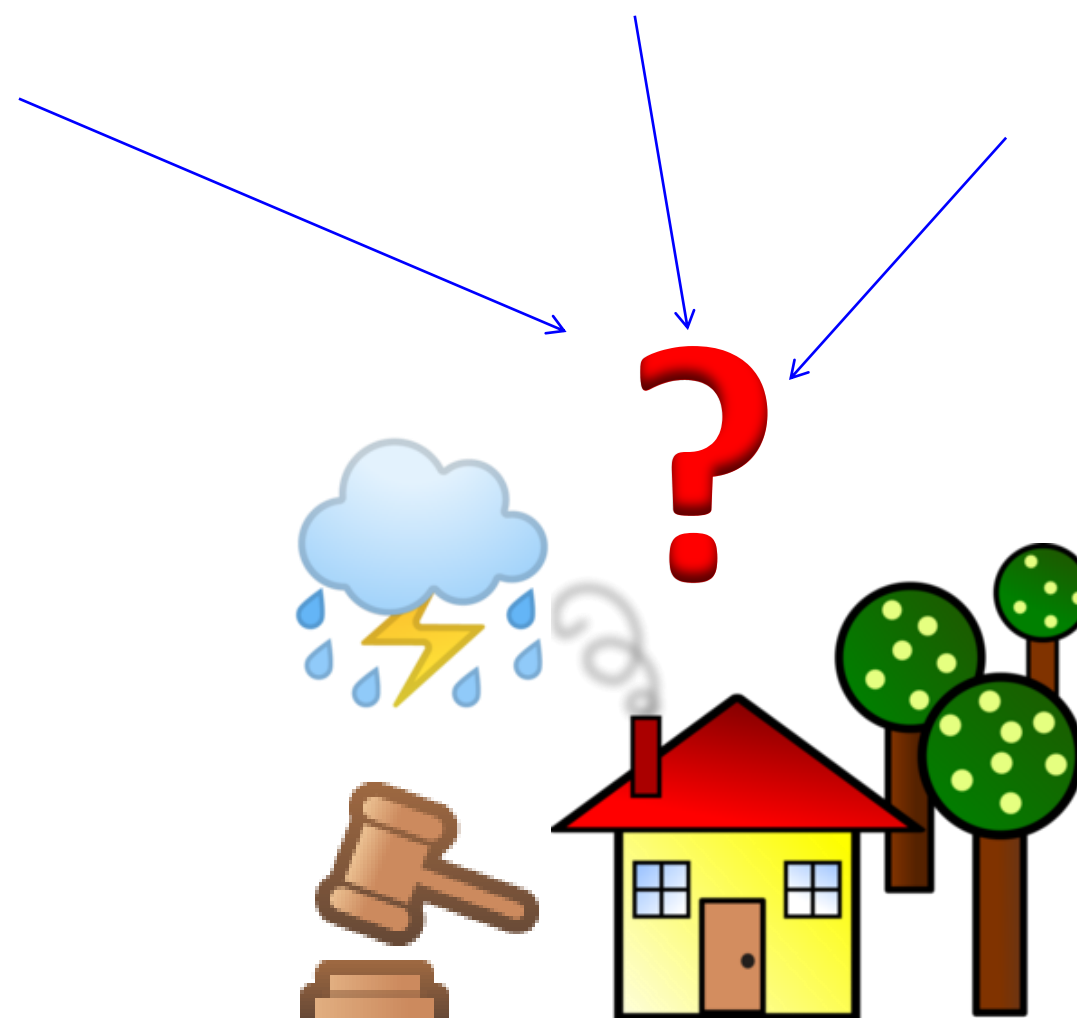


Ku, Malhotra and Murnighan (2005): study competitive arousal model in live and internet auctions

