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After the Boom: Transitory and Legacy Effects of Foreclosures

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Abstract
Foreclosures lead to lower house prices in the short run. However, whether or not foreclosures also have long-run or legacy price effects has not been addressed extensively. Do neighborhoods with a greater number of past foreclosures exhibit long lasting house price discounts? This paper examines both transitory and legacy foreclosure price effects. We use almost 20 years of data from one of the epicenters of the foreclosure crisis: Orange County, Florida. We measure the number of recent and past foreclosures within narrowly defined neighborhoods for each house sold during 2016–2019:Q2. We compare transaction prices with different numbers of recent and past foreclosures, while controlling for differences in observed property characteristics and taking measures to reduce the impact of unobserved heterogeneity. We find that greater numbers of recent and past foreclosures are associated with lower house prices. We find strong transitory effects consistent with the existing literature. We also find significant but modest legacy effects on surrounding prices. These long-run discounts are about 0.41 percent to 0.79 percent in Orange County, Florida.

Keywords Foreclosure crisis · House prices · Homeownership · Defaults · Tenure change · Local housing markets · Depreciation · Long-term foreclosure effects

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Introduction

Foreclosures lead to lower house prices in the short run, both for the foreclosed property as well as for neighboring properties (Campbell et al. 2011; Towe and Lawley 2013; Burnside et al. 2016). There is a substantial literature focusing on these short-run or transitory price effects. This literature has established that foreclosed properties sell at an average discount of approximately 25 percent (Campbell et al. 2011; Chinloy et al. 2017). As for neighboring properties, the literature has established that foreclosures reduce house prices by approximately 1 percent (Harding et al. 2009, 2012; Lin et al. 2009; Campbell et al. 2011; Towe and Lawley 2013; Anenberg and Kung 2014; Hartley 2014; Fisher et al. 2015; Ihlanfeldt and Mayock 2016; Biswas et al. 2021). However, do neighborhoods with a greater number of past foreclosures exhibit long lasting house price discounts? Foreclosures may have long-run or legacy price effects. A decade after the beginning of the foreclosure crisis, the literature has only recently turned its attention to long-run consequences of the foreclosure crisis (Piskorski and Seru 2021).

Legacy foreclosure price effects may emerge when neglected maintenance during foreclosure leads to persistent negative neighborhood externalities and lower house prices in the neighborhood as a consequence. These effects may also arise when the past wave of foreclosures, which prompted more tenure transitions from owner-occupied to rental properties (Gabriel and Rosenthal 2015; Ihlanfeldt and Yang 2021), results in tenure tipping of neighborhoods and accelerated filtering (Rosenthal 2008; Coulson and Wommer 2019). Recent evidence suggests that foreclosures often result in the permanent loss of homeownership in many neighborhoods, as only a quarter of foreclosed households have regained homeownership by the end of 2017 (Piskorski and Seru 2021). Further, legacy effects may arise when the short-run or transitory price effect of foreclosures makes previously inaccessible neighborhoods more affordable to a wider range of households. Many foreclosed households moved out of their neighborhoods (Piskorski and Seru 2021), while both greater affordability and more rental properties have opened these neighborhoods to different types of households, possibly changing the composition of neighborhoods after the housing crisis. Neighborhood household composition is known to have long-term consequences for schooling (Ioannides 2011; Ihlanfeldt and Mayock 2018), labor market outcomes (Ellen and O'Regan 2010) and neighborhood dynamics (Ferreira et al. 2010) and, in turn, are reflected in house prices.

