Internet Appendix for

"Long-Run Labor Costs of Housing Booms and Busts"

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Internet Appendix A: Measuring Non-Fundamental House Price Growth

We follow the procedure developed and used in Ferreira and Gyourko (2011), Charles, Hurst, and Notowidigdo (2018), and DeFusco, Ding, Ferreira, and Gyourko (2018) to measure non-fundamental house price growth at the MSA-level. The measure of non-fundamental house price growth is based on the magnitude of the estimated structural break in local house price growth during the run-up period (2000-2006). We run a regression of the following form to estimate the structural break for each MSA:

$$\log(HPI_{q,msa}) = \omega_{msa} + \gamma_{msa} q + \lambda_{msa}(q - q^*_{msa})\mathbb{1}\{q > q^*_{msa}\} + \epsilon_{msa,q}, \tag{IA.A1}$$

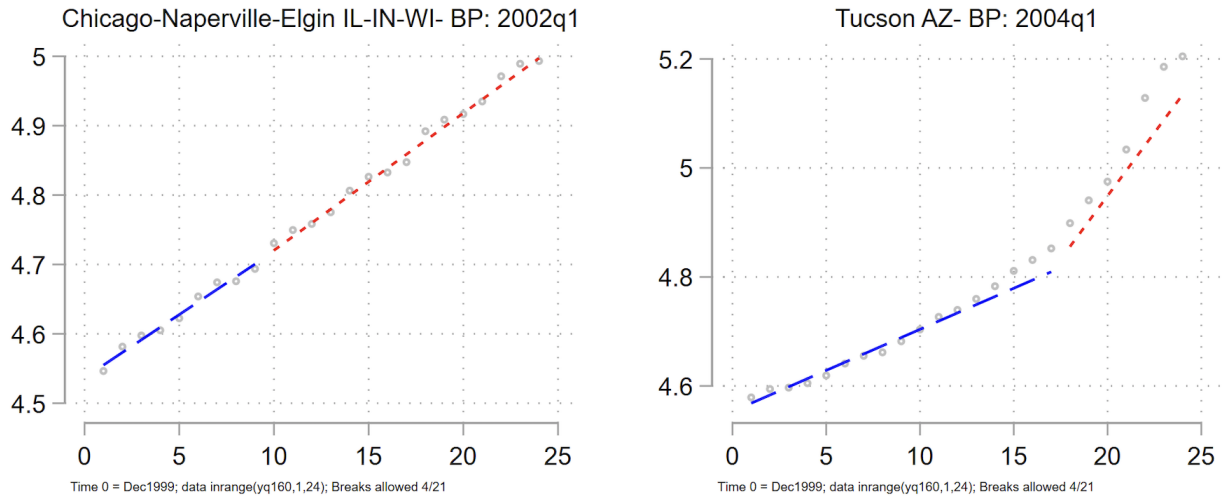
where $\log(HPI_{q,msa})$ is the logarithm of the house price index for MSA msa in year-quarter q, ω_{msa} is an intercept term, and q^*_{msa} is the year-quarter of the structural break. The coefficient λ_{msa} captures the change in house price growth post-structural break for MSA msa. We run a regression for each potential point of structural break (each quarter in the sample), and the regression with the best fit (highest R^2) is kept. The estimated $\hat{\lambda}_{msa}$ for the best fit regression is the magnitude of structural break for the MSA (MoSB).

To illustrate our measure, we present the time-series of house prices for two MSAs, Tucson, AZ and Chicago, IL, in Figure IA.A1. Tucson, AZ experienced a significant increase in house price growth starting around the first quarter of 2004, while Chicago experienced a relatively constant growth rate in house prices throughout the run-up. For Tucson, the structural break is estimated to have occurred in Q1 2004 with a much higher MoSB than Chicago (with a break date of Q1 2002). The MoSB is the difference between the post-break (red) and pre-break estimated slopes (blue). Tucson is considered to have higher non-fundamental house price growth than Chicago based on our methodology.

