Cash to Spend: IPO Wealth and House Prices*

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Abstract

This study empirically demonstrates the positive impact of initial public offerings (IPOs) on local housing prices in California from 1993 through 2017. In the spirit of the difference-in-difference approach, we test whether hedonic price indexes increase after IPO events more for the areas around IPO firm headquarters. We use the IPO events of public filing, issuing, and lockup expiration to distinguish changes in the shareholders' expected wealth, assessed wealth, and immediately available wealth, respectively. On the filing and issuing dates, house prices increase by more for markets that are closer to the headquarters around IPO firms. On the lockup date, houseprices only increase if the listing-to-lockup return is positive. This result suggests that original shareholders change their housing demand when their wealth changes but not when liquidity constraint is relaxed. We also use the San Francisco Bay as a natural barrier to commuting. Relative to the East Bay, house prices in San Francisco exhibit a long term increase in response to the IPO filing date but only a short term increase in response to the issue and lockup expiration dates.

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1 Introduction

An initial public offering (IPO) rewards the founders, angel investors, venture capitalists, and employees that have stock options (henceforth original shareholders). For example, PrivCo reported that twitter's IPO created 1,600 millionaires.[1] Changes in wealth and liquidity experienced by shareholders around an IPO leads to corresponding changes in their consumption. In particular, demand may increase for housing and services that impacts the local housing market.

In California, where start-up companies cluster (Figure 1), a positive correlation is observed between the number of IPOs and house prices (Figure 2). Although this positive correlation is sometimes interpreted as a causal effect of the wealth created by start-up companies, causality is not immediately obvious.[2] Furthermore, anticipated wealth changes should be internalized in the shareholders' consumption and tenure choices well before an IPO (Friedman, 1957). Thus, for an IPO to affect housing demand, the wealth changes must be unexpected or there must be obstacles to consumption smoothing. There is an additional concern that if IPOs are causing house prices to appreciate, increases in the cost of living and business may be a negative side-effect on economic agglomeration (e.g., Cornaggia et al., 2017; Butler et al., 2019).[3]

In this study, we ask two questions. First, do IPOs influence local housing markets? The positive correlation between IPOs and house prices can be a coincidence or can be generated by confounding factors such as high amenities and housing supply constraints. We attempt to isolate the causal effect of IPOs on housing prices in two ways. First, we estimate a spatial difference-in-difference approach that compares the effect of IPOSs on housing markets that are close to the headquarters of IPO firms to those that are farther away. An second, we use the San Francisco Bay as a natural geographic barrier and comparing house price changes in San Francisco to those in Alameda around IPO events. We then ask if IPOs influence housing markets, when and how are IPOs internalized into house prices? Most IPOs have three sequential events: IPO filing, share issuing, and the expiration of a lock-up period. These sequential stages provide a unique setting for decomposing a shock to shareholder wealth into an update of the expected future wealth at the time of an IPO filing, an update of the assessed wealth at issuance as the stock is priced mark-to-market, and when the liquidity constraint is relaxed at the lockup expiration event. Because of requirements related to mortgage financing (i.e. cash for the down payment), the liquidity constraint is likely to play an important

[1] PrivCo does market research of private firms and reported on twitter's IPO: `http://www.privco.com/the-twitter-mafia-and-yesterdays-big-irs-payday`.

[2] New York Times, February 20, 2017, "With Snap's I.P.O., Los Angeles Prepares to Embrace New Tech Millionaires," (`https://www.nytimes.com/2017/02/20/technology/snap-ipo-los-angeles-real-estate.html`); and Zillow Blog, "Millionaire's Row: How Did Facebook's IPO Affect Silicon Valley Real Estate?" (`https://www.zillow.com/blog/millionaires-row-how-did-facebooks-ipo-affect-silicon-valley-real-estate-86027/`)

[3] See also San Francisco Business Times, August 16, 2017, "Why 83 percent of Bay Area renters say they plan to leave (`https://www.bizjournals.com/sanfrancisco/news/2017/08/16/why-83-percent-of-bay-area-renters-say-they-plan.html`) and The Economist, August 30, 2018, "Why startups are leaving Silicon Valley" (`https://www.economist.com/leaders/2018/08/30/why-startups-are-leaving-silicon-valley`)

role in housing tenure choice (e.g., Artle and Varaiya, 1978; Schwab, 1982; Slemrod, 1982; Henderson and Ioannides, 1983; Brueckner, 1986).

We combine data for IPOs and residential property transactions in California from 1993 through 2017. To control for the housing heterogeneity, we construct hedonic constant-quality home price indexes (HPIs) for housing transactions to identify the trend in house prices associated with treatment, which is defined by housing transactions occurring near the IPO-firm's headquarters following an IPO event, as well as control groups to capture the general trend in house prices over the time period spanning the IPO events. Using the event-specific HPIs, we analyze the discontinuity in time of each IPO event by looking at the spatial difference in proximity to IPO firms and, also, exploit the natural barrier of San Francisco Bay.

We are exploiting the housing preferences of insiders to be closer rather than farther away from the firm's headquarters. Anecdotal evidence suggests that managers and employees of technology firms do tend to prefer to live near their companies.[4] Of course, some of the original shareholders may prefer other residential areas that are distant from their companies. Because the data does not identify home buyers as being original shareholders or not, we are unable to pinpoint specific areas where managers and workers moved. Testing for an IPO treatment effect when the impact is not localized, in this case, biases against finding a significant result in the spatial difference-in-differences analysis. Thus, our estimate includes both direct and indirect effects of IPOs on housing markets near headquarters. For example, there might be speculating buyers who hope to sell houses in the future at higher prices.

In our spatial difference-in-difference analysis, we estimate the average change in the HPI before and after IPO events for the area around the IPO-firm's headquarters (the treatment area) by interacting a indicator variable for transactions that occur within a window of an IPO event with indicators for distance to the IPO-firm's headquarters. We use a 180-day window to define pre- and post-event periods and indicators for distance bands in increments of 5 miles to define distance to the IPO-firm's headquarters.

The three types of IPO events are well-defined with explicit dates. When management decides to take the firm public, they file Form S-1 with the SEC that publicizes their intention of pursuing an IPO.[5] Subsequently, the firm issues a combination of primary and secondary shares on a public exchange and the firm's market value is revealed. Many IPOs have a lockup period, during which restricted shares cannot be sold.[6]

We find the statistically significant effect of IPOs on local house prices with varying sizes by event type,

[4] e.g., Business Insider, "Zuckerberg Buys A $7 Million Home Near Facebook's New Campus," https://www.businessinsider.com/zuckerberg-buys-a-7-million-home-near-facebooks-new-campus-2011-5; Marcotte Properties, "Where Do Silicon Valley's Tech Workers Really Live?" https://www.marcotteproperties.com/silicon-valleys-workers-live/

[5] Under the Securities Act of 1933, Form S-1 registers the securities being offered in an IPO. Emerging growth companies may have the ability to file registration materials confidentially based on the Jumpstart Our Business Startups (JOBs) Act that was enacted April 5th, 2012.

[6] The lockup period acts as a signal of the firm's quality to remedy information asymmetries and price supports by restricting the supply of shares (Brav and Gompers, 2003; Arthurs et al., 2009).

proximity to the firm, and the characteristics of firms and IPOs. The results for Silicon Valley are not significantly different from those for California. Based on the baseline estimation, the effect is largest for filing events: house prices within 5 miles of a firms headquarters increase by .864% more than house prices 20-25 miles way in response to a firm filing and intent to conduct an IPO. The effect is also large for IPO issuing events: house prices within 5 miles of a firms headquarters increase by .668% more than house prices 20-25 miles way in response to a firm issuing shares in an IPO. There appears to be no effect of the lockup expiration date in this baseline analysis..

These results suggest that original shareholders change their housing demand when their wealth changes but not when liquidity constraint is relaxed. Because the original shareholders cannot cash out their wealth at the time of share issuance or IPO filing, our result suggests that the original shareholders can finance their home purchases based on their illiquid wealth. It is unlikely that arbitrageurs (flippers) with enough liquidity buy houses to make short-term profits because of large housing brokerage fees. Banks in California may not be very restrictive in originating mortgages to entrepreneurs and workers at start-up firms because of their relatively rich experience with this type of consumers. Thus, the result of no liquidity constraint may not extend to other states. For example, in a related study, Hartman-Glaser et al. (2017) use the IPO and housing data for Denver, Colorado, and find a larger treatment effect for the lockup expiration event than for the filing and issuing events. Although this difference between California and Colorado is not conclusive because of differences in data sources and estimation methods, this contrast is very suggestive of the uniqueness of mortgage origination markets in California.

We continue our analysis of the spatial effects of IPO's on house prices by splitting our sample by relevant features of the firm's and IPO's. We see little difference in the effects we describe above when we separately estimate the regression for the largest and smallest firms at IPO or for the oldest and youngest firms at IPO. However, when we split the sample by return from listing-to-lockup expiration, we see an economically large difference between the lockup expiration date effect for firms with a large listing-to-lockup return versus those with a small one. Specifically, the lockup date expiration has a large spatial effect on house prices for firms with a high listing-to-lockup return and no effect for firms with a small one. This result is again consistent with the hypothesis that the effect of IPOs on house prices opperates through wealth creation and not through liquidity relaxation.

Our second analysis using the San Fransisco Bay as a barrier to commuting that allows us to estimate a difference-in-difference like regression. In this regression, the San Francisco housing market serves at the treated group while the housing markets of nearby East Bay cities serve as a control group. We estimate this regression using treatment windows at 30, 90, and 180 days. At the 30 day treatment window, we observe a significant effect of the issue and lockup expirations dates of 2.62% and 3.33% respectively, although

the lockup-expiration effect is only significant at the 10% level. At 180 days, these effects are no longer significant, indicated that the added price appreciation in San Francisco relative to the East Bay reverses in the longer run. However, at the 180 day window, we do observe a large and significant effect on the filing date of 2.37%. These results are consistent with the results from spatial difference-in-difference approach that we estimate for the entire Bay Area.

The identifying, or parallel trends, assumption in our San Francisco difference-in-difference regression is that absent an IPO for a firm headquartered in San Francisco, San Francisco and East Bay housing markets would appreciate at the same rate. We evaluate this assumption by repeating our analaysis with "placebo" dates. To generate placebo dates, we shift the actual filing, issue, and lockup-expiration dates forward or backwards a fixed number of days. Consistent with out parallel trends assumption, we do not see significant effects on house prices on these placebo dates.

In summary, the evidence supports an *expectations hypothesis*, in which the original shareholders without liquidity constraints change their demand for housing consumption at the IPO filing event. The evidence also supports a *wealth hypothesis*, in which the original shareholders change their housing demand when their book value of wealth is determined in the stock exchange. However, the evidence does not support a *liquidity hypothesis*, in which the original shareholders change their housing demand only when they can monetize their book wealth. In general, IPOs partly explain the appreciation of local housing prices.

This paper contributes to the literature in two ways. First, to our knowledge, this is the first study that identifies a causal effect of IPOs on local house prices. We demonstrate that positive correlations between IPOs and home price appreciation cannot be entirely attributed to the causal effect of IPOs. On average, we find a 1% effect of a filing event and a 0.8% effect of a share issuing event; i.e., a 1.8% increase in local house price around IPO firms' headquarters for each IPO. Second, different IPO events provide a unique setting for comparing the impact of wealth and liquidity constraints. Our findings indicate that original shareholders in California shift their housing demand when a future wealth increase is anticipated and when a wealth increase is confirmed regardless of weather wealth is immediately available. This result suggests that personal financing function well for high-wealth individuals in California, allowing them to smooth consumption.

The paper is structured as follows. Section 2 provides institutional background and sets up the hypotheses. There is a discussion about the data and methods in section 3, which includes summary statistics. The main results are presented in section 4. In section 5 the treatment is decomposed at the property transaction level by market segment and composition. Finally, there is a concluding section.

2 Background and Hypothesis Development

Underwriting standards in mortgage lending and credit constraints in home purchasing are explicit and uniformly applied. For example, the down payment constraint also known as loan-to-value (LTV) thresholds limit the amount of a property's sales price that a borrower can finance and impose additional costs for higher LTV loans.[7] Also, the debt-to-income (DTI) restriction limits the amount of outstanding debt that a borrower can have in proportion to their income.

The LTV and DTI constraints are most likely to affect original shareholders. First, original shareholders are unable to use pre-IPO shares and firm equity for a down payment. Second, stock options that compensate original shareholders with equity substitutes for cash compensation. In the case of cash constrained start-ups, they are more likely to compensate employees with stock options where the larger the proportion of compensation to original shareholders is in the form of stock options increases the likelihood of a binding DTI constraint because it lowers the amount of housing services that original shareholders can purchase as a function of their income. As a result, original shareholders are disproportionately likely to be bound by credit constraints that lead them to forego housing consumption today. In addition, to smooth consumption original shareholders are more likely to use their stock options and equity stake as a mechanism to save for a down payment. Therefore, by saving less of their income original shareholders are able to smooth their consumption.

Under the null hypothesis, there is no association between property values and IPOs.

H_0**:** *(Null Hypothesis)* There is no change in property values associated with IPO events.

In this case, the credit constraints are not binding and there is no unexpected changes to the personal wealth of original shareholders that would lead them to change their demand for housing services. If there is evidence of a post-treatment effect then we reject the null hypothesis in favor of the alternative that either there are binding credit constraints or there is an unexpected wealth shock.

In rejecting the null hypothesis in favor of the alternative that IPOs influence local housing markets, there are three mechanisms that may be driving the treatment effect that are not mutually exclusive. These are the *expectations, wealth,* and *liquidity* hypotheses, which closely follow from the sequential events of a completed IPO.