This study aims to establish the presence of any legacy foreclosure effects in house prices. The question we address is whether such price effects persist for neighborhoods that have been hard hit in the past; or, regardless of the factors possibly driving the process, do neighborhoods with a greater number of past foreclosures associate with house price discounts? We study this question using data from one of the foreclosure epicenters in the U.S.: Orange County, Florida. We use almost 20 years of property tax records covering all parcels and properties and providing information about location, property ownership, transaction price, and deed type. One advantage of the long data series is that we are able to follow properties and neighborhoods over time. The data allow us to examine each sales price in conjunction with the number of recent foreclosures and the cumulative number of foreclosures within narrowly defined neighborhoods. Furthermore, the tax records for all parcels allow us to construct measures of neighborhood quality through the use of more granular information than zip code-level. With the data, we are able to identify owner-occupied properties and construct measures of neighborhood homeownership, and subsequently control for neighborhood price effects associated with the mix of tenure types at census block-level. We also use these records to measure the number of foreclosures in each time period for each neighborhood. We show that, while many neighborhoods experienced foreclosed properties, foreclosures were not as evenly distributed across the market as the popular press sometimes has suggested. We estimate price functions for properties sold during 2016 and 2019:Q2. We capture the short-run or transitory foreclosure effects using recent nearby foreclosures, and long-run or legacy foreclosure effects using nearby foreclosures that occurred during 2000-2012, which was before the estimation period. We determine the extent to which differences in house price levels are associated with differences in the number of foreclosures, and empirically identify separate transitory and legacy foreclosure price effects on surrounding properties.

Our identification challenge is to control for all observed and unobserved property and neighborhood qualities that are unrelated to the change in neighborhood qualities arising from earlier foreclosures. We take several approaches to reduce the impact of unobserved heterogeneity on our estimates, starting with a baseline model and comparing transaction prices across neighborhoods with different numbers of recent and past foreclosures, while controlling for observed quality differences in property characteristics and neighborhood and time (interaction) fixed effects. Then, to help control for unobserved differences in quality, we include the age of the subject property relative to the average for the neighborhood, and whether the subject property has ever been foreclosed. Next, we explore other ways of accounting for differences across neighborhoods by including a control to measure differences in nearby homeownership rates in an attempt to capture the effect of nearby owner-occupied-to-rental transitions on local house prices. Further, following Aliprantis (2017) we use Principal Component Analysis (PCA) to construct a single index of neighborhood quality and include this measure in the hedonic analysis to control for variation in neighborhood quality. Last, we apply a two-stage process to separate neighborhood fixed effects unrelated to the history of foreclosures from neighborhood price effects driven by past foreclosures – first, by estimating neighborhood fixed effects for the period 2000–2005 prior to the start of the flood of foreclosures – and then by imposing these fixed effects as constraints in the second stage estimation of the hedonic price function using data for 2016–2019:Q2.

In the next step of our analysis, we adopt a repeat sales approach to identify separate transitory and legacy foreclosure effects on transaction price changes. The repeat sales approach controls for unobserved property quality in general (Rosenthal 2014). For instance, the subject property may have been foreclosed or previously been a rental unit. Repeat sales remove these house-specific fixed effects so that whether a housing unit has ever been foreclosed no longer biases our results. However, not all house-specific effects are removed using house fixed effects because houses depreciate over time. Our repeat sales approach allows for depreciation and filtering as well as transitions between owner-occupied and rental status (Rosenthal 2014).

We find that foreclosures are associated with both transitory and legacy price effects on surrounding properties. Not surprisingly, the transitory effects are considerably larger than the legacy effects; marginal transitory effects are over 10 times the marginal legacy effects. Both are robust across models and persist even after we take measures to reduce the impact of unobserved heterogeneity. Through whatever source – changes in the quality of housing, changes in the composition of neighborhood households, changes in the mix of owner-occupied/rental properties, or other factors – foreclosures are associated with long-term changes in neighborhood property values.

This paper makes two contributions to the literature. First, we add to the foreclosure literature: much of the literature focuses predominantly on transitory price effects (Shuetz et al. 2008; Campbell et al. 2011; Anenberg and Kung 2014; Gerardi et al. 2015; Biswas et al. 2021). Only recently has research focus turned to the long-run consequences of the foreclosure crisis Piskorski and Seru (2021). To the best of our knowledge, our paper is the first to address the transitory and legacy effects question. It offers a simple approach for empirically separating transitory and legacy effects of foreclosures on property values within narrowly defined neighborhoods.