Winner's Curse



Oh (2002): winner's curse in two types of auctions: B2C and C2C



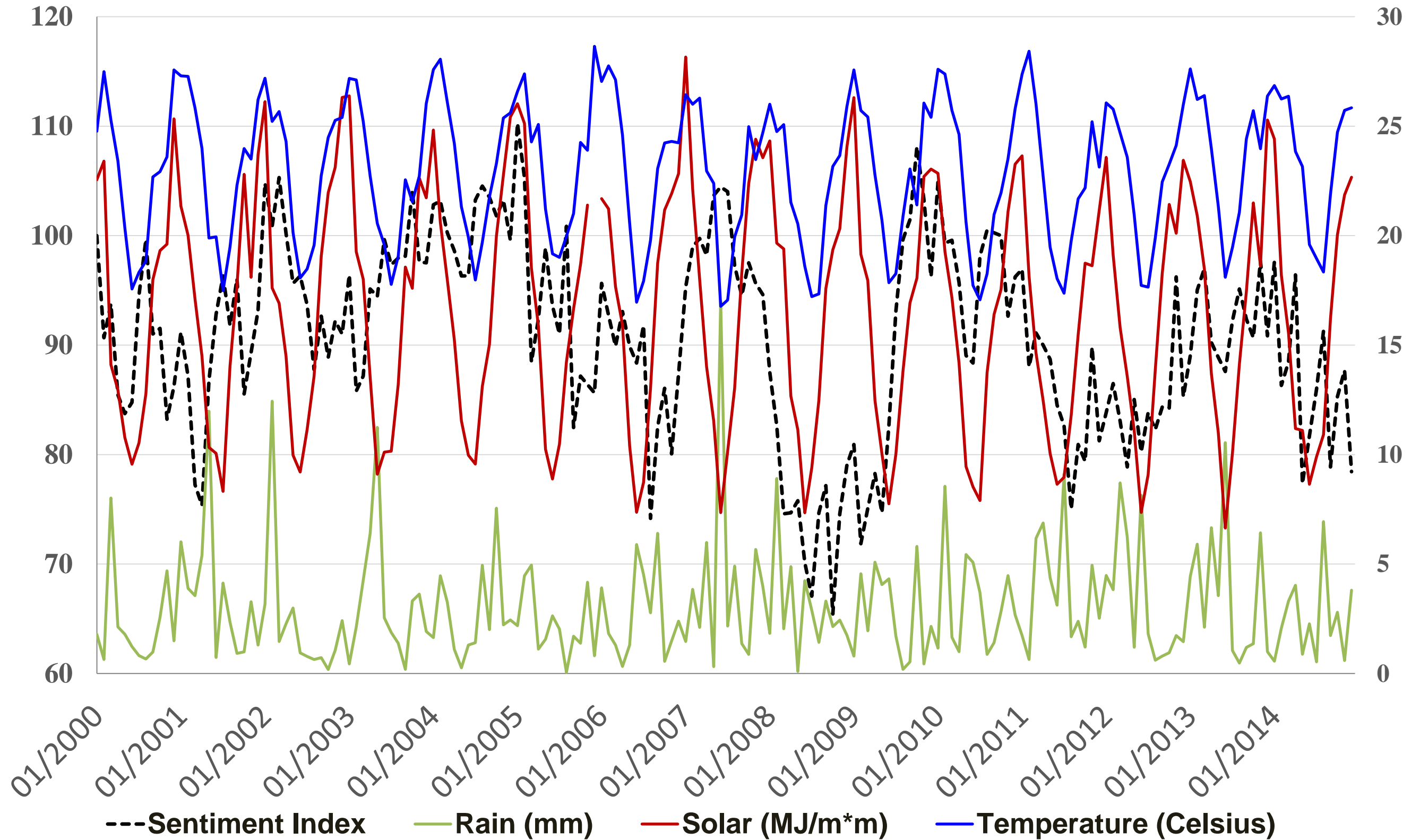
Literature Review

- Weather and **asset pricing**:
 - Hirshleifer and Shumway (JF 2003): sunshine leads to higher stock return
 - Goetzmann et al (RFS 2014): trading decision of institutional investors
- Weather induced sentiment and **subjective judgment**:
 - Cortés et al (JFE 2016) on loan officer credit approval
 - Busse et al. (QJE 2015) on vehicle purchase: convertible vs four wheel drive
- **Auction fever**: Ku et al (2005), Heyman et al (2004)
- **Winner's curse**: Oh (2002) reports that 60% of C2C online bidders experience winner's curse.
- Scant evidence of how sentiment affects decisions in **housing investments**.