First, a firm declares their intent to go public. The firm is signaling that their IPO is imminent and removing uncertainty about the timing and exit strategy for original shareholders.[8] Using the date when

[7] For example, loans with an LTV in excess of 80% are charged private mortgage insurance (PMI) that is added to the monthly mortgage payment as a percentage of the loan amount.

[8] If original shareholders consider the present value of the payoff from the IPO as the discounted sum of the probability that the firm IPOs in each period then filing increases the present value of the payoff by significantly reducing the number of discounted periods.

Form S-1 is submitted as the IPO filing event, we define the *expectations hypothesis* as a change in the demand for housing from this updated expectation.

H_1**:** *(Expectations Hypothesis)* There is a change in local property values following the submission of Form S-1.

A change in expectation increases the demand for housing if credit constraints to acquire financing are not binding. In this case, original shareholders can adjust their consumption of housing services even if wealth cannot be immediately monetized.

Second, at the IPO event the firm issues equity and they are listed on an exchange. At this point, any uncertainty around the firm's market value is removed as well as the uncertainty about whether the firm would successfully IPO.

H_2**:** *(Wealth Hypothesis)* There is a change in local property values after the firm's shares are listed on a public exchange when an unexpected change to original shareholders' book value of wealth leads to a change in their demand for housing.

There are two possible reasons for a change in house prices around the issuing event. First, original shareholders changer their housing demand in response to the realization of a wealth shock from the IPO when their book value of wealth is determined in the stock exchange. An unexpected change impacts the consumption and tenure choice of original shareholders in the post-IPO period (Friedman, 1957). Second, if there were binding constraints in the pre-IPO period that no longer bind. For example, if the firm's listing occurs at the same time that they make significant changes to the compensation structure for original shareholders. However, original shareholders' wages are unlikely to change around the IPO event and in the presence of a lockup restriction their pre-IPO shares cannot be liquidated to go towards a down payment. Under the *wealth hypothesis* changes in property values around the IPO event are due to unexpected changes in the book value of wealth for unconstrained original shareholders that lead to changes in the demand for housing.

At this point, wealth-constrained original shareholders respond to changes in their illiquid assets whereas liquidity-constrained original shareholders will not (Tobin, 1972). The presence of a lockup restriction may lead original shareholders to be liquidity constrained because they are unable to liquidate their equity position in the firm until the lockup period expires. During this period, which is usually 180 days between the IPO and the expiration of the lockup, original shareholders are restricted from selling and cashing-out their shares. In some cases, there are IPOs that do not have a lockup period but that is not the norm. The lockup period benefits original shareholders by signaling the firm's quality to investors, aligns incentives, and protects underwriters.

However, firms can offer existing "secondary shares" at the IPO from original shareholders to the public in addition to new "primary shares" that allows original shareholders to liquidate their pre-IPO shares at the issuance when a lockup restriction is present. In this case, the lockup restriction does not apply to this subset of original shareholders. In Chua and Nasser (2016) does find that original shareholders are motivated to offer secondary shares by apparent liquidity needs. For example, smaller cash-pay is associated with larger secondary offerings. However, secondary shares are viewed negatively by investors and Aggarwal et al. (2002) demonstrate that it is optimal for managers to wait for the end of the lockup. Therefore, the majority of firms do not offer secondary shares and when they do it tends to be only a small proportion of original shareholders that have this opportunity (Field and Hanka, 2001).

Third, the lockup event occurs when the limits on original shareholders' trading restricted shares expires.[9] To restricted shareholders, the only difference between immediately before and immediately after the lockup expiration is their ability to liquidate their restricted shares. Under the *liquidity hypothesis* there is a change in the demand for owner-occupied housing following the expiration of the lockup restriction when liquidity constrained original shareholders are no longer subjected to binding credit constraints.

H_3**:** *(Liquidity Hypothesis)* Higher property values follow the expiration of the lockup period.

We assume that the wealth associated with the restricted shares is either not fungible or is costly to access. However, there is a concern that the lockup event is associated with additional potentially confounding treatment effects. For example, Field and Hanka (2001) find an abnormal three-day return of -1.5% from looking at the returns around lockup expiration events. Therefore, changes to original shareholders' wealth consistent with an abnormal negative return around the lockup expiration only biases against finding evidence supporting the *liquidity hypothesis*.

The lockup period acts as a triggering event similarly to the down payment requirement. Artle and Varaiya (1978) show how down payments deter home ownership when the benefits from ownership do not exceed the loss in utility from having to save. Therefore, individuals make tenure choices as soon as they reach the down payment threshold associated with their demand for housing consumption where the down payment acts as a triggering event. Similarly, when original shareholders are liquidity constrained such that credit constraints are binding then they are unable to fulfill their demand for housing services until the lockup expires, which then acts as a trigger event. The question about the magnitude and significance of the impact on local housing markets is an empirical one.

[9]When more than one lockup expiration date appears in the IPO data from SDC the first incidence is considered as the lockup expiration date for that IPO.

3 Methodology and Data

We follow a hedonic approach for modeling house prices to test for an association between IPOs and local house price changes. Rosen (1974) is credited with developing the hedonic price method that assumes property values can be regarded as the sum of implicit prices of a bundle of attributes in equilibrium. It is a common method applied in housing related research.

However, there is an omitted variable concern when prices and implicit goods are determined in a spatial equilibrium. In this case, if the choice of the firm's location correlates with the timing of the IPO; if the timing of the IPO correlates with local housing market cycles; or they both correlate with an unobserved omitted variable then the estimates for treatment will be biased.

Our main concern is that the timing of an IPO and the location of the firm are choice variables that are endogenous. In Brau and Fawcett (2006) they survey chief financial officers (CFOs) and find that creating shares for acquisitions is the most important motivating factor for going public where the overall stock market and industry performance are the largest determinants of IPO timing. Therefore, IPOs are not timed in coordination with house prices directly but the determinants of IPO timing may still correlate with an omitted variable that correlates with local property values.

To deal with this problem, we exploit spatial-temporal variation of IPOs and follow two main approaches. Our first approach is similar to Pope and Pope (2015) that looks at Walmart openings and compares transactions that are closer to a Walmart to those slightly farther away before and after it opens. Other studies with similar designs have looked at the impacts of sex offenders (Pope, 2008), the spillover effects associated with foreclosures (Gerardi et al., 2015; Lin et al., 2009; Schuetz et al., 2008), and forced sales (Campbell et al., 2011). In our case, we construct IPO specific house price indexes that capture house prices movements in geographic annuli, that is, distance bands, surrounding a firms headquarters at multiple distances. We then regress those indexes on an indicator for periods following an IPO event, indicators for distance bands, and interactions between the distance bands and the post indicator.

In addition to the spatial difference in difference approach, we also exploit the geographic features of the location of many of the IPO's in our sample. Specifically, we treat the San Fransisco Bay as a natural barrier to commuting for workers at IPO firms. We then consider cities an the San Francisco Peninsula in which IPO firms are headquarter as "treated cities" and choose cities on the east side of the San Francisco to act as "control cities." We then estimate a traditional difference-in-difference model for each IPO event using this classification of treated and control.

This difference-in-differences approach requires two assumptions for a causal interpretation of the results. First, original shareholders are assumed to value proximity to the firm's headquarters, ceteris paribus. As

long as they place some cost on the time they spend commuting and there is an association between distance and commuting time this assumption holds. Second, we attribute changes in house prices levels right before and right after an IPO event to the IPO event itself. By only including transactions that occur around the IPO event date being considered and within 5 miles of the firm's headquarters limits the possibility of confounding events. This approach controls for the trend in house prices and time invariant omitted variables related to the firm's location.

Also, we consider each IPO as three separate event studies corresponding to the sequential events of a completed IPO. In this way, the IPO events being considered do not occur simultaneously with the decision to go public. Instead the time between the decision to go public and the each IPO event varies by event and by firm. For example, the length of time between the filing event and issuance depends on the length of time that managers spend with underwriters on the road show gauging investor interest. Then after the firm is listed, the time between IPO issuance and the expiration of the lockup period is generally 180 days, which is defined by institutional convention and not from any consideration of local house prices. As a result, the length of time between IPO filing and the expiration of the lockup period can span years and there is no indication that IPOs are timed with the local housing cycle over the course of the IPO events. Therefore, it is assumed that IPO events are exogenous shocks to the local housing market.

3.1 Data and Summary Statistics

Transaction Level Data

We use Zillow residential property level data for California. It is the product of merging their transaction and property assessment files. In the raw file there are 12.8 million transactions with 99% falling between 1993 and 2017. The observations are cleaned on missing and unwanted or unreasonable property characteristics. For example, intra-family transactions are excluded. Also, properties are filtered by property type, the number of parcels, and the number of buildings. We restrict the sample to single parcels where there is only one building and include property types: residential general, single family or inferred single family, rural residence, townhouse, row house, planned unit development, and bungalow. The final sample consists of properties that: have at least one full bathroom and at least one bedroom, non-negative property age and less than or equal to 150 years old, non-missing sales price greater than or equal to $1,000, not more than four units, non-missing latitude and longitude, non-missing land size strictly greater than 500 square feet, and non-missing number of stories less than or equal to three. The final sample has around 6.5 million unique property transactions from 1993 to 2017.

Initial Public Offering (IPO) Data

From SDC, we obtain 1,987 unique IPOs for California from 1970 through 2017.[10] This list of IPOs is filtered for missing address information, when a P.O. Box is listed as the firm's address, and when geocoding returns a less than to the street address level accurate longitude and latitude.[11] Ultimately, the final sample includes 725 IPOs from California with an IPO event between 1993 and 2017.

We summplement the IPO data from SDC with data from CRSP and from data available from Ritter.[12] From CRSP, we obtain the daily open and closing stock prices, returns with and without dividends, the number of shares outstanding, and the volume of shares traded. From Ritter, we obtain the firm's founding year and rollup status.[13] From the 725 unique IPOs: there are 224 firms that offer secondary shares at the IPO; 447 that are identified as being backed by venture capital; 71 where the IPO issue is backed by private equity; and 16 identified as being rollup firms.

Summary Statistics

Table 1 summarizes the distribution of transactions and IPOs by year and by IPO event. It does appear that the IPOs come in waves with the most filings in 1999 at the peak of the dot-com bubble and smaller waves around 2004 and then again around 2014. Therefore, our period of analysis covers multiple cycles and market environments including the financial crisis period.

Descriptive statistics are provided in Table 2 at the property and firm level. Panel A summarizes the transacted properties where the average sales price over this period is $335,145. After adjusting for inflation the average adjusted sales price over this period is $415,363.[14] For the analyses, the adjusted sales prices are used to generate the results althought they are robust to using the raw sales price. In terms of property characteristics, there are large standard deviations but they are inline with similar studies.

Panel B summarizes the sample of IPOs where the average target price is $12.99 per share with a max of $97.00 and average proceeds from the IPOs of roughly $131 million. There is a lot of variation within IPO and firm level characteristics exhibited by the large ranges and standard deviations. For example, the average for total assets is $224.24 million where the minimum is $0.10 million and the maximum is $7,190 million for the largest firm by total assets. We will exploit the variation in firm and IPO characteristics in robustness tests to further examine the relationship between IPOs and local house prices. Specifically, we focus on the variation in firm age, total assets, offer type, offer price, IPO proceeds, IPO underpricing, and

[10] See figure B of the appendix for a comprehensive summary of the SDC IPO search criteria.
[11] The Google maps geocoding API was used to return longitude and latitude of the firm's listed address.
[12] The Field-Ritter data on IPOs was downloaded (10/21/2017) from: `https://site.warrington.ufl.edu/ritter/ipo-data/`
[13] A rollup is a firm that grows by acquiring other firms.
[14] Sales prices are adjusted by finding the 05/2017 dollar equivalent according to the monthly Consumer Price Index (CPI) for All Urban Consumers: All Items from `https://fred.stlouisfed.org/series/CPIAUCSL` (downloaded 7/19/2017).

the firm's stock performance post-IPO.

Panels C and D provide additional summary information about the performance of the IPO. The average return at 1 year from the IPO is 25.47% with a minimum return of -227.78% and a maximum of 740.83%. Here the firm's return is calculated as the percentage change from the offer price to the closing price on the date considered (i.e. 1 year following IPO) and the displayed average return is the simple average across the firm's. To quantify the risk associated with the IPO, we calculate the relative volatility for each firm's stock post-IPO as the standard deviation of daily closing prices divided by the average of closing prices for the period.

Event Level Statistics

Table 3 shows mean differences in adjusted sales prices of transactions in a pre or a post-period by event type and across distances of 1, 5, and 10 miles from the IPO firm's headquarters. Specifically, transactions are identified as occurring in a pre or post event window if they are within a specified radius of a firm's headquarters (1, 5, or 10 miles) and the sales date for the property is within 90 days of that firm's IPO event. For example, for Facebook's IPO case, we define a 5-mile radius from Facebook's headquarters and identify property transactions that occurred within 90 days before and after Facebook's IPO filing event (Figure 3). We repeat this procedure for each IPO firm (e.g., Figures 4 and 5). It is possible that a transaction will be included in the pre-period for one IPO and the post or treatment period for another. For this table, we only include those observations that are in one pre-period or one post-period window by event type for a clean interpretation of treatment. For example, a transaction that appears in the pre-lockup expiration period for XYZ and the post-lockup expiration period for another IPO is excluded from this table summary of the lockup event. Instead the main results are based on house price indexes that are generated at the firm event level where overlapping observations are not excluded.