Second, we contribute to the literature on neighborhood dynamics that include the transition of properties from owner-occupied to rental houses (Coulson and Wommer 2019) and neighborhood filtering (Rosenthal 2008, 2014). The literature identifies a number of drivers. One is the physical deterioration of structures and neighborhoods over time, in which maintenance also plays a role (Ioannides 2002). Another factor relates to neighborhood household composition dynamics in terms of education, occupation, income and other household characteristics (Brueckner and Rosenthal 2009). Structures filter into lower quality housing as they age, making them more accessible to lower income households (Rosenthal 2014), leading to differences across neighborhoods that persist for longer periods of time (Ioannides 2011). While these factors are important, we allow for the possibility that the financial crisis created yet another factor driving neighborhood dynamics: foreclosures. Foreclosure is exogenous to and independent of the normal filtering process and its associated changes in household composition. Foreclosure leads to temporarily higher turnover rates and thus constitutes a shock to the neighborhood, possibly leading to structural decline, transition from owner-occupied to rental ownership, and a different mix of households. We find for Orange County, Florida that foreclosures are associated with both transitory and legacy price effects on surrounding properties.

The remainder of the paper is organized as follows. Section 2 describes the data and summary statistics. Section 3 discusses the empirical models and identification strategies. Section 4 reports the results and Section 5 offers concluding remarks.

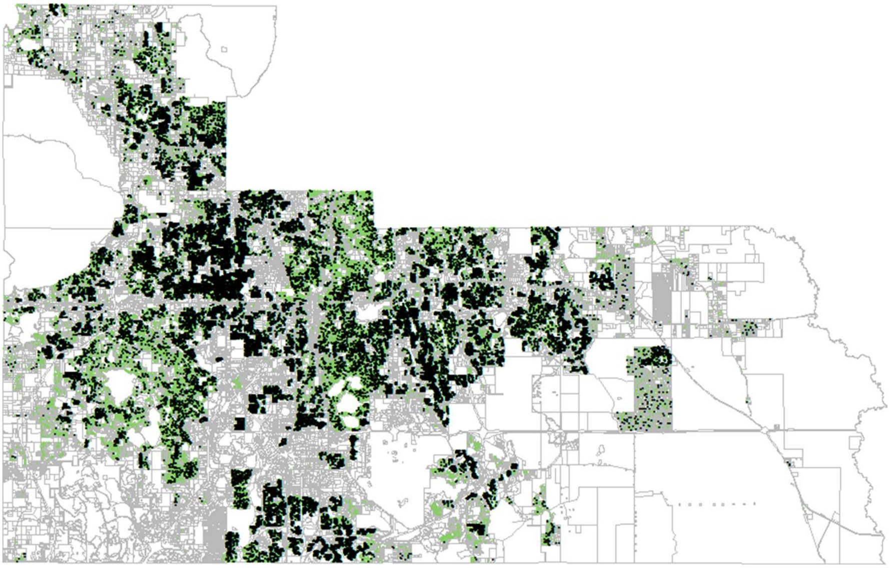

Fig. 1 Geography of Sales in Orange County, FL, 2000-2019:Q2. Figure maps Certificate of title (in black dots) and Warranty deeds (green dots)

Study Area and Data

Study Area

Orange County, Florida offers a unique opportunity to study transitory and legacy foreclosure effects on house prices. Orange County is one of the foreclosure epicenters and among the counties that experienced the greatest number of foreclosures in the United States during the foreclosure crisis. Foreclosures almost outnumbered open market sales in some years. Our study area is the largest county in the Orlando-Kissimmee-Sanford Metropolitan Statistical Area (MSA) and includes the primary city of Orlando, shown in Fig. 1. The context in which we study transitory and legacy foreclosure house price effects is one of urban population growth. Orange County, Florida has been experiencing long-term above-national population growth from 896,344 (2000 Census) and 1,145,956 (2010 Census) to 1,429,908 (2020 Census).