Data

- Australian Property Monitors dataset for individual housing transactions 2000 to 2014 for Sydney.
 - 852,734 sales
 - Contains transaction date, address, housing characteristics (beds, baths, house type, block area size, etc).
- Daily weather data from the Bureau of Meteorology website as collected from Observatory Hill, Sydney.
 - **Rainfall** (in mm), **solar exposure** (MJ/m²), day's **temperature** (°C)
- Other sentiment: Melbourne Institute Sentiment indicator for NSW, public holidays, Melbourne Cup day.

Sentiment and Three Weather Measures



Univariate Test Result

Variable	Auction		Private Sale		Diff	
	Mean	Median	Mean	Median	Mean	t-stat
Price (000')	870.83	727	595.6	473	275.23	(205.46)***
Beds	2.99	3	2.88	3	0.11	(35.03)***
Baths	1.64	1	1.59	1	0.05	(25.69)***
House	0.71	1	0.56	1	0.15	(104.49)***
New Development	0.01	0	0.05	0	-0.04	(-75.32)***
SurveySenti	106.03	106.7	105.57	106.2	0.46	(15.47)***
Rain	3.29	0	3.04	0	0.25	(9.21)***
Solar	16.28	15.1	16.14	14.9	0.14	(6.32)***
Temp	22.72	22.7	22.84	22.7	-0.12	(-9.37)***
Boom	0.52	1	0.47	0	0.05	(33.62)***
Saturday	0.66	1	0.08	0	0.58	(622.84)***

SurveySenti is the lagged month Melbourne Institute Sentiment index level.

Rain is the amount of rain in millimeters for the transaction day.

Solar is the amount of solar exposure for the transaction day.

Temp is the temperature in degrees Celsius for the transaction day.

Boom is a dummy indicating booming period

Correlation

	Auction	Price	SurveySenti	Rain	Solar	Temp
Auction	1.00					
Price	0.22	1.00				
SurveySenti	0.02	-0.01	1.00			
Rain	0.01	-0.00	-0.00	1.00		
Solar	0.01	-0.00	0.07	-0.23	1.00	
Temp	-0.02	0.01	0.05	-0.16	0.60	1.00
Boom	0.04	-0.02	0.0	-0.03	0.02	0.06
House	0.11	0.29	0.01	0.00	0.01	0.01
Saturday	0.56	0.11	-0.01	0.01	0.02	-0.01

Auction and **Weather-Sentiment** measures have **low** correlation

Auction and **Saturday** have **high** correlation

Auction and **Price** are **moderately** correlated

Empirical Design

Full Sample:

House Price $\sim \alpha * \text{auction} + \beta * \text{Sentiment} + \gamma * \text{Auction} * \text{Sentiment}$

Auction Sample:

House Price $\sim \beta * \text{Sentiment} + \text{Control}$

Interact with Boom period, and investor dummy

Baseline Regression:

$$\text{House Price} \sim \text{auction} + \text{Sentiment} + \text{Auction} * \text{Sentiment}$$

	Dependent Variable: log(price)			
	(1)	(2)	(3)	(4)
SurveySenti	0.718*** (0.001)			
Auction*SurveySenti	0.734*** (0.003)			
Rain		-0.123*** (0.001)		
Auction*Rain		-0.174** (0.003)		
Solar			0.028 (0.001)	
Auction*Solar			0.847*** (0.003)	
Temp				0.185** (0.003)
Auction*Temp				0.635*** (0.006)
Auction	-0.007 (0.01)	0.071*** (0.003)	0.056*** (0.003)	0.056*** (0.006)
Other Housing Char	Yes	Yes	Yes	Yes
Monthly Time Trend, Yr Qtr	Yes	Yes	Yes	Yes
FE, Suburb FE				
Cluster S.E.	Suburb	Suburb	Suburb	Suburb
Adjusted R-square	0.8417	0.8416	0.8424	0.8416
Observations	852,734	852,734	836,523	852,734

Main Findings

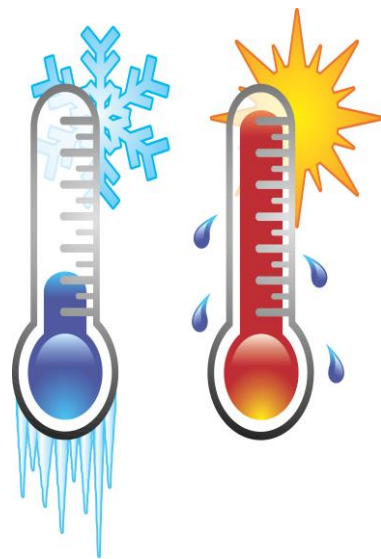
For home sold in auctions:



Clear vs heavy rain day (+10 mm):
-\$2,839 in prices



Cloudy vs sunny day (+12 MJ/m²):
\$8,642 in price



Cold vs warm day (+10°C):
\$5,713 in price

All \$ values based on mean price of **\$870,830** in auction,
Change based on from **P25 to P75**.