In Table 3 the post-filing prices are consistently higher than the corresponding pre-filing prices or roughly a 3.7% increase in unconditional mean at 1 mile, which falls to 2.8% and 1.3% at 5 miles and 10 miles respectively. The lockup expiration event shows a consistent negative price change in local house prices across the distances with the largest decrease or -6.5% at 1 mile around the firm. The change around the issue date varies from negative at 1 mile and 10 miles but is positive at 5 miles. The largest magnitude of price change around the issue date is -2.4% within a 1 mile distance boundary from the firm. To control for differences in the composition of properties transacted and trends in house prices in the pre versus post-period by IPO event additional analysis is necessary.

3.2 Baseline Hedonic Price Index for California

In analysis below we will examine house price indices associated with IPO firm headquarters and IPO events that account for aggregate conditions in California. We call these indices residual house price indices as estimate them as follows. First, we estimate a hedonic house price index using the entire sample of cleaned transactions (6,381,800 from 1993 to 2017) for California. It is a log-linear specification run at the property level (i) that includes controls for property characteristics (X_i), county fixed effects (δ_c), year/month fixed effects (δ_{t_c}) in "calendar" time, and quarterly dummies to separately identify the effect of seasonality (δ_s).

$$ln(P_{icst_c}) \quad = \quad \beta_0 + uX_i + \delta_{ic} + \delta_{it_c} + \delta_{is} + \varepsilon_{icst_c} \tag{1}$$

From the coefficient estimates, the residual or unexplained variation in house prices is given by:

$$Residual_{icst_c} = ln(P_{icst_c}) - \widehat{ln(P_{icst_c})} \tag{2}$$

With the residuals at the transaction level, the house price indexes by firm (f) and by IPO event (e) are constructed following the time dummy approach. The transactions included are only those observations identified in the firm's pre or post-period by IPO event and either within a certain distance band of the headquarters (i.e. within five miles or five to ten miles), within the city of San Franisco, or with cities in the East Bay that serve as control cities for San Francisco. Where time (t_c) previously identified "calendar" months, now time (t_{fe}) is "event" time or indicators defined in 10 day intervals from each by firm event date. We estimate the following regression

$$Residual_{it_{fe}} \quad = \quad \beta_0 + \sum_{t_{fe}=-s}^{s} \delta_{t_{fe}} T_{it_{fe}} + \varepsilon_{it_{fe}} \tag{3}$$

where s is a time window around the event and $T_{it_{fe}}$ are time dummies for the dates around the event.

In this specification, the coefficient estimates on the time dummies ($\hat{\delta}_{t_{fe}}$) give the variation in house prices that is unexplained by property characteristics or the trend in house prices in California generally. The by firm by IPO event regressions are run separately to construct the firm event level residual house price indexes ($RHPI_{fedt_{fe}} = 100 \cdot exp(\hat{\delta}_{t_{fe}})$) where d identifies the boundary or geographic proximity constraint imposed on the within (treated) transactions (i.e. 5-miles from the headquarters).

However, the residuals are estimated based on certain limiting assumptions, for example, that the trends in housing are held constant across the entire state of California. Therefore, a comparable per firm per event index or $RHPI^c_{fedt_{fe}}$ is constructed to control for the local trend. The $RHPI^c_{fedt_{fe}}$ is defined in the same

event time as that of the treated $RHPI_{fedt_{fe}}$ for the county where the firm is located but with the within or treated transactions excluded.

4 The Spatial Effects of IPOs on House Prices

4.1 Main Results

In this section we describe the spatial effects of the three IPO events on house prices. The first step in this analysis is to generate unique RHPIs by distance band (zero to five miles, five to 10 miles, up to 45 to 50 miles from the firm) for each firm for each IPO event. As a result, there will be 10 distinct RHPIs for each firm-IPO event with each representing unexplained house price variation for the mutually exclusive regions. The omitted or base period is defined as the earliest 10-day bucket. We then include on obersvation of each RHPI for a plus and minus 180 day window around each firm-IPO event.

Next, we estimate a regression model provides estimates of average level changes in RHPIs in the post-period compared to the pre-period by distance band. Specifically, the constant term is omitted as well as the main effect of the post-period. We include the main effects of each distance region, the interaction of distance and post-period indicator, and firm fixed effects, which controls for variation by region, time, and firm characteristics. Specifically, we estimate the following regression.

$$RHPI_{fetd} = \sum_{d_{fe}=1}^{10} \left[\delta_{d_{fe}} DistanceBand_{d_{fe}} + \beta_{d_{fe}} (Post_{fe} \cdot DistanceBand_{d_{fe}})\right] + \eta_f + \varepsilon_{fetd} \tag{4}$$

This analysis is similar to the spatial difference-in-difference design of Pope and Pope (2015). The indictors $DistanceBand_{d_{fe}}$

The coefficient estimates for the interaction terms identify the relative RHPI level change from the pre-period to the post-period by distance band. The standard errors, which are clustered by year and the zip code of the firm's headquarters, for the coefficient estimates of the interaction terms then represent the likelihood that the treatment effect differs from the distance band price levels captured by the main effects.

Figure 6, displays the coefficients and standard error from estimating the regression in equation 4. Panel A of Figure 6 displays the estimates for the Filing date event. The figures shows a significant decline in the effect of the IPO filing date as the distance from the headquarters of the IPO firms. The coefficient $\beta_{1_{fe}}$ on the closest disance band, that is, zero to five miles, is 2.722% with a standard error of .428, while the coefficient $\beta_{5_{fe}}$ on 20 to 25 miles is 1.556% with a standard error of .221. Similar, though less pronounced, patterns are present in Panels B and C of Figure 6 that display the effects of the listing date and lockup

expiration date respectively. In Panel B, we can see that $\beta_{1_{fe}}$ is 2.507% with a standard error of .334 and $\beta_{5_{fe}}$ is 1.681% with a standard of .209, again indicated that the listing date had a positive effect that decays with distance. In Panel C, we note that there is no significant difference between the effect of the lockup date on house prices close to the firm (within five miles) and at a greater distance (20 to 25 miles). However, in all three plots a large difference is apparent in the effects of house prices close the firm, and at the extreme distance of 45 to 50 miles. In sum, it appears there is a clear spatial effect of the filing date on house prices, with a weaker effect of the listing date, and little to no effect of the lockup date.

To verify the statistical significance as the effects apparent in Figure 6, we estimate a simplified version of the regression in equation (4). Specifically we estimate the following difference-in-difference regression

$$RHPI_{fetd} = \alpha + Post_{fe} + DistanceBand_{1_{fe}} + Post_{fe} * DistanceBand_{1_{fe}} + \eta_f + \varepsilon_{fetd} \tag{5}$$

where the treated group, $DistanceBand_{1_{fe}}$, consists of the RHPI estimated on transactions within five miles of headquarters and the control group consists of the RHPI estimated on transactions in the 20 to 25 mile distance band around headquarters. We report the results of this regression in Table 8 for three different time windows. Panel A of Table 8 shows the results with a 30 day estimation window. In Panels A and B of Table 8, we report the results for 30- and 90-day windows respectively and see that the only the issue date appears to have a significant effect on house prices, and that is only at for a 90 day window and is only marginally significant. Panel C of Table 8 shows the results for a 180 day estimation window and corresponds to the effects we document in Figure 6. We see a .864 percentage point greater appreciation of house prices around the filing date for transactions within five miles of headquarters than for transaction 20-25 miles from head quarters. Similarly, the same comparison around the issue dates shows a .668 percentage point greater increase.

We now investigate how the effects we document in Figure 6 vary by Firm and IPO charactersitics as well as

4.2 Variation By Firm Characteristics

In terms of firm characteristics, firm age is a likely proxy for growth and time at the headquarters while total assets is a proxy of firm size. For example, growth firms can be cash constrained and thus rely more heavily on stock options to compensate original shareholders. Because firm level characteristics may not be linearly related with the treatment effect, we sort the firms into buckets by quartiles of the characteristic of interest and estimate the base model (4) for the top and bottom quartiles.

In Figure 7 we repeat the analysis of Figure 6 separately fo the top and bottom quartile of firm age at the

filing date. Interestingly, there does not appear to be a substantial difference in the spatial effect of IPO's on house prices for old and young firms.

In Figure 8 we repeat the analysis of Figure 6 separately fo the top and bottom quartile of total assets. Firms are sorted into quartiles by their total assets where the firm's total assets is measured just prior to going public. Again, there does not appear to be a substantial difference in the spatial effect of IPO's on house prices for old and young firms.

4.3 By IPO Performance: Returns

We measure post-IPO performance by the firm's stock return and volatility. Larger returns increase the original shareholders' wealth whereas larger volatility may increase the early exercise of employee stock options (ESOs) (Huddart, 1994; Kulatilaka and Marcus, 1994; Huddart and Lang, 1996). We estimate the following IPO performance model that incorporates event specific returns and volatility to test whether the treatment effect significantly differs by the firm's post-IPO performance.

Figure 9 repeats the analysis of Figure 6 separately for firms with large (small) first trading day returns, i.e., underpricing. Firms with larger first day returns exhibit a greater effect on house prices at both the filing date and the listing date.

Figure 10 repeats the analysis of Figure 6 separately for firms with large (small) listing-to-lockup expiration returns. There appears to be a substantial difference in the effect of the lockup expiration date on house prices once we condition on returns. When a firm has a large listing-to-lockup return, the lockup expiration date has a large effect on house prices. This effect is consistent with hypothesis H_1, when the insiders share's appreciate by more, the lockup expiration date represents a larger wealth shock for those households.

5 The Effect of IPOs on San Francisco House Prices

In this section, we use the San Francisco Bay as a natural geographic barrier that provides an added cost of commuting from the East Bay to the headquarters of IPO firms located in the city of San Francisco. This added cost of commuting implies that housing markets in the East Bay are less likely to be affected by IPOs in San Francsico. We thus compare house price changes in San Francisco to those in Alameda around IPO events. Assuming no omitted variables and good control for the trend in house prices, the difference-in-differences approach is appropriate and identifies the house price change following IPO events. There are three steps in our difference-in-differences procedure. First, we exploit the population of California transactions to control for trends and seasonality in house prices. We describe this analysis in section 3.2. Second, we generate per firm per event house price indexes (HPIs). Lastly, we generate difference-in-differences

coefficient estimates to identify the average treatment effect of IPO events on the treated.

We construct by firm (f) by event (e) level house price indexes ($RHPI_{fetd}$) using the transaction-level residuals obtained from equation 2. Each RHPI is estimated separately and only includes those transactions that appear in the pre-period or post-period of a firm's IPO event.[15] Using the time dummy approach and bucketing transactions at 10-day intervals from the event, the treated RHPI is restricted to transactions located in the same city as the firm's headquarters and is estimated according to the following specification:

$$Residual_{it_{fe}} = \beta_0 + \sum_{t_{fe}=1}^{5} \delta_{t_{fe}} T_{it_{fe}} + \varepsilon_{it_{fe}}$$

To control for regional house price trends over the event windows, we estimate a complementing HPI per firm per event in the same manner as that of the treatment group but with transactions from the other side of the Bay. The control group transactions are defined by a set of cities that are situated on the other side of the bay, specifically Alameda, San Leandro, San Lorenzo, Castro Valley, Albany, Berkeley, Emeryville, Kensington, Oakland, and Piedmont.

We then estimate difference-in-differences coefficient to identify the conditional average treatment effects of IPO events on the treated. Each event is run separately and is based on the following model specification:

$$RHPI_{fetd} = \beta_0 + \beta_1 Post_{fe} + \beta_2 Treated_{fe} + \beta_3 (Post_{fe} \cdot Treated_{fe}) + \eta_f + \varepsilon_{fet} \tag{6}$$

The left-hand variable ($RHPI_{fetd}$) gives the time series of house price levels over the pre-post windows. The dummy variable $Post_{fe}$ identifies the post-period by firm (f) and event (e) and treatment identifies the RHPI series associated with area of the firm's headquarters. The RHPI complement controls for regional trends in house prices and confounding events. Also, firm fixed effects (η_f) are included to control for omitted variables from firm level variation. Lastly, the standard errors are clustered by the zip code of the headquarters and the year of the event.

Table 5 displays the results of estimating the regression in (6) at three different time horizons. In Panel A, we estimate the regression for a window of 30 days plus or minus the event date. At this horizon, the is a significant increase of approximately 2.6% in house prices on the issue date and a 3.3% increase in house prices on the date of the lockup expiration, although the change on the lockup date is only significant at the 10% level. There is no effect of the filing date at this time horizon. At a 90 day window, the lockup expiration date effect is no longer positive, and the issue date effect is smaller in both magnitude and statistical significance. At the 180 day window, the both the issue date and the lockup date effects disappear.

[15] Given a 30-day pre-period and post-period, there will be six HPI periods: -29 to -20, -19 to -10, -9 to 0, 1 to 10, 11 to 20, and 21 to 30 days from the event.

However, at this horizon there is a significant effect of the filing date of approximately 2.4%. Taken together, the results in Table 5 indicate a degree of efficiency in the housing market of San Francisco consistent with hypothesis H_1. When a firm announces its intention to conduct and IPO, the housing market has a long term reaction indicated by the results of the difference-in-difference regression at the 180 day window. There is a slight reaction of the housing market to the liquidity events that occur on the issue date and the lockup expiration date, but this effect is quickly reversed at longer time horizons.

In Tables 6 and 7 we repeat the analysis of Table 5 but split the sample by characteristics of the IPOs. Table 6 shows that issue date effects of Table 5, Panel A are driven by those older and larger firms whose IPO's were more underpriced and had a great listing-to-lockup return while the lockup date effects are driven by older firms whose IPO's had a greater listing-to-lockup return. Table 7 shows the the filing date effect evident in 5, Panel C is driven by older firms that whose IPO was more underpriced.