Data and Variable Selection

Data are drawn from Orange County, Florida property tax records and include information on all parcels.[1] We have property tax records over each year 2000 to

[1] Public tax records have several advantages (Ihlanfeldt and Mayock 2012). First, they provide information on the entire stock of existing properties, not just those that sell. Second, it includes all sales: open market sales and foreclosures.

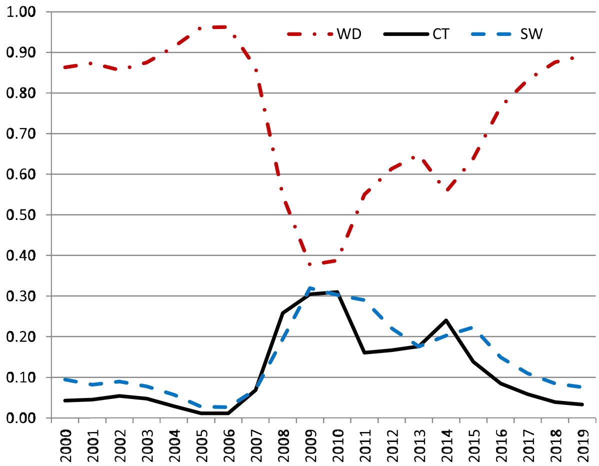

Fig. 2 Share of Deeds, 2000-2019. Figure gives shares of Deeds by year in Orange County, FL. Deeds refer to Certificate of Title, Special Warranty Deeds, and Warranty Deeds

2019:Q2, and have geocoded all properties. We use 2000–2019:Q2 to create our variables of interest, and use 2016–2019:Q2 as our sample for estimation.

The property tax records consist of information on property characteristics, ownership and transactions. The records provide details on property features such as physical address, type, size, construction year, type of building construction, presence of a pool, and parcel size. Information on ownership includes mailing address, and homestead exemption details. Information on transactions include deed type, sale amount, and sale date.

Foreclosure and Deed Information – Our measure of interest is the number of recent and past foreclosures. The foreclosures in our study area are registered in property tax records. Florida is a judicial foreclosure state, which means that the clerk of court must promptly file a certificate of sale after a foreclosure auction takes place. If no objections to the sale are filed within 10 days after filing the certificate of sale, a Certificate of Title (CT) is recorded.[2] The Certificate of Title instrument is thus used to foreclose and let lenders take back their properties. Lenders subsequently seek to sell foreclosed property in the market either through auction or listing. In selling foreclosed properties, lenders typically use a Special Warranty (SW) instrument which warrants only the last owner. A property remains in foreclosure until it is liquidated, that is, the calendar time between the Certificate of Title and the Special Warranty deed. A Warranty deed (WD) instrument refers to an open market transaction and warrants the entire chain of title.[3]

Figure 2 maps the share of deeds over 2000-2019. A number of interesting patterns emerge. First, the share of Certificate of Title remains reasonably constant over 2000-2007, after which time it increases sharply, almost exceeding the share of Warranty Deeds in 2009 and 2010. Second, the series for Certificate of Title shows a

[2] See Fla. Stat. 45.031.

[3] In our data for single family homes we have a total of 382,306 deeds over 2000-2019 (excluding administrative deeds or quit claims) of which 74 percent includes Warranty Deeds, 11 percent Certificate of Title, and 14 percent Special Warranty Deeds. Note that short sales are within the Warranty Deed transactions.

second wave of foreclosures in 2013 and 2014, reflecting the aftermath of the robo-signing scandal that imposed a temporary halt on many foreclosures. After 2014, the share of Certificate of Title gradually declines to levels more consistent with experience prior to the foreclosure crisis. The series for Special Warranty deeds closely follows the series on Certificate of Title.