Auction Only Sample

Private Sale Sample

Variables	(1)	(2)	(3)	(4)
	Dep Var: log(price)			
SurveySenti	1.047*** (0.003)			
Rain		-0.326*** (0.002)		
Solar			0.827*** (0.004)	
Temp				0.656*** (0.006)
Other Housing Char	Yes	Yes	Yes	Yes
Monthly Time Trend, Yr Qtr FE, Suburb FE	Yes	Yes	Yes	Yes
Cluster S.E.	Suburb	Suburb	Suburb	Suburb
Adjusted R-square	0.7966	0.7965	0.7974	0.7965
Observations	140,420	140,420	137,523	140,420

Variables	(1)	(2)	(3)	(4)
	Dep Var: log(price)			
SurveySenti	0.071 (0.002)			
Rain		-0.059* (0.001)		
Solar			-0.087* (0.001)	
Temp				0.11 (0.003)
Other Housing Char	Yes	Yes	Yes	Yes
Monthly Time Trend, Yr Qtr FE, Suburb FE	Yes	Yes	Yes	Yes
Cluster S.E.	Suburb	Suburb	Suburb	Suburb
Adjusted R-square	0.8416	0.8416	0.8425	0.8416
Observations	712,314	712,314	699,000	712,314

→ Much stronger Effect in Auction Sale

Event-Based Sentiment Measure

Sentiment event window: from one week prior to one week after these sentiment events

Melbourne Cup: Australia's most prestigious annual Thoroughbred horse

List of Public Holidays:

- 1) New Year's Day
- 2) Good Friday
- 3) Anzac Day
- 4) Queen's Birthday
- 5) Labor Day
- 6) Christmas

	Dependent Variable: log(price)	
	(1)	(2)
Holidays	-0.002** (0.001)	
Auction*Holidays	-0.013*** (0.003)	
Melcup		0.003 (0.002)
Auction*Melcup		0.016*** (0.004)
Auction	0.073*** (0.003)	0.071*** (0.003)
Other Housing Char	Yes	Yes
Monthly Time Trend, Yr	Yes	Yes
Qtr FE, Suburb FE		
Cluster S.E.	Suburb	Suburb
Observations	853,143	853,143
Adj R-squared	0.841	0.841

Other Sentiment Measures:



National Sport Events
Melbourne Cup Horse Race:
+1.60% (\$13,933 in price)

Around Public Holidays:
-1.30% (\$11,321 in price)



Melb. Consumer Sentiment Index:
+1.05% (\$13,585 in price)

All \$ values based on mean auction price of **\$870,830**,
Change based on from **P25 to P75**.

If during property boom

Boom - dummy for high growth period:
 Jan2000 – Feb2004,
 Jan2009 – Apr2010 &
 Jun2013 – Dec2015.

Finding:

Boom periods increase the sentiment sensitivity in auction more than with non-auction sales.

	(1)	(2)	(3)	(4)
Auction Sample		Dep Var: log(price)		
SurveySenti	2.717*** (0.003)			
Boom*SurveySenti	0.125 (0.006)			
Rain		-0.299*** (0.003)		
Boom*Rain		-0.624*** (0.005)		
Solar			0.415*** (0.005)	
Boom*Solar			0.752*** (0.006)	
Temp				0.671*** (0.008)
Boom*Temp				-0.70 (0.010)
Other Housing Char.	Yes	Yes	Yes	Yes
Suburb F.E.	Yes	Yes	Yes	Yes
Monthly Time Trend	Yes	Yes	Yes	Yes
Cluster S.E.	Suburb	Suburb	Suburb	Suburb
Adjusted R-square	0.7838	0.7814	0.7822	0.7813
Observations	140,420	140,420	137,523	140,420