FIGURE IA.A1

House Prices in Chicago, IL and Tucson, AZ (2000-2006)

This figure plots the time-series of house prices for Chicago, IL and Tucson, AZ during the 2000-2006 time period. We also plot the fitted line estimated from the structural break regression (Equation IA.A1).



Internet Appendix B: Entry into the Real Estate Agent Profession

In this Appendix, we provide additional results examining the relationship between house prices and entry, who enters in response to house price growth, and who enters in Bubble versus non-Bubble MSAs.

A. Changing Jobs to Become a Real Estate Agent

We start by examining the relationship between entry into REA and recent MSA-level growth in house prices, housing transactions, housing market revenue (prices×transactions), and REA wages during 2002 to 2006. While it might seem that all of these signals would move in tandem, we find relatively low correlations between the MSA-level REA wage growth and house price growth (0.09) and between wage growth and transaction growth (0.04). The reason wage growth need not move together with the other variables is that entry into the REA occupation can moderate or even eliminate potential gains in wages from rising house prices and transactions.[1] The degree to which individuals respond to these various signals by leaving their occupation and entering REA is an empirical question that we examine below.

We estimate the following regression specification:

$$\textit{Entry}^{\textit{REA}}_{i,msa,occ,t} = \rho \times \textit{HousingVariable}_{msa,t} + \Sigma(\textit{Fixed Effects})_{i,msa,occ,t} + \varepsilon_{i,t}, \tag{IA.B1}$$

where $\textit{Entry}^{\textit{REA}}_{i,msa,occ,t}$ is an indicator of whether an individual i in MSA *msa* and occupation *occ* at time $t-1$ switches from their prior job into REA as their sole occupation during the year $(t-1 \rightarrow t)$. For easier interpretation of the coefficient estimates, we rescale the indicator so the estimates will be in basis points. $\textit{HousingVariable}_{msa,t}$ is the $(t-2 \rightarrow t)$ annualized growth of the housing-related variables, capturing growth over the prior and contemporaneous year for

[1] In previous work, Hsieh and Moretti (2003) find no relationship between house prices and wages and Pischke (2018) finds a weak positive relationship.

MSA *msa*. Unique from earlier studies, our detailed data allow us to include granular fixed effects. Occupation×MSA fixed effects account for time-invariant drivers of entry for each occupation in each MSA, and occupation×year fixed effects account for any time-varying, occupation-specific drivers of switching into REA. For example, we are examining the propensity of a nurse switching into REA in Tucson, AZ in 2005 (sharp house price growth) compared to a nurse switching into REA in Chicago, IL in 2005 (modest house price growth) after controlling for the baseline propensity of nurses to switch into REA in their respective MSA and the average overall switching rate from nursing to REA in 2005. We cluster standard errors at the MSA level.[2]

Table IA.B1 presents the results. In column 1, we find that a 10% higher annualized house price growth is associated with a 0.85 basis point (p-value$<$0.01) higher probability of REA entry. Compared to the baseline REA entry rate of 4.57 basis points in this period, this represents a 18.6% increase. Column 2 shows that the relationship between MSA transaction volume and entry is also positive and statistically significant, though economically smaller in magnitude. Column 3 shows that these variables remain statistically significant and similar in magnitude when both are included in the same regression. Because REA commissions are typically a fixed rate across deals and over time, aggregate REA earnings should increase nearly one-for-one with total market revenue. We directly test whether growth in real estate revenue is related to entry in column 4. We find that a 10 percentage point increase in REA revenue corresponds to a 3.4% increase in REA entry relative to the baseline entry rate.

REA wage growth would seem to be a key factor in an individual's decision to change jobs, but it is also difficult to observe in real-time. In columns 5-7, we examine whether REA wage growth relates to entry into REA. We find that growth in REA wage is unrelated to entry into REA. When we include house price growth, transactions growth, and wage growth in the same regression (column 6), the coefficients on house price growth and transactions growth remain of similar magnitude and statistically significant, while the coefficient on wage growth is not statistically

[2]We do not cluster along the time dimension because clustering with few years can lead to bias in standard errors (Thompson, 2011).

different from zero. Similarly, when total revenue growth and wage growth are included, only total revenue growth is significantly related to entry. In untabulated tests, we find growth in other moments of the wage distribution (e.g., 50th, 90th percentiles) are also unrelated to REA entry. In sum, these results suggest that house price growth – not actual wage growth – is a key signal for entry into REA. In the next tests, we examine whether there is heterogeneity in the sensitivity of entry to house prices along dimensions of prior wage, job zone, or educational background.