We use information on Certificate of Title to measure the number of foreclosures. To measure recent nearby foreclosures (*ST*) for every open market transaction after 2015, we count the number of Certificates of Titles within a one-tenth mile radius for a narrowly defined time window. We use a time window of 90 days before the transaction date so as to capture transitory effects of nearby foreclosures. Hence, our measure of recent foreclosures measures the *flow* of new foreclosures, and not necessarily the total stock of foreclosures at a specific moment in time. While our approach may undercount the stock of under-maintained foreclosed properties, as the impact of foreclosures may start earlier and last longer than 90 days during the crisis (see Gerardi et al. 2015; Biswas et al. 2021), our measure of recent foreclosures relates to the period after 2015, when the number of foreclosures is relatively few and back to pre-crisis levels.[4] In order to capture legacy effects, a longer time window before the transaction time is needed. Hence, for each open market transaction after 2015, we count the cumulative number of Certificates of Title within a one-tenth mile radius between 2000 and 2012. This measure captures any legacy effects of past number of nearby foreclosures (*LT*). In the empirical analysis we relate these transitory and legacy measures to house prices using open market transactions after 2015. The foreclosure effects will consist of transitory effects (number of foreclosures within one-tenth mile and within 90 days before the transaction date) and long-term legacy effects (cumulative number of foreclosures within one-tenth mile from 2000 through 2012).

Property information – Tax records provide detailed information about property characteristics. Also, we use property tax records over 2000 to 2019 to measure whether the subject property has been previously foreclosed (*Ever foreclosed*) or whether it has been owner-occupied in the past (*Ever HX*). In addition, we calculate the age of the subject property relative to the median age for the neighborhood (*Older*) to help control for unobserved differences in quality. Table A1 in the appendix gives variable definitions.

Neighborhood information – Tax records also allow us to construct measures at neighborhood level. First, we calculate the share of properties with homestead exemptions per census block (*SHX*) for each year between 2016 and 2019. Homestead exemption gives owner-occupiers a partial property tax exemption and limits future increases in taxable value. The homestead exemption is highly valuable and gives owner-occupiers strong incentives to apply for it. Application for homestead exemption is not possible for rental units. The existence of a homestead exemption thus provides information for each and every property on whether it is an

[4] At the peak of the crisis, properties in Orange County, Florida remained in foreclosure for 186 days (median for 2011). We therefore also experimented with a time window of 180 days for *ST*. The results are similar to those reported here, using a time window of 90 days.

owner-occupier or a rental unit.[5] We aggregate this information at the neighborhood census block level to measure the share of owner-occupier units in the neighborhood.

Next, we create a direct measure of neighborhood quality (*Neigh quality*). Following the approach taken by Aliprantis (2017), we construct a scaler measure of neighborhood quality to capture variation in both observed and unobserved neighborhood characteristics. We use median household income, the percentage of high school graduates and the percentage of Black people reported in the 2010 American Community Survey (ACS), as the observed neighborhood (census block group) characteristics. Applying Principal Component Analysis (PCA) to the data, we use the first eigenvector as the quality index. Table A2 in the appendix reports the results from the PCA. The first eigenvector has an eigenvalue of almost 2 and explains 65 percent of the variation in neighborhood characteristics. No other eigenvector has an eigenvalue above 1. The left panel of the table shows the first eigenvector coefficients, which indicate that higher values of the corresponding eigenvector are associated with higher incomes, a greater proportion of high school graduates and a lower proportion of Blacks.

Last, we create two indicators, *Block foreclosure* referring to 2010 Census blocks with at least one foreclosure ever, and *Neigh foreclosure* referring to properties with at least one foreclosure ever within narrowly defined neighborhoods of one-tenth mile. This helps control for the possibility that such local neighborhoods have different characteristics when compared with neighborhoods with no foreclosures.