6 Conclusion

In this paper, we combine IPO and residential property transaction data for California from 1993 through 2017 and: (1) test for an association between IPOs and local house prices; (2) compare and contrast the different IPO events; (3) test for an association between IPOs and changes in the composition of residential properties being transacted by looking at property characteristics and market segment; and (4) test for an association between firm characteristics that includes IPO performance and house prices.

We find evidence consistent with there being a positive and significant association between local house price changes and firms going public. The evidence is consistent with the three non-mutually exclusive hypotheses for how IPOs impact local property values. There is support for the *expectations hypothesis* where original shareholders that are not liquidity constrained respond to changes for their demand for housing consumption from updated expectations around the IPO filing event. Also, for the *wealth hypothesis* or a positive change in property values when the IPO is issued. Finally, there is evidence supporting the *liquidity hypothesis* of a positive change following the expiration of the lockup restriction but there is heterogeneity in the treatment effect depending on firm characteristics and the performance of the IPO. We conclude that IPOs are associated with price changes to local property markets that are in part due to the presence of credit constraints in housing.

This study uses the setting of IPOs as a natural experiment to highlight credit constraints in mortgage lending that are binding for a segment of original shareholders and pre-IPO shareholders. Our results are preliminary and more studies are needed. This paper informs on the role entrepreneurs play in the demand and consumption of housing services and how completed IPOs impact local house prices. In addition, the

sequential events of the IPO provides a natural experiment to deconstruct an overall effect, in this case a wealth shock to original shareholders, into changes in expectation, wealth, and liquidity in the presence of mortgage lending constraints.

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Figure 1. California IPOs from 1993 to 2017. Displayed are the headquarter locations of firms that initiated IPOs between 1993 and 2017.

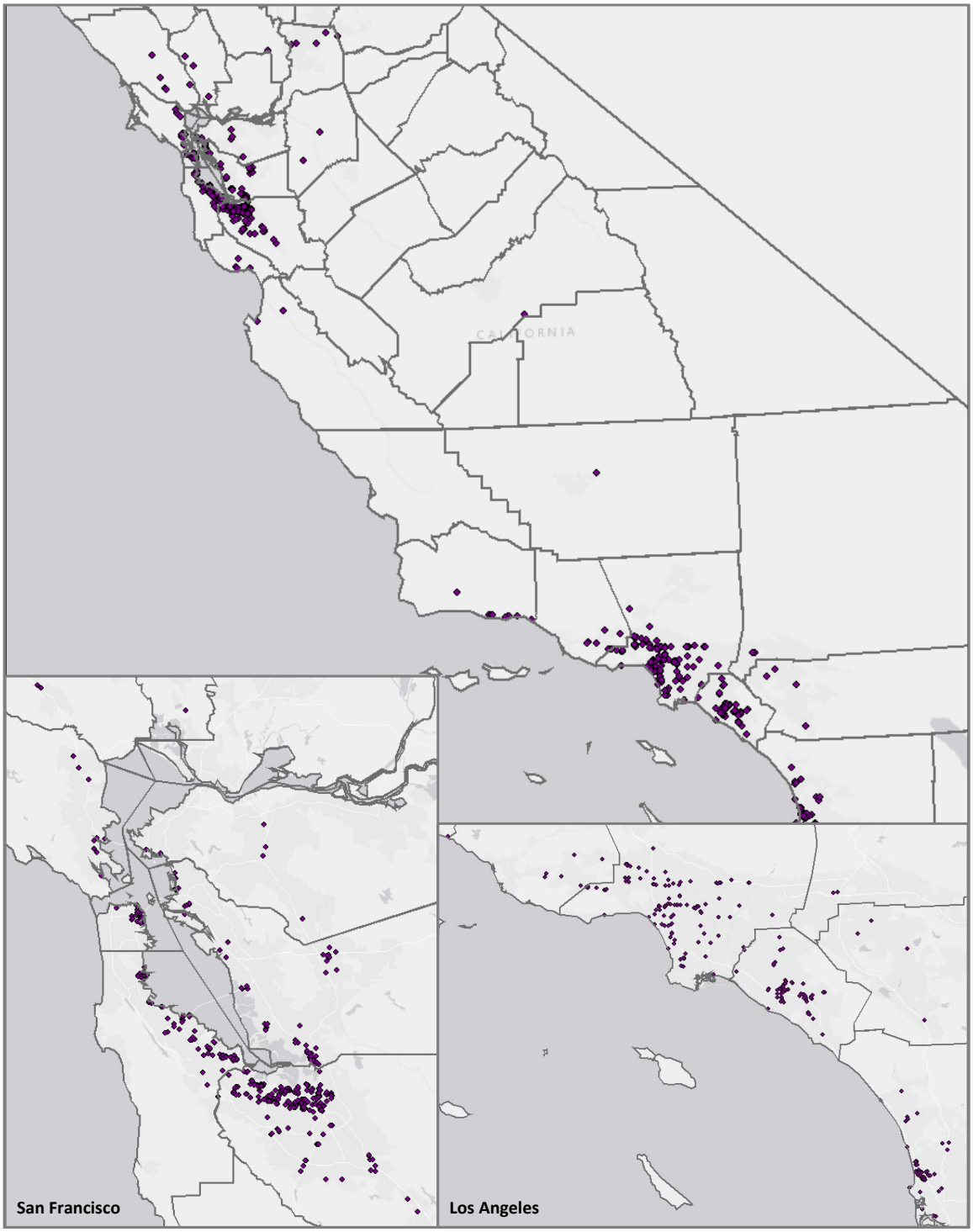


Figure 2. Number of IPOs and California House Prices from 1993 to 2017. This figure compares the number of IPO filings and house price indices for Silicon Valley and the rest of California between 1993 and 2017.

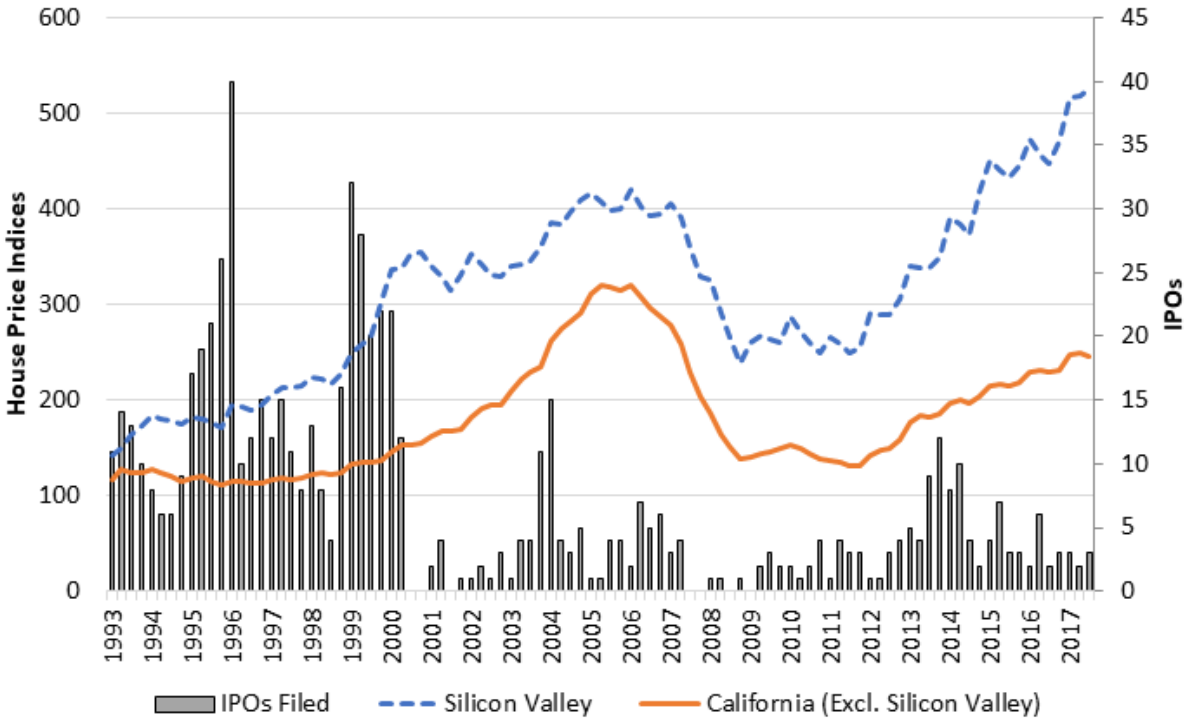


Figure 3. House Transactions within 5 miles of Facebook's headquarters by IPO Event. Displaying a 5-mile radius around Facebook's headquarters in Silicon Valley and the locations of house transactions around the filing, issuing, and lockup expiration events. The "pre" period is inclusive of 90 days prior to the event and the event. The "post" period is defined as the following 90 days after an event.

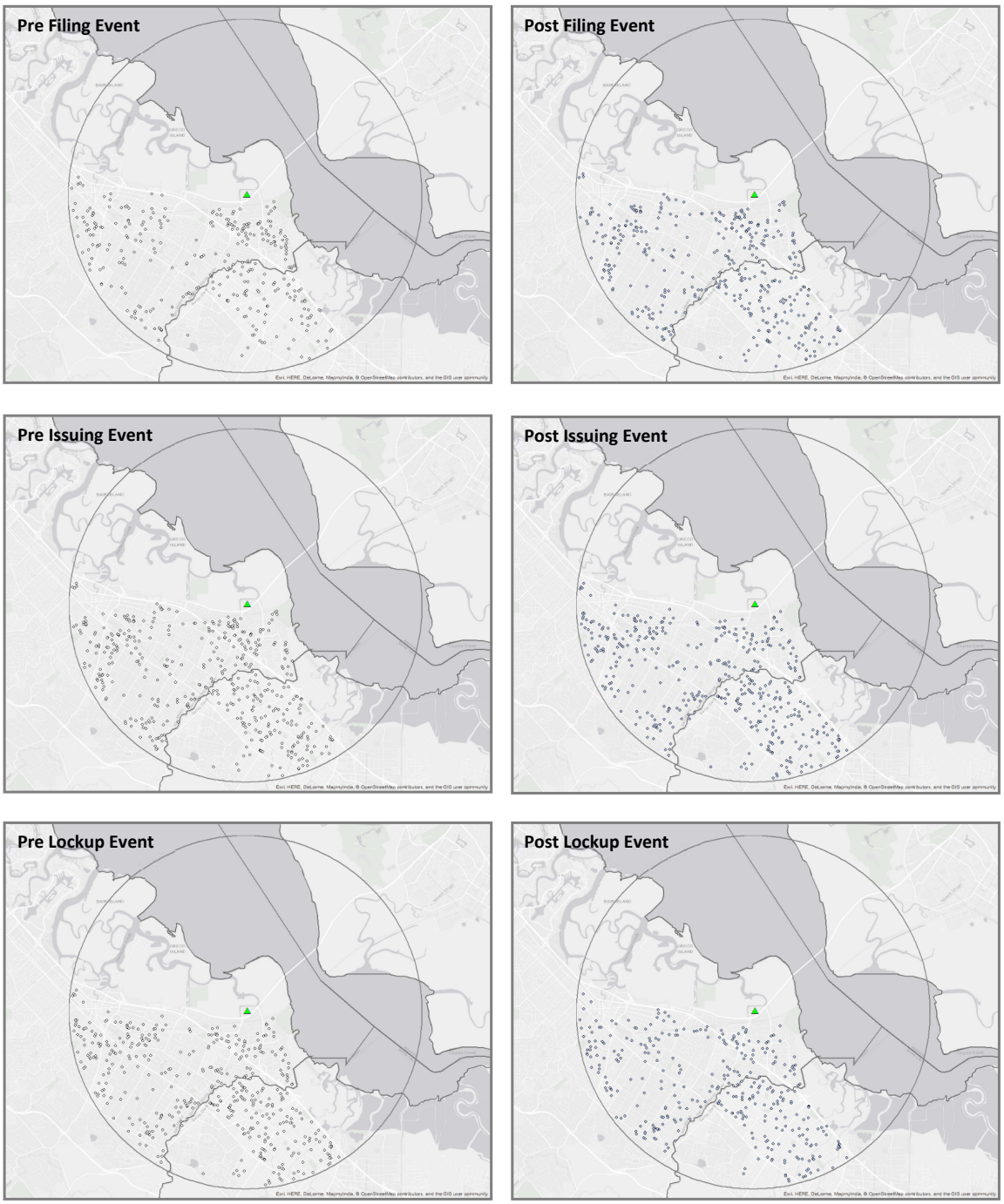


Figure 4. House Transactions within 5 miles of Google's headquarters by IPO Event. Displaying a 5-mile radius around Google's headquarters in Silicon Valley and the locations of house transactions around the filing, issuing, and lockup expiration events. The "pre" period is inclusive of 90 days prior to the event and the event. The "post" period is defined as the following 90 days after an event.