B. What Types of Workers Are Drawn Into Real Estate?

Figure 2 in the main text plots the relationship between entry and house price growth by relative wage group, occupational skill level ("Job Zone"), and education. In this subsection, we formally assess whether there is variation in the sensitivity of entry to house price growth across various worker characteristics: occupational wage relative to REA, job skill, and level of education.

We estimate the following regression specification:

$$\begin{aligned} \textit{Entry}^{\textit{REA}}_{i,msa,occ,t} =& \Theta(\mathbf{C}_{i,msa,occ,t} \times \textit{GrowthHPI}_{msa,t}) \\ &+ \Sigma(\textit{Fixed Effects})_{i,msa,occ,t} + \epsilon_{i,t}. \end{aligned} \tag{IA.B2}$$

The specification is identical to our main entry specification except we interact house-price growth with worker characteristic categories. $\mathbf{C}$ is a vector of indicator variables for each category of the particular characteristic (e.g., one for each relative wage group), and Θ represents a vector of sensitivities to HPI growth for the categories of the characteristic. We estimate separate regressions for each characteristic category of interest (relative wage, Job Zone, and education). The fixed effects continue to be at the Occupation$\times$MSA and Occupation$\times$Year levels. For the education regression, we include indicator variables for each level of education, which, unlike Job Zone and wage, is not subsumed by the Occupation$\times$MSA fixed effects (coefficients not reported for brevity).

Table IA.B2 presents the results starting with the entry sensitivity across relative wage bins

in Panel A. The coefficient point estimates are positive and significant for all four relative wage groups. The entry sensitivity increases monotonically with relative wage with individuals in the highest-paying jobs exhibiting the greatest sensitivity. In Panel B, we also find widespread sensitivity to house price increases across Job Zones. The estimates are similar across Job Zones 2-4 (REAs are in Job Zone 3) and smaller for those in Job Zone 5, which requires the highest amount of skills and training (e.g., medical doctors). In Panel C, we examine sensitivity across educational background and estimate statistically and economically significant coefficients for those with a Bachelors degree and for those with some lower degree or none listed. The point estimate for those with graduate degrees is not statistically different from zero.

C. Similarity of REA Entrants across MSAs

In this sub-section, we examine whether the types of individuals that enter REA are similar across Bubble and non-Bubble MSAs. In other words, is there *differential* selection into the REA profession according to whether the local house price growth was driven by a bubble. Occupation selection models (e.g., Roy, 1951) predict individuals will choose their occupation to maximize their wage (or lifetime utility) given their skill levels and the distribution of the return to skills across occupations. If individuals perceive differential changes in returns to skill across Bubble and non-Bubble MSAs, this could lead to differences in the types of entrants across those areas. While shedding light on who enters in response to non-fundamental price movements is of independent interest, whether there is differential selection across MSAs receiving similar house price signals has implications for the interpretation for our results on long-run outcomes.

We compare the characteristics of entrants across Bubble and non-Bubble MSAs conditioning on run-up period house price growth. We focus our analysis on 2005 and 2006 REA entrants for this analysis as these individuals entered at the height of the housing market run-up when many Bubble MSAs were experiencing large deviations in house prices from fundamentals. As such, we assure "treated" individuals received exposure to non-fundamental house price signals. We regress various REA entrant characteristics on a dummy for whether the entrant is in a Bubble MSA. We ensure

we are comparing entrants who experienced a similar signal about the housing market by matching MSAs based on 2001-2005 house price growth using coarsened exact matching. Coarsened exact matching is an algorithm to match groups of data by finding strata (cut-points) in the matching variables with the goal to ensure overlap in house price signals and minimize imbalance (Iacus, King, and Porro, 2012). This algorithm gives us seven house price growth strata with both Bubble and non-Bubble MSAs. We give each Bubble REA entrant a weight of one, and weight each non-Bubble MSA entrant so that there is an equal total weight of Bubble and non-Bubble entrants within each 2001-2005 house price growth strata. We also include 2001-05 house price growth strata fixed effects to flexibly account for any variation in characteristics related to 2001-2005 house price growth. We cluster standard errors at the MSA level.