Descriptive Statistics

Table 1 reports the descriptive statistics for all sales over the period 2000–2019:Q2, and for the estimating sample between years 2016–2019:Q2. We use open market sales over 2016 to 2019:Q2 for estimation purposes. We focus on single family detached houses with the aim to reduce the risk of unobserved heterogeneity related to dwelling type. Furthermore, we select properties older than 1 year because younger properties typically come with specific home warranties or other unobserved amenities. Properties within one mile of the county's boundary are excluded in order to avoid unobservable effects attributable to what would otherwise be nearby neighborhoods in surrounding counties. Atypical properties in terms of living area, parcel size, or unit price are also excluded from the estimating sample.

The descriptive statistics in column (1), for all sales over 2000–2019:Q2, indicate a mean sales price of just above $214,500, and a standard deviation of $132,000, thus reflecting the variation in house price. Structural property characteristics are represented by the type of building construction material (53 percent have stucco covered concrete block exterior walls versus wood frame construction), number of bedrooms (3.3 average), living area (2,395 square feet average), number of bathrooms (2.13 average), presence of a private pool (27 percent), lot size (0.24 acre average), and actual age of the house (27.3 years). Location controls include distance to the Orlando CBD (8.25 miles linear distance average) and census tract fixed effects.

[5] Homestead exemption for a given calendar year must be filed before March 1. See, https://www.ocpafl.org/exemptions/hx_file.aspx.

Table 1 Sample statistics

	(1) 2000-2019:Q2		(2) 2016-2019:Q2		(3) *Block foreclosure*=0		(4) *Block foreclosure*=1		(5) Repeat sales	
	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.
Sales price (*current*, $)	214,517	132,407	263,814	135,098	348,848	190,434	255,704	125,993	266,826	134,490
CBD distance (*miles*)	8.25	4.03	8.60	4.24	6.84	4.84	8.77	4.14	8.35	4.15
Walls of concrete stucco (1 = *yes*)	0.53		0.58		0.47		0.59		0.56	
Bedrooms (*number*)	3.29	0.75	3.36	0.76	3.34	0.82	3.36	0.75	3.32	0.74
Living area (*sq.ft*)	2,395	878.3	2,514	914.5	2,737	1,003	2,492	902.7	2,452	888.8
Age of house (*years*)	27.33	20.24	33.69	20.76	41.28	26.69	32.97	19.96	35.33	20.23
Baths (*number*)	2.13	0.66	2.21	0.69	2.30	0.82	2.20	0.68	2.18	0.67
Pool (1 = *yes*)	0.27		0.26		0.26		0.26		0.28	
Parcel size (*acre*)	0.24	0.16	0.24	0.16	0.27	0.21	0.24	0.16	0.23	0.15
ST (*number*)	0.10	0.35	0.06	0.25	0.02	0.16	0.07	0.26	0.06	0.25
LT (*number*)	4.39	5.25	8.78	7.02	2.86	3.41	9.34	7.01	9.02	6.94
Neigh quality (*PCA score*)	0.00	1.39	0.06	1.38	0.51	1.26	0.02	1.38	0.09	1.36
Older (1 = *yes*)	0.58		0.52		0.54		0.52		0.57	
Ever foreclosed (1 = *yes*)	0.21		0.19		-		0.20		0.21	
Ever HX (1 = *yes*)	0.76		0.73		0.72		0.73		0.83	
SHX (*share*)	0.62	0.16	0.58	0.16	0.58	0.21	0.58	0.15	0.59	0.15
Neigh foreclosure (1 = *yes*)	0.95		0.94		0.73		0.96		0.96	
	196,033		38,417		3,345		35,072		20,581	

The table reports summary statistics of property and neighborhood characteristics: column (1) for the full sample of sales, column (2) for the primary estimation sample, column (3) and (4) for indicated subsamples, and column (5) for the sample with resale transactions. See Appendix for variable definitions

The lower portion of Table 1 also reports the descriptive statistics on foreclosures. Table 1 indicates a mean of 0.10 foreclosures within one-tenth mile and 90 days before the sales date. The average number of cumulative foreclosures within one-tenth mile that occurred between 2000 and 2012 is 4.39. In total, 95.9 percent of the units have experienced at least one foreclosure within one-tenth mile during 2000–2019:Q2.