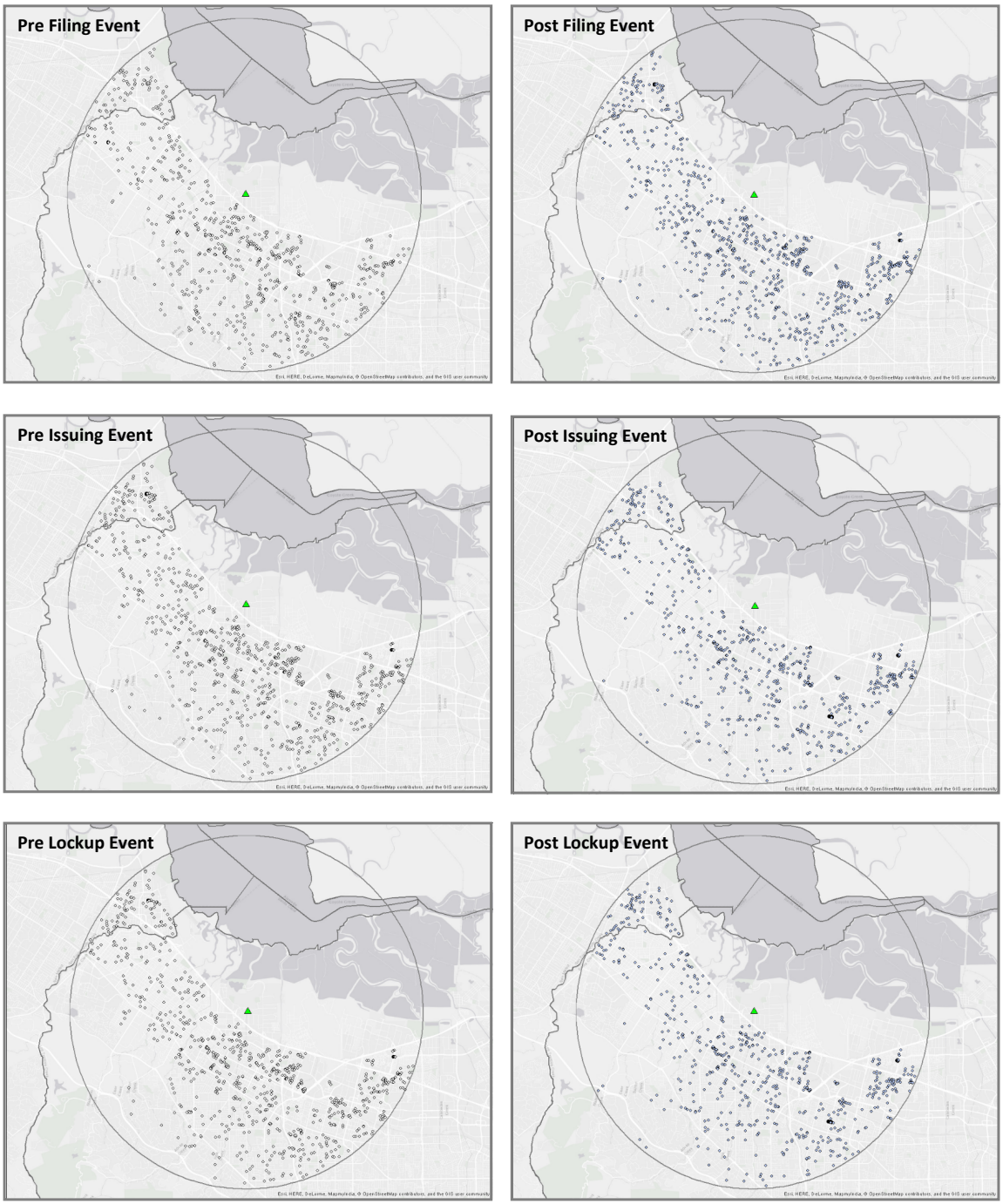


Figure 5. House Transactions within 5 miles of Twitter's headquarters by IPO Event. Displaying a 5-mile radius around Twitter's headquarters in Silicon Valley and the locations of house transactions around the filing, issuing, and lockup expiration events. The "pre" period is inclusive of 90 days prior to the event and the event. The "post" period is defined as the following 90 days after an event.

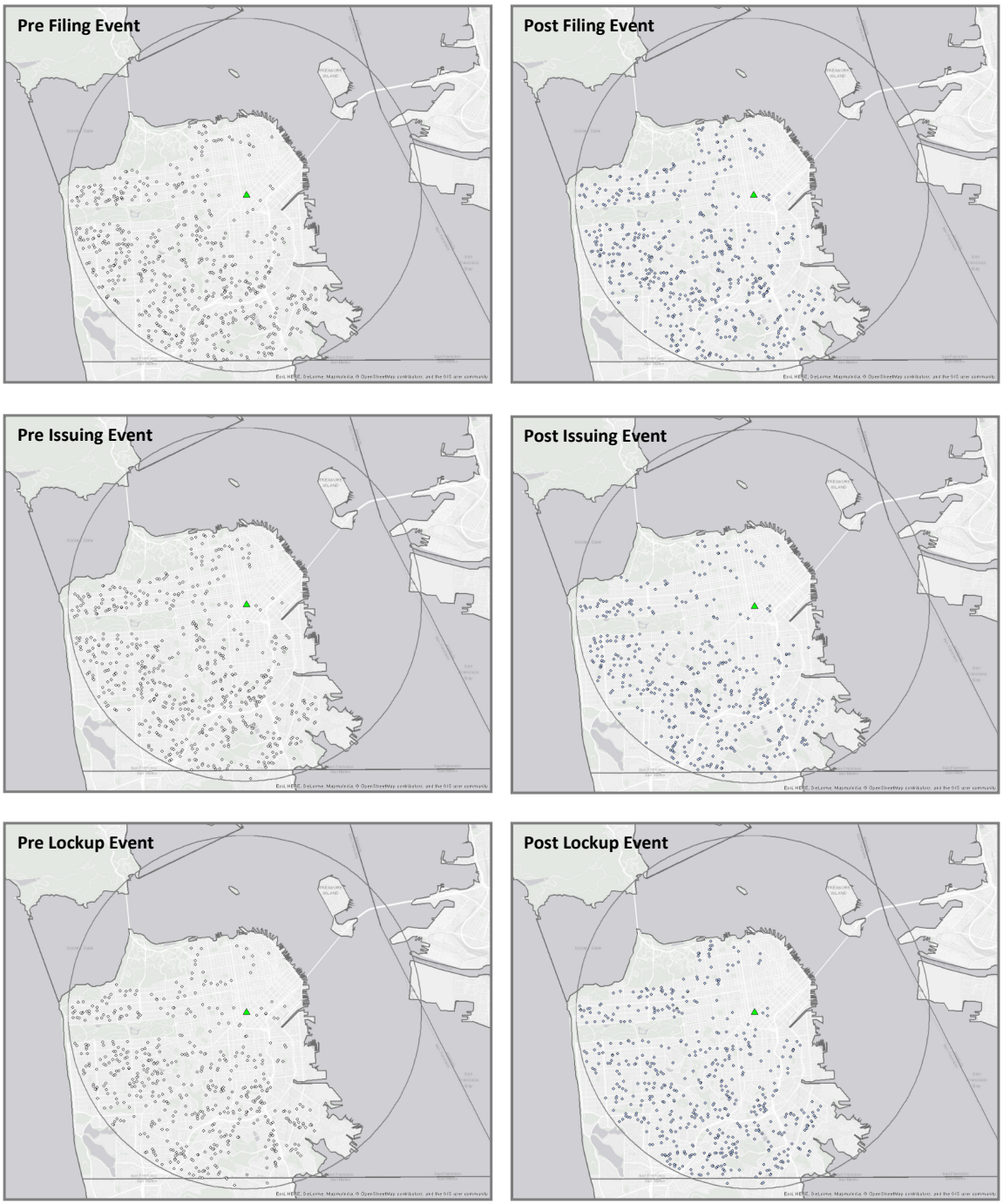
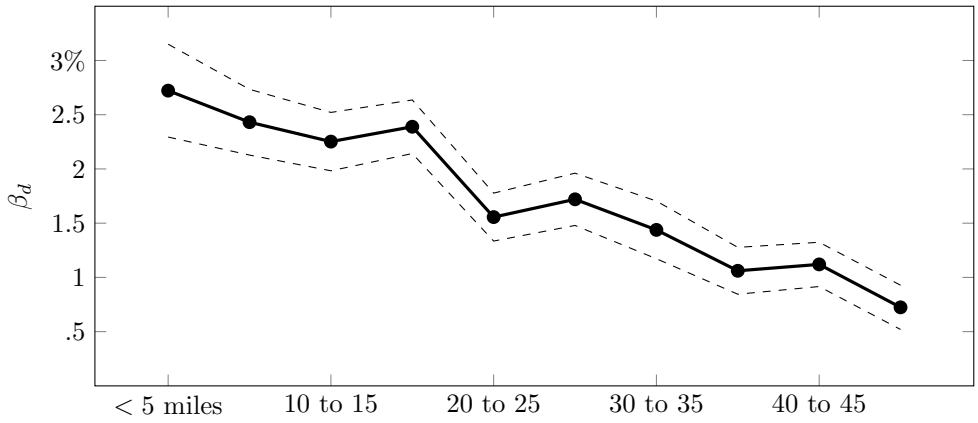
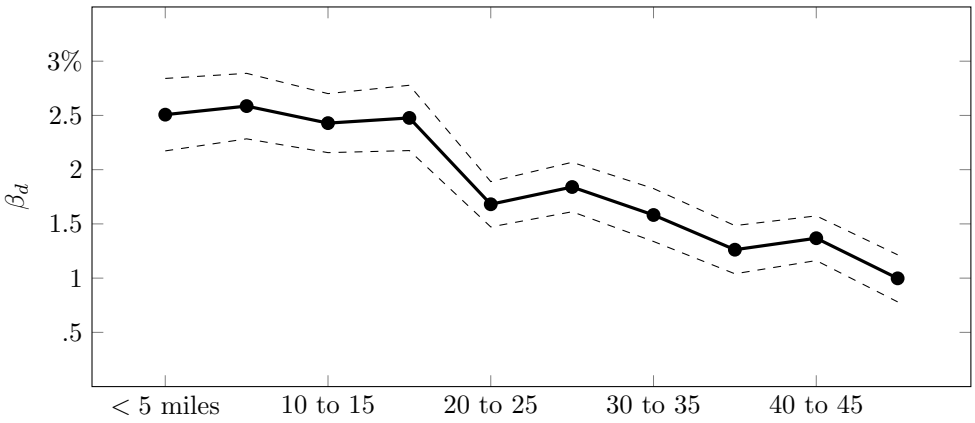


Figure 6. The spatial effects of IPOs on house prices. The plots display regression coefficients from estimating equation 4 in the solid black lines and standard error bounds in the dashed lines

Panel A: The Spatial Effects of IPO Filing Date on House Prices at 180 Days



Panel B: The Spatial Effects of IPO Listing Date on House Prices at 180 Days



Panel C: The Spatial Effects of IPO Lockup Expiration on House Prices

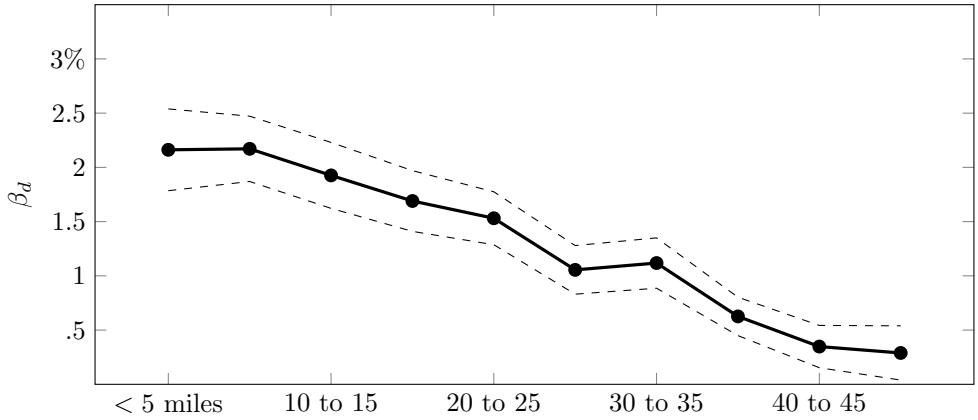
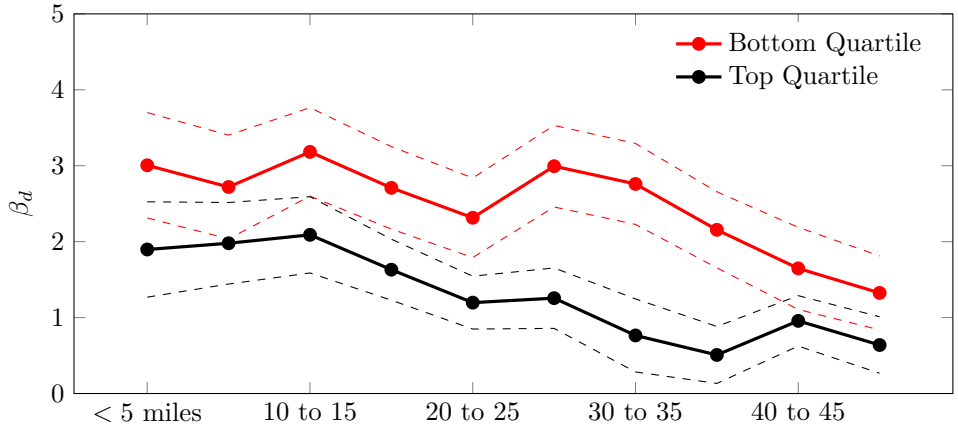
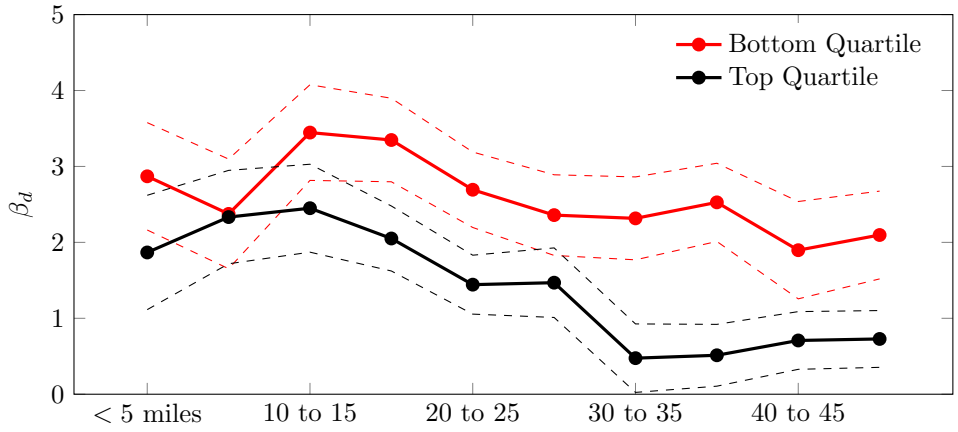