Internet Appendix Table IA.B3 presents the results. We find Bubble MSA entrants come from similar job zones, earn similar relative wage, have similar occupational-tenure, and similar industry-tenure as entrants from non-Bubble MSAs. The entrants in Bubble MSAs are approximately three months older on average and about 5% less likely to report a bachelor's degree. These broad similarities provide support that entrants in Bubble MSAs were not substantially different from those entrants in non-Bubble MSAs. These results lend credence to the idea that, at similar levels of house price growth, similar types of individuals were entering REA.

Finally, we compare entrants across Bubble and non-Bubble MSAs using CPS data. We find that the entrants in Bubble areas have similar wages compared to those in non-Bubble areas prior to switching. Specifically, we examine differences in the ratio of realized individuals' wage to MSA-occupation mean wage. The intuition being that worse quality workers will fall lower in the distribution of wages for a particular occupation. While this is a crude measure of quality and the sample size is very limited given the small number of respondents in the CPS data, we find no evidence to suggest that Bubble MSA entrants have significantly lower than average wages. Moreover, there is no evidence to support that they are more likely to have below average wages as compared to those entrants from non-Bubble areas.

TABLE IA.B1

Real Estate-related Signals and Entrance Into Realty

This table presents OLS estimates from the regression of entry into real estate agent on MSA-level variables related to the real estate agent profession. The dependent variable is a dummy variable equal to 10,000 if an individual entered realty between June of year t-1 and June of year t, zero otherwise (i.e., a scaled dummy variable). House Price Growth is the growth in the local MSA house price index. Transactions Growth is the growth in the number of home purchase mortgage originations. REA Wage Growth is the growth in the mean REA wage. Total Revenue Growth is the growth in the total housing revenue (transactions $\times$ local house price index). Growth rates are calculated between year $t-2$ and year t. Only individuals that are not realtors as of June of year $t-1$ are included in the regressions. We examine entry between the years 2002-2006. We include occupation$\times$MSA fixed effects and occupation$\times$year fixed effects in all regressions. Standard errors are clustered by MSA. We provide p-values in parentheses below the coefficents.

	1	2	3	4	5	6	7
House Price Growth	8.500***		7.650***			6.475***	
	(<0.01)		(<0.01)			(<0.01)	
Transactions Growth		1.427***	1.189***			1.203***	
		(<0.01)	(<0.01)			(<0.01)	
Total Revenue Growth				1.545***			1.470***
				(<0.01)			(<0.01)
REA Wage Growth					-0.205	-0.015	-0.040
					(0.54)	(0.97)	(0.91)
Observations	119 million	119 million	119 million	119 million	96 million	96 million	96 million
R^2	0.102	0.102	0.102	0.102	0.127	0.128	0.128

TABLE IA.B2

House Price Growth and Entrance Into Realty By Type

This table presents OLS estimates from regressions of entry into real estate agent on local house price growth variables across individual-level characteristics. The dependent variable is a dummy variable equal to 10,000 if an individual entered realty between June of year $t-1$ and June of year t, zero otherwise (i.e., a scaled dummy variable). House Price Growth is the growth in the local MSA house price index from June of year $t-2$ to June of year t. Only individuals that are not realtors as of June of year $t-1$ are included in the regressions. The regressions are fully saturated pooled regressions so there are no omitted groups. In Panel A, we focus on an individual's relative wage calculated as the ratio of an individual's previous year occupation's average wage to the previous year REA average wage. Panel B repeats the same exercise, but focuses on the skill of their previous occupation as captured by Job Zone, as defined by BLS. Panel C examines the level of education. We include dummies for each relative wage group or education-level in the relevant regressions (results not reported for brevity). We include occupation×MSA fixed effects and occupation×year fixed effects in all regressions. Standard errors are clustered by MSA and p-values are provided in parentheses below the coefficients.