The descriptive statistics for the primary estimation sample are given in column (2). For the sample over 2016–2019:Q2, the table indicates a mean sales price of just above $263,500. The price distribution is skewed to the right, so we use the natural logarithm of price in the empirical analysis. The statistics on number of foreclosures within one-tenth mile and 90 days before sales date reflect the decline in number of foreclosures over time: between 2016 and 2019:Q2 we find a mean of 0.06 foreclosures within one-tenth mile and 90 days before the sales date. The remaining columns report the summary statistics for various subsamples; in column (3) the subsample of transactions in census blocks with no history of foreclosures, column (4) the subsample of transactions in census blocks with at least one foreclosure, and column (5) the subsample with resale transactions used in the repeat sales analysis.

Empirical Models

Hedonic model

The price function of the log of market price of property i at time t is a linear function of property characteristics, transitory and legacy effects of foreclosures, and neighborhood and time effects, or:

$$lnP_{it} = \beta_X X_{it} + \beta_{ST} ST_{it} + \beta_{LT} LT_{it} + \varepsilon_{it}, \tag{1}$$

where P is the selling price; X is the vector of relevant characteristics, including census tract and transaction year fixed effects; ST is an indicator of recent foreclosures; and LT is an indicator of the cumulative number of past foreclosures, some of which may have occurred a long time ago. The last term ε_{it} in equation (1) is the stochastic error. We allow for clustered errors at the census block level (Angrist and Pichke 2008) and bootstrap errors where appropriate.

We estimate variations of the baseline model. The parameter β_{ST} gives information on short-term transitory effects, whereas β_{LT} gives information on long-term legacy effects. The transitory effect β_{ST} captures what has become the standard concern of foreclosure studies, that is, how nearby foreclosures affect prices of surrounding houses by increasing the supply of properties on the market, or by negative externalities from neglect or abandonment prior to, or during, the foreclosure process. The legacy effect β_{LT} is new and captures the long-term price effects of changes in neighborhood composition or ownership status induced by past foreclosures. The intent is that β_{LT} picks up neighborhood effects associated with the neighborhood foreclosure history.

As already noted, it is possible that both β_{ST} and β_{LT} might be subject to unobservables bias. We take several approaches to minimize the impact of unobserved heterogeneity. First, we consider the extent to which unobserved property-related factors drive our results. For this, we include the age of the subject property relative to the average for the neighborhood to help control for unobserved quality differences related to age. We also include information on whether the subject property has ever been foreclosed prior to the current (open market) transaction. While many foreclosed properties were neglected or abandoned before foreclosure, many were also updated or renovated afterwards by the new buyers (Harding et al. 2012), so it is not clear whether previously foreclosed properties sell later at a discount or a premium. Nonetheless, to include this control reduces the likelihood that previous foreclosure status affects our transitory or legacy effects estimates. Also, we include information on whether the subject property currently has a homestead exemption (which means it is occupied by the owner) and whether it ever had a homestead exemption in the past. The literature offers considerable evidence that rental properties (i.e., do not have a homestead exemption in our sample) sell at a substantial discount (Harding et al. 2000; Iwata and Yamaga 2008; Turnbull and Zahirovic-Herbert 2012).

Second, we consider the extent to which unobserved neighborhood-related factors drive our results. The hedonic specifications include census tract and transaction year fixed effects, or census tract × transaction year fixed effects to allow for local differences in price trends. We include information on average homeownership rates in the census block, calculated from the all-parcel homestead exemption information in the raw data, along with a neighborhood quality index based on PCA of 2010 census block characteristics.