Figure 7. The spatial effects of IPOs on house prices by firm age. The plots display regression coefficients from estimating equation 4 seperately on those IPO's for which the firm's age at the filing date is in the top (bottom) quartile in the solid black (red) lines and standard error bounds in the dashed lines

Panel A: The Spatial Effects of IPO Filing Date on House Prices by Firm Age at Filing



Panel B: The Spatial Effects of IPO Listing Date on House Prices by Firm Age at Filing



Panel C: The Spatial Effects of IPO Lockup Expiration on House Prices by Firm Age at Filing

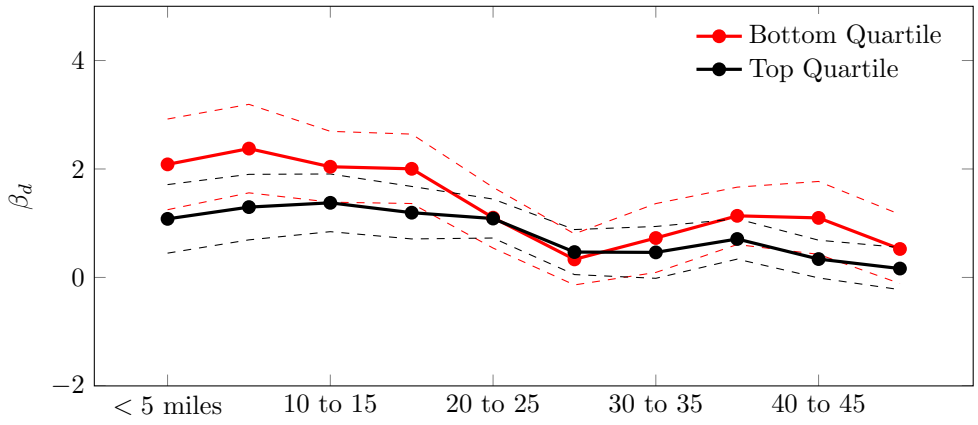


Figure 8. The spatial effects of IPOs on house prices by total assets. The plots display regression coefficients from estimating equation 4 seperately on those firms with total assets in the top (bottom) quartile in the solid black (red) lines and standard error bounds in the dashed lines

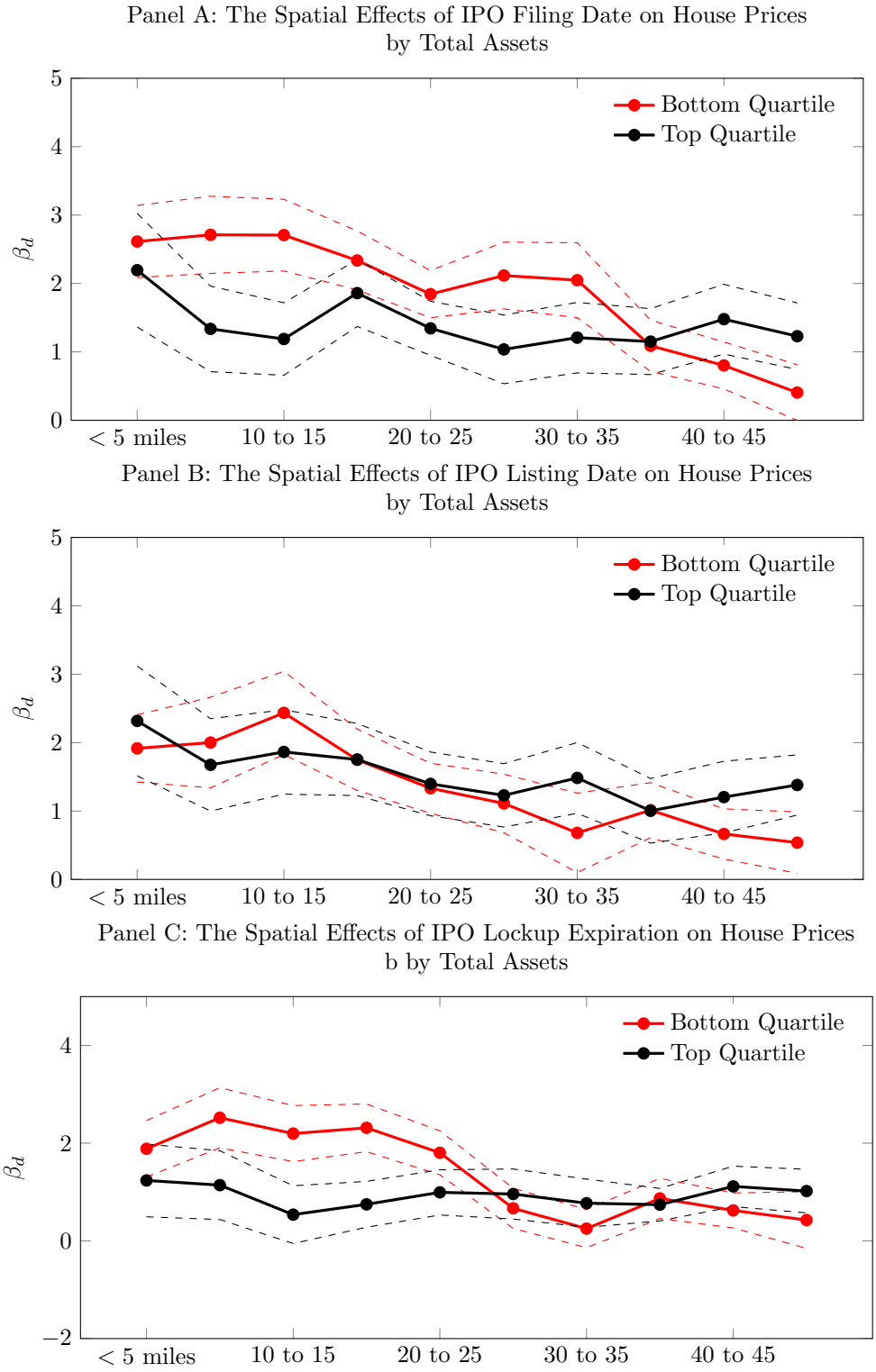
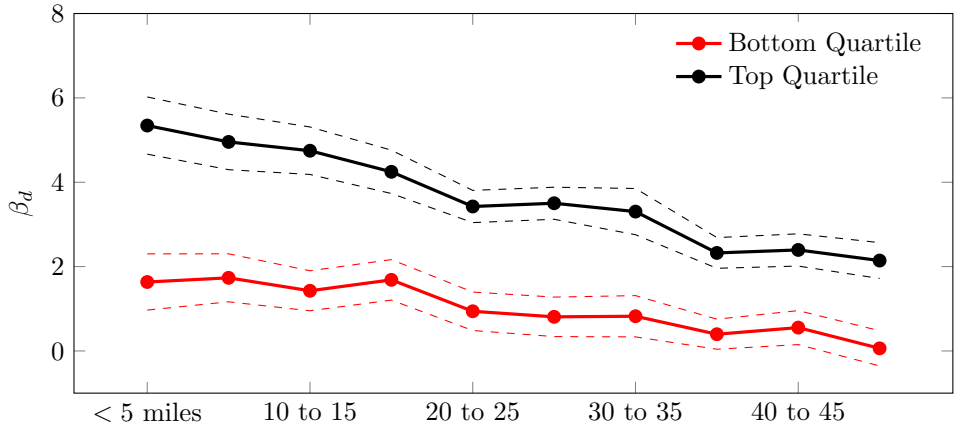
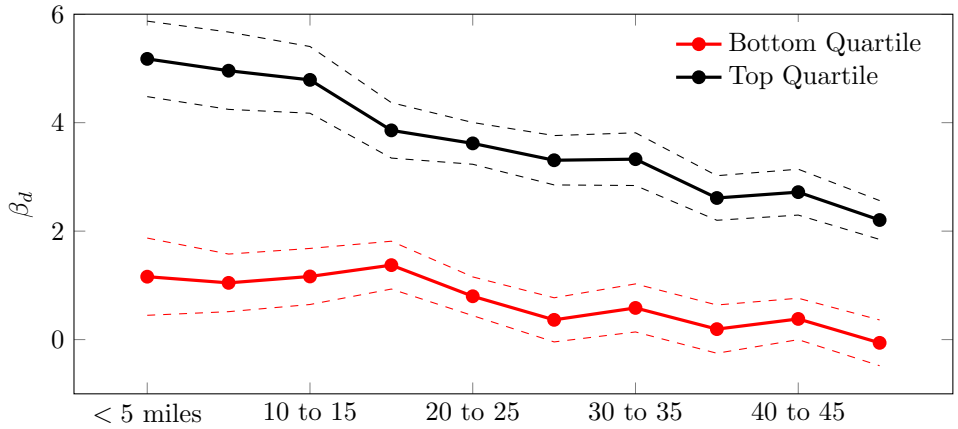


Figure 9. The spatial effects of IPOs on house prices by degree of underpricing. The plots display regression coefficients from estimating equation 4 seperately on those IPO's for which the listing-to-end-of-day one return is in the top (bottom) quartile in the solid black (red) lines and standard error bounds in the dashed lines

Panel A: The Spatial Effects of IPO Filing Date on House Prices by Underpricing



Panel B: The Spatial Effects of IPO Listing Date on House Prices by Underpricing



Panel C: The Spatial Effects of IPO Lockup Expiration on House Prices by Underpricing

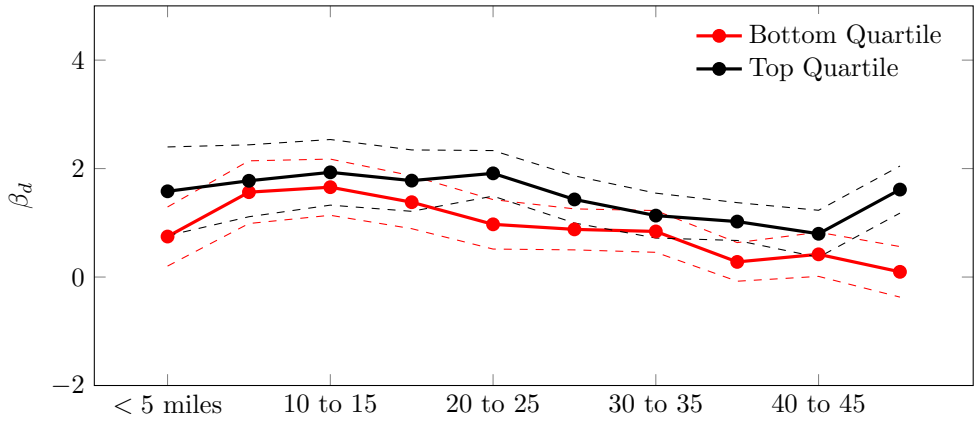
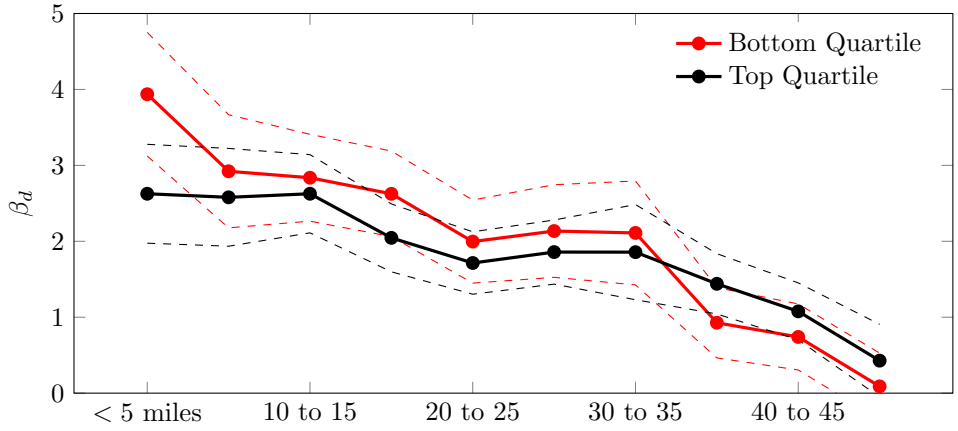
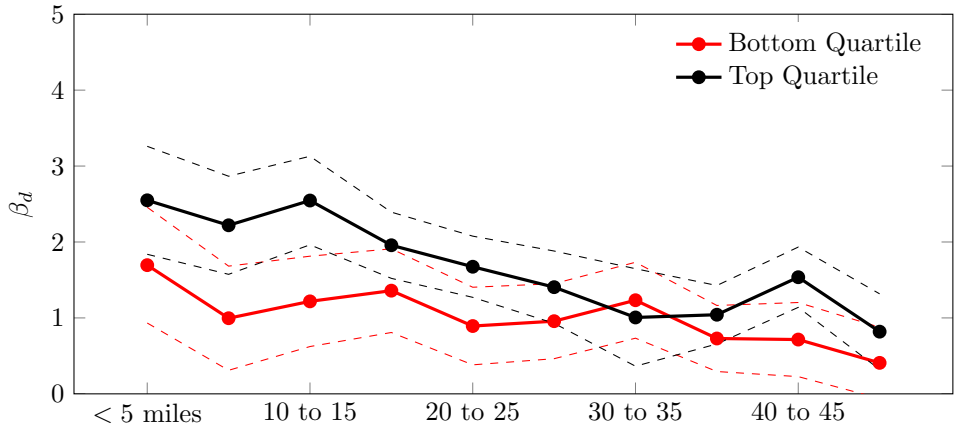