Panel A: Entry to House Price Sensitivity by Relative Wage

	1
House Price Growth × Relative Wage $< 75\%$	4.754***
	(<0.01)
House Price Growth × Relative Wage $\in$ (75%,125%]	5.399***
	(<0.01)
House Price Growth × Relative Wage $\in$ (125%,200%]	7.173***
	(<0.01)
House Price Growth × Relative Wage $> 200\%$	9.202***
	(<0.01)
Observations	119 million
R^2	0.102

Panel B: Entry to House Price Sensitivity by Job Zone

	1
House Price Growth × Job Zone 2	9.475***
	(<0.01)
House Price Growth × Job Zone 3	9.545***
	(<0.01)
House Price Growth × Job Zone 4	9.763***
	(<0.01)
House Price Growth × Job Zone 5	5.893***
	(<0.01)
Observations	119 million
R^2	0.102

Panel C: Entry to House Price Sensitivity by Level of Education

	1
House Price Growth × Other Degree/None Listed	8.078***
	(<0.01)
House Price Growth × Bachelor's	15.593***
	(<0.01)
House Price Growth × Graduate	-1.623
	(0.38)
Observations	119 million
R^2	0.102

TABLE IA.B3

Differences in REA Entrants across Bubble MSAs and non-Bubble MSAs

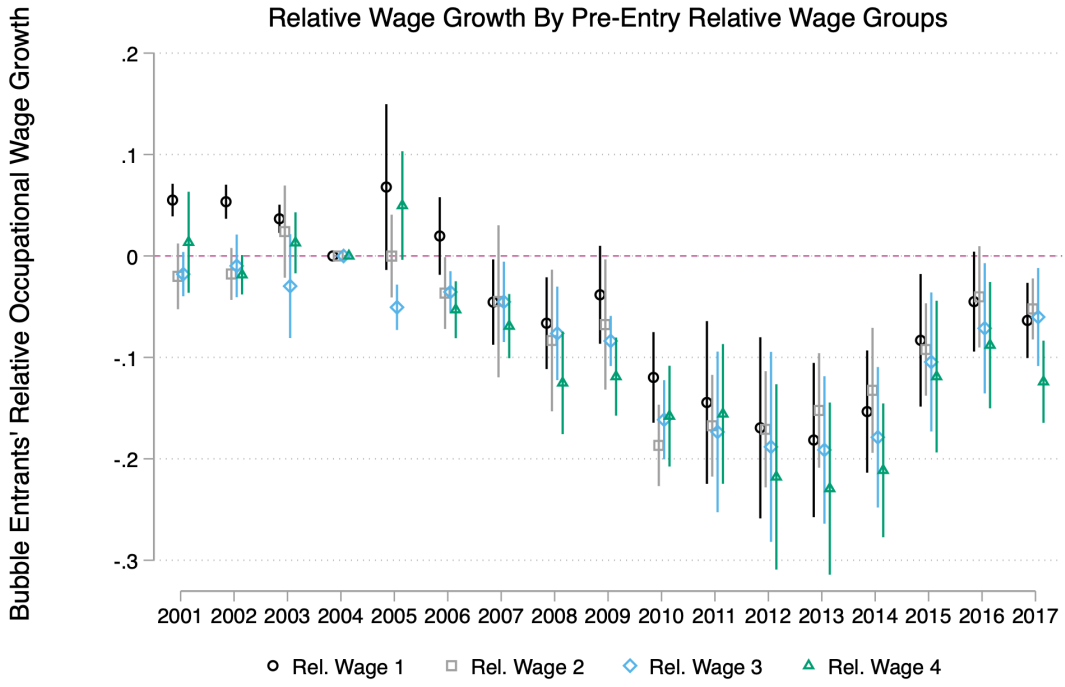
This table presents OLS estimates from the regression of real estate agent characteristics on an indicator for being located in a Bubble MSA. The dependent variables are: *Job Zone*, the numerical classification of the skill-level of their pre-REA occupation; *Relative Wage*, the ratio of the average occupational wage for their pre-REA occupation relative to the REA average wage in the year prior to entry; *Occ. Exp.*, is the number of year spent in their previous occupation; *Ind. Exp.* is the number of years spent in their prior industry; *Bachelor's+* is a dummy variable equal to one if the individual has reported a Bachelor's or more advanced degree by 2006; and *Age* is a proximate age. *Bubble* is an indicator variable equal to one if the MSA has a structural break magnitude in the top quartile. Only individuals who enter realty in 2005 or 2006 are included in the regressions. We match Bubble and non-Bubble MSAs based on 2001-2005 house price growth using coarsened exact matching. The matching algorithm produces house price growth strata with both Bubble and non-Bubble MSAs. We drop all MSAs that are not matched. We weight each observation such that Bubble and non-Bubble MSAs have equal total weights within each 2001-2005 house price growth strata. We include 2001-2005 house price growth strata fixed effects in all regressions. Standard errors are clustered by MSA and p-values are presented in parentheses below the coefficient.