If the buyer is an investor

Auction Sample	(1)	(2)	(3)	(4)
	Dep Var: log(price)			
SurveySenti	1.047*** (0.104)			
Invest*SurveySenti	-0.039 (0.195)			
Rain		-0.339*** (0.078)		
Invest *Rain		0.146 (0.190)		
Solar			0.820*** (0.119)	
Invest *Solar			0.421 (0.443)	
Temp				0.617*** (0.220)
Invest *Temp				0.750*** (0.241)
Other Housing Char.	Yes	Yes	Yes	Yes
Yr Qtr Mth Suburb F.E.	Yes	Yes	Yes	Yes
Cluster S.E.	Suburb	Suburb	Suburb	Suburb
Adjusted R-square	0.7838	0.7814	0.7822	0.7813
Observations	140,420	140,420	137,523	140,420

Investor: Dummy which equals 1 if the property is for investment purpose, 0 otherwise

Findings:

Investors pay more on hotter days

Sudden Change in Weather

VARIABLES	Dependent variable: log(price)		
	(1)	(2)	(3)
auction	0.074*** (0.003)	0.073*** (0.003)	0.074*** (0.003)
rain_suddenchange	-0.003*** (0.001)		
rain_suddenchange*auction	-0.006*** (0.002)		
solar_suddenchange		-0.002* (0.001)	
solar_suddenchange*auction		0.002 (0.003)	
temp_suddenchange			-0.003*** (0.001)
temp_suddenchange*auction			-0.009*** (0.002)



Rationale: Sudden change in weather is in general unpleasant.

Finding: Sudden changes in rain and temperature indeed have a negative influence on auction premium.

Propensity Score Matching

Variables	(1) log_price	(2) log_price	(3) log_price	(4) log_price
SurveySenti	0.828*** (0.089)			
Auction* SurveySenti	0.754*** (0.111)			
Rain		-0.153* (0.082)		
Auction*Rain		-0.180* (0.108)		
Solar			-0.176 (0.108)	
Auction*Solar			0.940*** (0.132)	
Temp				-0.062 (0.205)
Auction*Temp				0.909*** (0.250)
Auction	-0.019* (0.012)	0.062*** (0.003)	0.046*** (0.003)	0.041*** (0.006)
Other Housing Char.	Yes	Yes	Yes	Yes
Suburb Yr Qtr F.E	Yes	Yes	Yes	Yes
Cluster S.E.	Suburb	Suburb	Suburb	Suburb
Observations	280,557	279,193	275,309	280,660
Adj R-squared	0.808	0.807	0.801	0.808

The sample:

- 1) Estimate propensity scores using a logit regression with the auction dummy as the dependent variable
 - 2) Each auction home is then paired with a non-auction home sale based on propensity scores
- Less observations as each auction sale is matched with a non-auction sale with similar propensity score.
 - Results remain robust.

Address Selection Bias using 2SLS

Auction may be endogenous: Sellers may choose auction for an unobserved reason

2SLS: first stage Probit model: Auction ~ Saturday as Instrument + control

Second stage: log(price) ~ estimated auction + control

Dependent Variable: log(price)				
SurveySenti	0.042			
	(0.002)			
<i>Auction</i> *SurveySenti	0.503***			
	(0.005)			
Rain		-0.089***		
		(0.001)		
<i>Auction</i> *Rain		-0.147		
		(0.004)		
Solar			-0.078	
			(0.001)	
<i>Auction</i> *Solar			0.489***	
			(0.005)	
Temp				0.195**
				(0.003)
<i>Auction</i> *Temp				0.117
				(0.009)
<i>Auction</i>	0.066***	0.12***	0.11***	0.116***
	(0.016)	(0.004)	(0.005)	(0.008)
Other Housing Char	Yes	Yes	Yes	Yes
Yr Qtr Mth FE, Suburb FE	Yes	Yes	Yes	Yes
Cluster S.E.	Suburb	Suburb	Suburb	Suburb
Adjusted R-square	0.8429	0.8429	0.8436	0.8429
Observations	852,734	853,138	836,925	853,138

→ Results stay robust using 2SLS.

Conclusion

- Housing prices are related to sentiment indicators.
- Auction sales particularly are more sensitive to sentiment.
- Implications for the pricing of homes not just on fundamentals but on buyer sentiment.