Figure 10. The spatial effects of IPOs on house prices by listing-to-lockup return. The plots display regression coefficients from estimating equation 4 seperately on those IPO's for which the listing-to-lockup return is in the top (bottom) quartile in the solid black (red) lines and standard error bounds in the dashed lines

Panel A: The Spatial Effects of IPO Filing Date on House Prices by Listing-to-Lockup Return



Panel B: The Spatial Effects of IPO Listing Date on House Prices by Listing-to-Lockup Return



Panel C: The Spatial Effects of IPO Lockup Expiration on House Prices by Listing-to-Lockup Return

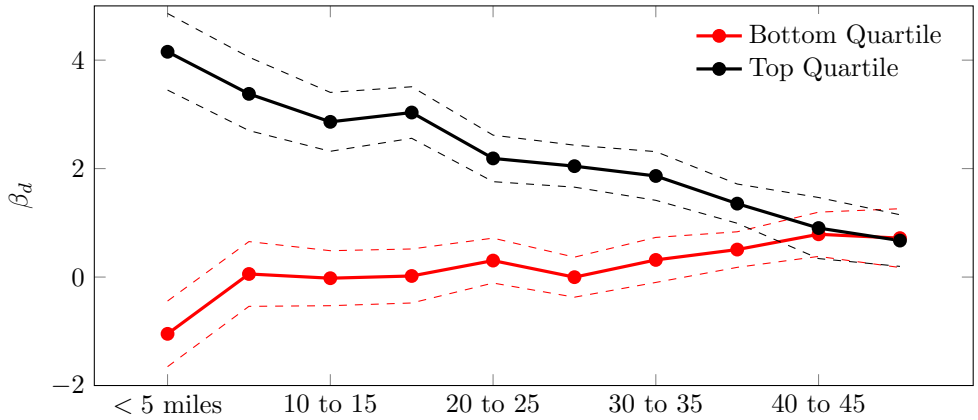


Table 1. Property Transactions and IPO Events by Year. Displaying the counts of California IPO events and property transactions from the cleaned data sample. The firm level data is from SDC and Zillow ZTraxx provides the property transaction level data.

	Property	California IPO Events		
Year	Transactions	Filed Date	Issue Date	Lockup Date
1993	65,877	50	53	32
1994	200,200	30	32	32
1995	182,591	66	56	34
1996	212,709	88	92	81
1997	240,619	53	49	55
1998	276,327	33	37	37
1999	288,666	96	83	24
2000	283,809	56	71	35
2001	266,668	6	11	23
2002	294,527	5	8	7
2003	318,125	12	6	3
2004	348,088	33	34	22
2005	346,806	11	12	26
2006	258,758	18	14	11
2007	213,637	13	20	19
2008	335,477	2	3	10
2009	328,327	6	4	1
2010	297,348	7	6	6
2011	287,641	12	10	9
2012	268,893	8	13	10
2013	233,346	22	17	13
2014	214,384	34	30	23
2015	231,224	16	19	21
2016	226,731	13	14	12
2017	161,022	11	17	18
Total	6,381,800	701	711	564

Table 2. Descriptive Statistics. Displaying California IPOs and property transactions from the cleaned data sample. (*) are adjusted to current prices using the monthly CPI or Consumer Price Index for All Urban Consumers: All Items (to December 2017 prices). IPO returns (%) are calculated as the percentage change from the IPO offer price to the most recent closing price by event date being considered. IPO relative volatility is the standard deviation of closing prices divided by the average of closing prices over the holding period.

Variables	Mean	S.D.	Minimum	Maximum
Panel A: Property Transaction Level				
Sales Price	335,145	501,165	1,000	400,000,000
Sales Price*	415,363	610,106	1,005	487,142,528
Land (sf)	18,707	741,819	502	433,566,875
Total Rooms	5.06	3.38	0.00	99.00
Bed Rooms	3.24	0.87	1.00	20.00
Full Bathrooms	2.00	0.70	1.00	20.00
Half Bathrooms	0.26	0.44	0.00	11.00
Age	29.20	23.53	0.00	150.00
Stories	1.32	0.48	1.00	3.00
Observations	6,381,800			
Panel B: IPO Level				
Firm Age	11.60	16.86	0.00	158.00
Total Assets ($ mil)	224.95	733.18	0.10	7,190.00
IPO Offer Price	12.99	6.94	0.10	97.00
Proceeds Amount ($ mil)	131.11	640.86	0.04	16,006.88
Shares Outstanding After Offer	41,643,796	112,713,832	900,000	2,138,084,992
Secondary Shares of Shares Offered	3,647,752	17,049,468	3,395	241,233,616
Secondary Shares of Shares Offered (%)	9.40	19.45	0.00	100.00
Primary Shares of Shares Offered (%)	90.60	19.45	0.00	100.00
Secondary Shares Flag	224			
No Lockup	152			
Number of IPOs	725			
Panel C: IPO Returns (%) from Offer Price to Close of				
Issue Date	35.87	60.96	-23.07	525.00
Lockup Date	28.50	101.26	-260.42	1,140.00
IPO at 1 year	25.47	112.97	-227.78	740.83
Panel D: IPO Relative Volatility (%) from IPO to Close of				
Lockup Date	26.83	24.80	0.71	302.33
IPO at 1 year	36.64	27.50	5.12	319.13

Table 3. Sales Price by IPO Event. Displaying California mean differences of sales price for property transactions in current (December 2017) dollars that are identified as falling in a pre or post-IPO event window. The pre and post-periods include transactions within 90 days of the event date where day 0 is (the event date itself) is included in the pre-period and transactions present in more than one pre-post window per event are excluded.

	Total		Pre-Period		Post-Period		T-Stat
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Diff.
Panel A: at 1 Mile and 90 Days							
Filed Date	629,279	563,366	617,520	528,570	640,645	594,880	2.71
Issue Date	646,357	740,927	654,034	828,953	638,329	635,938	-1.40
Lockup Date	668,347	912,462	690,948	1,089,577	645,953	693,064	-2.92
Panel B: at 5 Miles and 90 Days							
Filed Date	681,985	807,360	672,437	802,307	691,254	812,131	5.60
Issue Date	694,828	799,696	692,611	824,883	697,135	772,627	1.40
Lockup Date	706,437	814,693	708,142	795,428	704,718	833,664	-1.02
Panel C: at 10 Miles and 90 Days							
Filed Date	631,072	673,299	627,083	612,071	634,981	728,321	3.76
Issue Date	627,098	656,341	629,227	657,589	624,903	655,047	-2.20
Lockup Date	651,237	702,546	653,601	707,191	648,864	697,849	-2.22

Table 4. Pre-Post Spatial Difference-in-Differences Firms. Displaying coefficient estimates for California IPOs based on IPO by event level HPIs with two-way clustering of the standard errors by the zip code of the firm's headquarters and the year of the event. The RHPIs give house price levels for 10-day buckets and are consistent in IPO event time from 30, 90, and 180 days before and to 30, 90, and 180 days after the event. The treated RHPI is estimated using transactions within 5 miles of the IPO firm's headquarters. The control HPI corresponds to transactions at 20 to 25 miles from the headquarters. The 1, 2, and 3 stars indicate statistical significance at 10%, 5%, and 1%, respectively.

	Filed Date		Issue Date		Lockup Date	
Panel A: At 30 Days						
Post Event Date	0.495**	(0.221)	0.445**	(0.202)	0.173	(0.219)
0 to 5 Miles	-0.392	(0.388)	0.655*	(0.364)	-0.719*	(0.426)
Post*(0 to 5 Miles)	-0.135	(0.367)	0.592	(0.393)	0.581	(0.429)
Constant	103.100***	(0.219)	96.736***	(0.223)	105.419***	(0.238)
Adjusted R-Squared	0.19		0.20		0.21	
Number of Periods	5,448		5,568		4,308	
Number of IPOs	454		464		359	
Panel C: At 90 Days						
Post Event Date	0.799***	(0.178)	0.754***	(0.175)	0.643***	(0.192)
0 to 5 Miles	-0.681	(0.495)	-0.820*	(0.475)	0.066	(0.464)
Post*(0 to 5 Miles)	0.146	(0.269)	0.517*	(0.284)	0.379	(0.322)
Constant	90.685***	(0.275)	102.555***	(0.260)	97.066***	(0.240)
Adjusted R-Squared	0.29		0.26		0.27	
Number of Periods	14,652		14,760		11,772	
Number of IPOs	407		410		327	
Panel D: At 180 Days						
Post Event Date	1.557***	(0.240)	1.453***	(0.241)	1.173***	(0.243)
0 to 5 Miles	0.130	(0.425)	-0.022	(0.509)	-1.209**	(0.473)
Post*(0 to 5 Miles)	0.864***	(0.286)	0.668**	(0.297)	0.188	(0.305)
Constant	96.365***	(0.252)	91.324***	(0.293)	110.800***	(0.280)
Adjusted R-Squared	0.30		0.29		0.27	
Number of Periods	26,568		25,272		22,032	
Number of IPOs	369		351		306	

Table 5. Pre-Post San Francisco (City-ByCity) Firms. Displaying coefficient estimates for San Francisco IPOs based on IPO by event level HPIs with two-way clustering of the standard errors by the zip code of the firm's headquarters and the year of the event. The RHPIs give house price levels for 10-day buckets and are consistent in IPO event time from 30, 90, and 180 days before and to 30, 90, and 180 days after the event. The treated RHPI is estimated using transactions from the city of San Francisco. The control HPI corresponds to a group of cities in Alameda county: Alameda, San Leandro, San Lorenzo, Castro Valley, Albany, Berkeley, Emeryville, Kensington, Oakland, and Piedmont. The 1, 2, and 3 stars indicate statistical significance at 10%, 5%, and 1%, respectively.

	Filed Date		Issue Date		Lockup Date	
Panel A: At 30 Days						
Post Event Date	-0.671	(0.726)	0.956	(0.763)	0.922	(2.193)
Treated	-0.327	(1.371)	1.217	(2.360)	0.160	(1.676)
Post*Treated	1.608	(1.329)	2.627**	(1.044)	3.332*	(1.852)
Constant	85.578***	(0.983)	102.188***	(1.484)	85.921***	(0.910)
Adjusted R-Squared	0.31		0.35		0.19	
Number of Periods	684		696		564	
Number of IPOs	57		58		47	
Panel C: At 90 Days						
Post Event Date	0.103	(0.829)	1.496*	(0.806)	1.202	(1.033)
Treated	-2.614	(1.721)	-0.835	(1.488)	-4.620	(3.793)
Post*Treated	1.148	(0.954)	1.266*	(0.733)	-0.617	(1.343)
Constant	94.078***	(0.971)	96.669***	(0.941)	90.973***	(1.780)
Adjusted R-Squared	0.28		0.35		0.40	
Number of Periods	2,016		2,016		1,656	
Number of IPOs	56		56		46	
Panel D: At 180 Days						
Post Event Date	0.681	(0.630)	2.511***	(0.790)	1.865**	(0.824)
Treated	1.721	(1.606)	2.237	(1.866)	-1.217	(1.391)
Post*Treated	2.374***	(0.778)	1.053	(0.901)	-0.838	(1.561)
Constant	91.304***	(0.871)	118.736***	(1.030)	99.678***	(0.839)
Adjusted R-Squared	0.27		0.30		0.38	
Number of Periods	3,960		3,960		3,096	
Number of IPOs	55		55		43	

Table 6. The effect of IPO dates on house prices by split sample. The table shows the coefficient on Post*Treated in equation 6 for a treatment window of 30 days for the subsample of IPOS with below median (right columns) and above median (right columns) values of Firm Age, Underpricing, Lisiting-to-Lockup Return and Assets. Standard errors are parenthesis. The 1, 2, and 3 stars indicate statistical significance at 10%, 5%, and 1%, respectively.

	Coefficient on Post*Treated			
Sort Variable	Below Median		Above Median	
Panel A: Filing Date Effect with 30 Day window				
Firm Age	-15.491	(13.866)	3.633	(2.287)
Underpricing	1.686	(1.586)	0.740	(2.237)
Issue-to-Lockup Return	1.508	(2.317)	1.869	(2.740)
Assets	1.427	(2.447)	-9.329	(10.721)
Panel B: Listing Date Effect with 30 Day window				
Firm Age	-14.856	(15.809)	3.295**	(1.539)
Underpricing	4.703**	(1.730)	1.081	(0.922)
Issue-to-Lockup Return	4.222**	(1.621)	2.520	(1.627)
Assets	-11.493	(13.149)	3.845**	(1.448)
Panel C: Lockup Expiration Date Effect with 30 Day window				
Firm Age	-15.118	(13.133)	5.283**	(2.086)
Underpricing	3.108	(2.158)	4.281*	(2.341)
Issue-to-Lockup Return	2.547	(2.322)	4.842**	(2.255)
Assets	0.655	(2.641)	-7.881	(11.153)

Table 7. The effect of IPO dates on house prices by split sample. The table shows the coefficient on Post*Treated in equation 6 for a treatment window of 180 days for the subsample of IPOS with below median (right columns) and above median (right columns) values of Firm Age, Underpricing, Lisiting-to-Lockup Return and Assets. Standard errors are parenthesis. The 1, 2, and 3 stars indicate statistical significance at 10%, 5%, and 1%, respectively.