	1 Job Zone	2 Relative Wage	3 Occ. Exp.	4 Ind. Exp.	5 Bachelors+	6 Age
Bubble MSA	-0.034	-0.084	0.064	-0.001	-0.055**	0.261*
	(0.26)	(0.44)	(0.18)	(0.99)	(0.02)	(0.08)
Constant	3.359***	1.255***	1.960***	2.383***	0.307***	27.793***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Observations	21916	23005	29479	27451	29807	29807
R^2	0.004	0.022	0.001	0.000	0.009	0.001

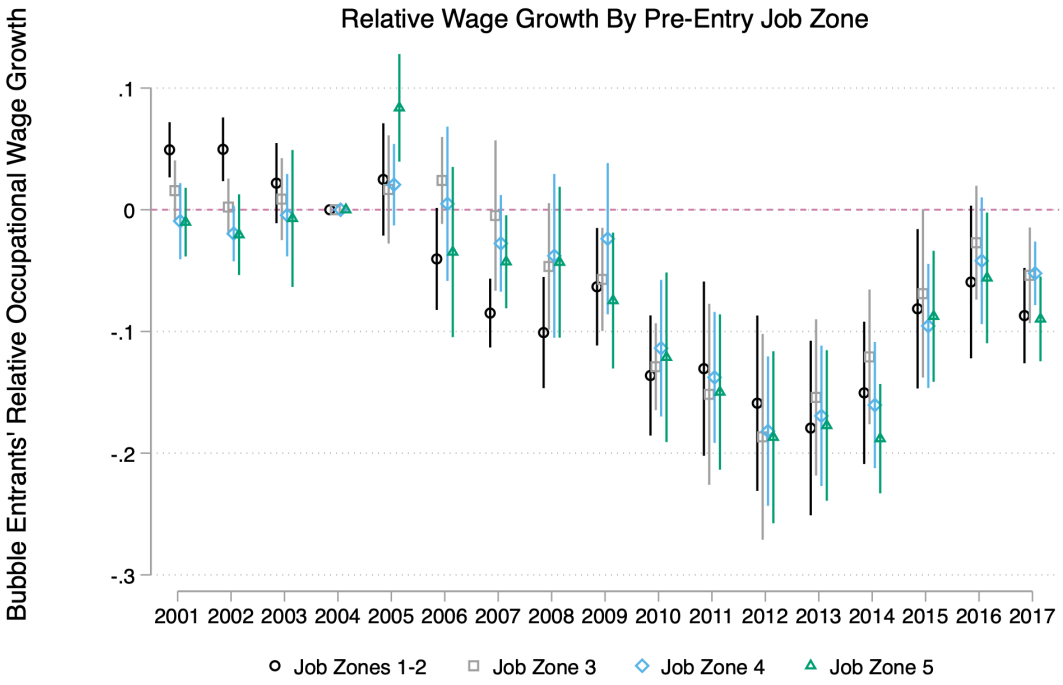
Internet Appendix C: Additional Figures

This figure presents the estimated relative wage growth of REA entrants in areas with high non-fundamental house price growth ("Bubble") compared to similar REA entrants in other areas. High non-fundamental growth is defined as the top quartile of MSAs using the Magnitude of Structural Break (see Internet Appendix IA.A). For each panel, we run separate regressions depending on pre-entry individual level characteristics. Coefficients are estimated using the regression in Equation (2). The outcome variable is the average log-wage at the MSA-occupation-year level. A *REA entrant* is an individual who entered the real estate profession in 2005 or 2006 and REA was their only occupation. We include $Year \times Occupation^{Pre\text{-}Entry} \times$ Bachelor Degree Indicator $\times$ 2001 – 2005 House Price Growth Strata fixed effects. In Panel A, we focus on an individual's relative wage calculated as the ratio of an individual's previous year occupation's average wage to the previous year REA average wage. Panel B repeats the same exercise, but focuses on the skill of their previous occupation as captured by Job Zone, as defined by BLS. Panel C examines the level of education. Confidence intervals at the 90%-level are calculated with standard errors clustered by MSA.

(a) Long-run Outcome by Relative Wage Group



(b) Long-run Outcome by Job Zone



(c) Long-run Outcome by Education

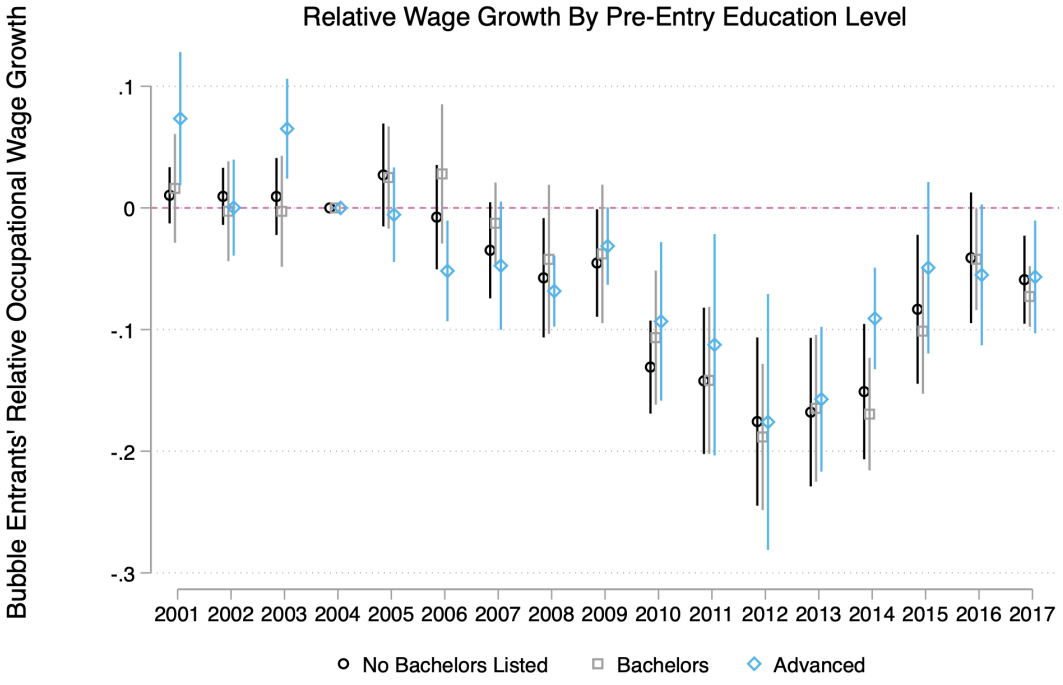
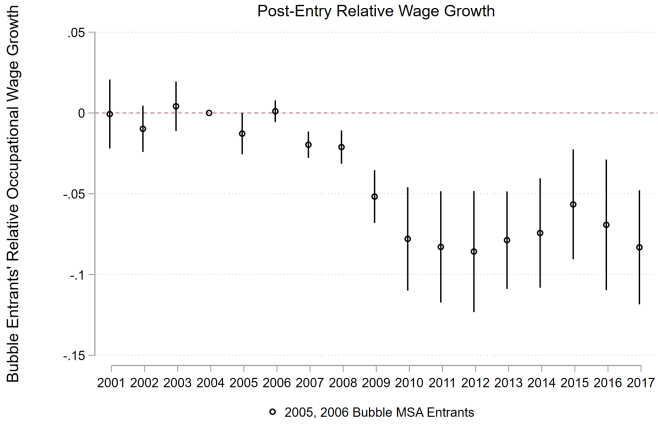