	Coefficient on Post*Treated			
Sort Variable	Below Median		Above Median	
Panel A: Filing Date Effect with 180 Day window				
Firm Age	-14.036	(14.380)	2.645**	(1.108)
Underpricing	0.677	(1.216)	3.314***	(1.071)
Issue-to-Lockup Return	0.404	(1.252)	3.260**	(1.397)
Assets	1.462	(1.344)	-9.154	(11.401)
Panel B: Listing Date Effect with 180 Day window				
Firm Age	-20.670	(19.247)	1.285	(1.469)
Underpricing	1.813	(1.429)	0.502	(1.237)
Issue-to-Lockup Return	1.398	(1.644)	0.874	(1.673)
Assets	0.433	(1.318)	-14.104	(14.917)
Panel C: Lockup Expiration Date Effect with 180 Day window				
Firm Age	-24.906	(17.421)	1.306	(1.219)
Underpricing	-2.203	(2.819)	0.068	(1.367)
Issue-to-Lockup Return	0.977	(1.736)	-3.112	(2.540)
Assets	-2.027	(1.313)	-15.441	(13.962)

Table 8. Pre-Post Spatial Difference-in-Differences Firms. Displaying coefficient estimates for California IPOs based on IPO by event level HPIs with two-way clustering of the standard errors by the zip code of the firm's headquarters and the year of the event. The RHPIs give house price levels for 10-day buckets and are consistent in IPO event time from 30, 90, and 180 days before and to 30, 90, and 180 days after the event. The treated RHPI is estimated using transactions within 5 miles of the IPO firm's headquarters. The control HPI corresponds to transactions at 20 to 25 miles from the headquarters. The 1, 2, and 3 stars indicate statistical significance at 10%, 5%, and 1%, respectively.

	Filed Date		Issue Date		Lockup Date	
Panel A: At 30 Days						
Post Event Date	0.495**	(0.221)	0.445**	(0.202)	0.173	(0.219)
0 to 5 Miles	-0.392	(0.388)	0.655*	(0.364)	-0.719*	(0.426)
Post*(0 to 5 Miles)	-0.135	(0.367)	0.592	(0.393)	0.581	(0.429)
Constant	103.100***	(0.219)	96.736***	(0.223)	105.419***	(0.238)
Adjusted R-Squared	0.19		0.20		0.21	
Number of Periods	5,448		5,568		4,308	
Number of IPOs	454		464		359	
Panel C: At 90 Days						
Post Event Date	0.799***	(0.178)	0.754***	(0.175)	0.643***	(0.192)
0 to 5 Miles	-0.681	(0.495)	-0.820*	(0.475)	0.066	(0.464)
Post*(0 to 5 Miles)	0.146	(0.269)	0.517*	(0.284)	0.379	(0.322)
Constant	90.685***	(0.275)	102.555***	(0.260)	97.066***	(0.240)
Adjusted R-Squared	0.29		0.26		0.27	
Number of Periods	14,652		14,760		11,772	
Number of IPOs	407		410		327	
Panel D: At 180 Days						
Post Event Date	1.557***	(0.240)	1.453***	(0.241)	1.173***	(0.243)
0 to 5 Miles	0.130	(0.425)	-0.022	(0.509)	-1.209**	(0.473)
Post*(0 to 5 Miles)	0.864***	(0.286)	0.668**	(0.297)	0.188	(0.305)
Constant	96.365***	(0.252)	91.324***	(0.293)	110.800***	(0.280)
Adjusted R-Squared	0.30		0.29		0.27	
Number of Periods	26,568		25,272		22,032	
Number of IPOs	369		351		306	

Appendix A IPO Events and Sample Period

Initial Public Offering (IPO) Date Events

- **IPO filing event:** when a firm submits the appropriate documents required for the IPO. The filing event date is the date that a firm files Form S-1 with the U.S Securities and Exchange Commission (SEC).
- **IPO issuing event:** when the firm's equity is listed on an exchange. This is the date when the firm goes public. Issuing coincides with a firm's submission of their IPO prospectus Form 424 with the SEC.
- **Lockup event:** when restrictions on some shareholders and insiders are lifted allowing them to sell and liquidate their shares. It is usually 180 days.

Changes in the IPO Landscape Over this Sample Period

The decision to pursue an IPO is taken as exogenous and is assumed to be independent of local house price changes. However, regulatory changes over this period that impact IPOs may fundamentally change the composition of the sample of firms that choose to go public. This is a concern if the change in composition correlates with house prices in proximity to the firm's headquarters and cannot be controlled by specifications that include controls to capture variation at the firm level and over time.

In Gao et al. (2013), they identify a significant drop in the number of IPOs annually spanning 2001 to 2013 than during 1980 to 2000. They attribute this difference to changing market and regulatory conditions that make it more advantageous for small private firms to be acquired than to go public. Iliev (2010) found that the passage of the Sarbanes-Oxley Act (SOX) in 2002 and the requirements, specifically, under Section 404 imposed additional compliance costs reducing the value of small firms. In 2012 congress passed the Jumpstart our Jobs Act intended to increase the frequency of IPOs by lowering the cost of going public. For example, under the JOBS Act firms considering an IPO can test-the-waters and communicate with potential investors prior to submitting the registration Form S-1 publicly. Dambra et al. (2015) find that the changes implemented under the JOBS Act increased IPO activity in the two years following its passage. The issue of IPO composition and regulatory changes is compounded by evidence of hot and cold IPO markets going back to Ibbotson and Jaffe (1975) and Ritter (1984).

Appendix B Additional Tables and Figures

Table A1. SDC IPO Search Criteria. According to the following search criteria we obtained a population of 8,626 IPOs from SDC, which included 1,987 IPOs that have their firm's headquarters in California.

Request	**Operator**	**Description**	**Hits**
Database	Include	Common Stock Convertible Equity Pipeline and Registrations Equity Private Placements	n\a
Issuer\Borrower Nation (Code)	Include	United States of America	83,432
Listing: Primary Exchange Nation of Issuer's Stock (Code)	Include	United States of America	68,295
SDC Deal Type	Include Include	US Common Stock US Common Stock Withdrawn from Registration	38,246
Issue Type	Include	IPO	14,696
Original IPO Flag (Y/N)	Equals	Yes	14,696
Closed-end Fund/Trust Flag (Y/N)	Equals	No	13,301
Unit Investment Trust Flag (Y/N)	Equals	No	10,967
Blank Check Company (Y/N)	Equals	No	10,233
Foreign Issue Flag (eg Yankee) (Y/N)	Equals	No	10,233
Unit Issues: Unit Issue Flag (Y/N)	Equals	No	9,344
REIT Type (Code)	Exclude	Equity Hybrid Mortgage Unknown	9,000
Security Type (Code)	Include	Class A Common Shares Class B Common Shares Series B-1 Common Stock Series 1 Common Stock American Depository Receipts Ordinary Shares Class A Common Shares of Beneficial Interest Class C Common Stock Class D Common Stock Class A Limited Voting Common Stock Special Common Stock Class B Voting Common Stock Class E Common Shares Class C Ordinary Shares Class A Ordinary Shares Class A Voting Common Stock Class B Ordinary Shares Common Stock Equity Shares Class Share	8,739
Standard Common Stock Eligible Flag	Equals	Yes	8,626
favorites		favorites ...	8,626

Table A2. Firm Level Summary. IPO returns (%) are calculated as the percentage change from the IPO offer price to the most recent closing price for the lockup date or the date of the IPO at 1 year. IPO relative volatility is the standard deviation of closing prices divided by the average of closing prices over the period.

	Facebook Inc	Google Inc	Twitter Inc
Panel A: Firm and IPO Characteristics			
Firm Age	8	6	7
Total Assets ($ mil)	6,859	1,328	993
IPO Offer Price	38	85	26
Proceeds Amount ($ mil)	16,007	1,915	2,093
Shares Outstanding After Offer (mil)	2,138.0	271.2	555.2
Secondary Shares of Shares Offered (%)	57	28	0
Primary Shares of Shares Offered (%)	43	72	100
Panel B: IPO Returns (%) from Offer Price to Close of			
Issue Date	0.61	18.04	72.69
Lockup Date	-47.71	19.42	49.04
IPO at 1 year	-30.92	229.40	57.08
Panel C: IPO Relative Volatility (%) from IPO to Close of			
Lockup Date	15.56	3.18	16.56
IPO at 1 year	15.77	28.51	19.24

Table A3. Transaction Level Descriptive Statistics by Firm. Displaying California IPOs and property transactions from cleaned data sample. (*) are adjusted or current prices using the monthly CPI or Consumer Price Index for All Urban Consumers: All Items (to December 2017 prices).

Variables	Mean	S.D.	Minimum	Maximum
Panel A: Facebook Inc at 5 miles and 90 days				
Sales Price	1,491,879	1,691,618	2,000	21,750,000
Sales Price*	1,614,614	1,828,451	2,167	23,457,038
Land (sf)	22,115	372,217	512	10,000,069
Total Rooms	7.02	2.20	0.00	19.00
Bed Rooms	3.25	1.05	1.00	8.00
Full Bathrooms	2.20	1.05	1.00	8.00
Half Bathrooms	0.25	0.44	0.00	1.00
Age	51.09	26.19	0.00	109.00
Stories	1.30	0.49	1.00	3.00
Observations	1,441			
Panel B: Google Inc at 5 miles and 90 days				
Sales Price	761,098	505,289	5,000	12,700,000
Sales Price*	999,141	664,160	6,498	16,732,891
Land (sf)	9,131	189,195	512	10,000,069
Total Rooms	6.49	1.86	1.00	15.00
Bed Rooms	2.92	0.95	1.00	9.00
Full Bathrooms	1.95	0.72	1.00	7.00
Half Bathrooms	0.35	0.48	0.00	1.00
Age	35.16	21.45	0.00	101.00
Stories	1.39	0.55	1.00	3.00
Observations	2,794			
Panel C: Twitter Inc at 5 miles and 90 days				
Sales Price	1,189,188	960,534	2,000	11,000,000
Sales Price*	1,253,474	1,011,562	2,094	11,516,995
Land (sf)	4,056	25,987	808	1,137,903
Total Rooms	6.90	2.18	0.00	17.00
Bed Rooms	3.13	1.12	1.00	9.00
Full Bathrooms	2.22	1.07	1.00	8.00
Half Bathrooms	0.00	0.04	0.00	1.00
Age	76.70	26.18	0.00	134.00
Stories	1.53	0.65	1.00	3.00
Observations	2,077			

Table A4. Sales Price by Firm and IPO Event. Displaying California mean differences of sales price for property transactions in current (December 2017) dollars that are identified as falling in a pre or post IPO event window by firm. The pre and post-periods include transactions within 5 miles and ±90 days of the event date where the exact event date is included in the pre-period.

	Total		Pre-Period		Post-Period		T-Stat
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Diff.
Panel A: Facebook Inc							
Filed Date	629,279	563,366	617,520	528,570	640,645	594,880	2.71
Issue Date	646,357	740,927	654,034	828,953	638,329	635,938	-1.40
Lockup Date	668,347	912,462	690,948	1,089,577	645,953	693,064	-2.92
Panel B: Google Inc							
Filed Date	1,000,426	714,765	993,529	635,877	1,006,327	776,215	0.37
Issue Date	991,647	668,993	989,682	751,588	993,933	558,185	0.13
Lockup Date	987,215	556,426	961,754	522,277	1,017,355	593,262	2.02
Panel C: Twitter Inc							
Filed Date	1,201,027	958,956	1,147,601	927,995	1,258,857	989,114	1.82
Issue Date	1,209,390	982,272	1,234,634	1,093,861	1,175,555	809,114	-0.89
Lockup Date	1,314,508	1,064,281	1,300,317	1,004,717	1,327,297	1,116,056	0.40

Table A5. Pre-Post at 5 Miles by Firm. Displaying transaction level OLS estimates where the dependent variable is the natural log of sales price (December 2017 dollars). Displaying robust standard errors and the 1, 2, and 3 stars indicate statistical significance at 10%, 5%, and 1%, respectively.

Dependent Variable: ln(Sales Price)	Filed Date	Issue Date	Lockup Date
Panel A: Facebook Inc			
Post Event Date	0.134**	0.099**	0.075
	(0.060)	(0.049)	(0.046)
Constant	9.488***	9.890***	10.011***
	(0.666)	(0.882)	(0.891)
Property Characteristics	Y	Y	Y
Adjusted R-Squared	0.47	0.48	0.50
Observations	638	792	705
Panel B: Google Inc			
Post Event Date	0.020	0.038**	0.030
	(0.020)	(0.018)	(0.019)
Constant	11.019***	11.289***	11.553***
	(0.202)	(0.332)	(0.366)
Property Characteristics	Y	Y	Y
Adjusted R-Squared	0.47	0.49	0.48
Observations	1,735	1,707	1,640
Panel C: Twitter Inc			
Post Event Date	0.090**	0.023	-0.039
	(0.039)	(0.039)	(0.043)
Constant	11.296***	11.257***	10.513***
	(0.621)	(0.725)	(0.530)
Property Characteristics	Y	Y	Y
Adjusted R-Squared	0.18	0.18	0.18
Observations	985	894	981