FIGURE IA.C2

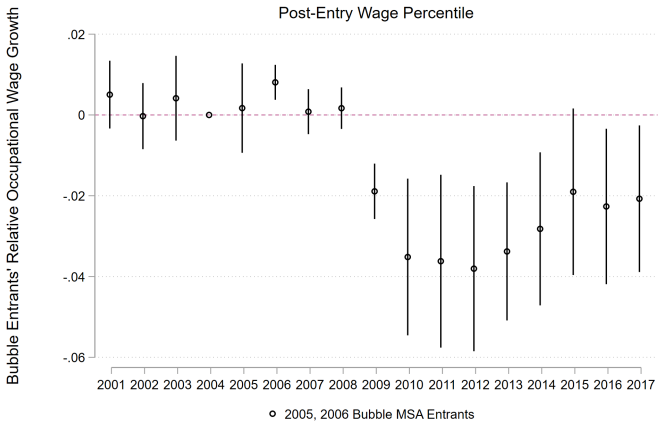
Occupational Wage Effects for Set of Other Housing-Related Occupations

This figure presents the estimated relative wage growth and percentile effects for of a set of 10 additional housing-related occupation entrants in areas with high non-fundamental house price growth ("Bubble") compared to similar entrants in other areas. The included occupations are: Loan officer, Loan Interviewer and Clerk, Appraiser, Construction Manager, Civil Engineer, Title Examiner, Construction and Building Manager, Property Manager, Assessor. High non-fundamental growth is defined as the top quartile of MSAs using the Magnitude of Structural Break (see Internet Appendix IA.A). Coefficients are estimated using the regression in Equation (2). The outcome variable is the average log-wage at the MSA-occupation-year level (Panel A) or the wage percentile of the MSA-occupation-year relative all occupations in that MSA that year (Panel B). An *entrant* is an individual who entered a housing-related occupation in 2005 or 2006, was not in the occupation in the prior year, and the housing-related occupation was their only occupation at entry. We include $\textit{Year} \times \textit{Occupation}^{Pre\text{-}Entry} \times \textit{Occupation}^{Entry} \times$ Bachelor Degree Indicator $\times$ $2001 - 2005$ House Price Strata fixed effects. Confidence intervals at the 90%-level are calculated with standard errors clustered by MSA.

(a) Post-Entry Wage Growth



(b) Post-Entry Wage Percentile



References

Charles, K. K.; E. Hurst; and M. J. Notowidigdo. "Housing booms and busts, labor market opportunities, and college attendance." *American Economic Review*, 108 (2018), 2947–94.

DeFusco, A.; W. Ding; F. Ferreira; and J. Gyourko. "The role of price spillovers in the American housing boom." *Journal of Urban Economics*, 108 (2018), 72–84.

Ferreira, F., and J. Gyourko. "Anatomy of the beginning of the housing boom: US neighborhoods and metropolitan areas, 1993-2009." National Bureau of Economic Research (2011).

Hsieh, C.-T., and E. Moretti. "Can free entry be inefficient? Fixed commissions and social waste in the real estate industry." *Journal of Political Economy*, 111 (2003), 1076–1122.

Iacus, S. M.; G. King; and G. Porro. "Causal inference without balance checking: Coarsened exact matching." *Political analysis*, 20 (2012), 1–24.

Pischke, J.-S. "Wage flexibility and employment fluctuations: Evidence from the housing sector." *Economica*, 85 (2018), 407–427.

Roy, A. D. "Some thoughts on the distribution of earnings." *Oxford economic papers*, 3 (1951), 135–146.

Thompson, S. B. "Simple formulas for standard errors that cluster by both firm and time." *Journal of Financial Economics*, 99 (2011), 1–10.