As a final approach to reduce the impact of unobservable neighborhood effects, we use the following two-stage procedure. Notice in Fig. 2 that the number of foreclosures is low and relatively steady from 2000 through 2005; it only begins to increase during 2006. Therefore, in order to obtain a measure of neighborhood effects prior to the foreclosure experience, we use the 2000-2005 data in the first stage to estimate the standard hedonic model, or:

$$lnP_{it} = \beta_X X_{it} + \mu_{it}, \quad (2)$$

where X is defined as above, and μ_{it} is the stochastic error. The vector of census tract fixed effects estimates is $\hat{\phi}$, which is drawn from the fixed effects in X_{it}. The second stage imposes $\hat{\phi}$ as constraints while estimating the hedonic function on the 2016–2019:Q2 data:

$$lnP_{it} = \beta_{\overline{X}} \overline{X}_{it} + \beta_{ST} ST_{it} + \beta_{LT} LT_{it} + \hat{\phi}_i + v_{it}, \quad (3)$$

where the vector $\overline{X}_{it}$ no longer includes neighborhood fixed effects, and where v_{it} is the stochastic error. Given that the fixed effects $\hat{\phi}$ are estimated values, we use bootstrapping to estimate the coefficient standard errors. The neighborhood value effects estimated before the wave of foreclosures remove neighborhood characteristics effects that are not driven by the history of foreclosures from the log of sales price. As a consequence, β_{LT} now picks up the effects of any differences in neighborhood characteristics attributable to the neighborhood foreclosure history. This is, of course, precisely what we have identified as the legacy foreclosure effect on property value.

Repeat sales model

As a next step, we estimate a set of repeat sales models. Repeat sales models have the advantage of controlling for housing unit-specific unobserved heterogeneity. The model for two successive sales $lnP_{it} - lnP_{it-1}$ reads as:

$$ln\left(\frac{P_{it}}{P_{it-1}}\right) = \gamma_t \Delta Age_{it} + \gamma_{HX}\Delta HX_{it} + \gamma_{ST}\Delta ST_{it} + \gamma_{LT}\Delta LT_{it} + \gamma_{SHX}\Delta SHX_{block_{it}} + u_{it}, \tag{4}$$

where γ_t captures the age-related filtering process and γ_{HX} any ownership transition for subject property i. The other terms on the right-hand side capture changes in the local neighborhood: the change in number of recent foreclosures (*ST*), the change in cumulative past foreclosures (*LT*), and the change in neighborhood mix of owner-occupier/rental properties (*SHX*). The time invariant house and neighborhood characteristics, *X,* now difference away.[6]

Empirical results

Table 2 reports the estimated parameters of interest for various versions of equation (1) estimated for open market transactions over 2016–2019:Q2. Model (1) includes number of foreclosures within 90 days to capture transitory effects, and the cumulative number of foreclosures before 2013 to capture legacy effects. The model, like all the others in the table, controls for property characteristics, neighborhood and time fixed effects, while allowing for clustered errors at the census block level. The model indicates joint significance of the specification with the model explaining about 76 percent of the variation in log of price.

The *ST* estimate shows that the transitory foreclosure effect is significantly negative. An additional foreclosure within one-tenth mile and within 90 days before the sale of the subject property is associated with 1.5 percent lower house prices. This marginal effect is in line with previous estimates. A review of empirical studies suggests that neighboring house prices tend to be approximately 1 percent lower in neighborhoods with foreclosures (see among others, Campbell et al. 2011; Anenberg and Kung 2014; Gerardi et al. 2015). These transitory effects arise from negative foreclosure externalities resulting from poorly maintained or vacant foreclosed property as well as pecuniary externalities attributable to the greater supply of houses for

[6] We convert transaction prices into real transaction prices in the repeat sales models using the BLS CPI-u index.

Table 2 ESTIMATION RESULTS, 2016-2019:Q2

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ST	-0.015**	-0.015**	-0.012**	-0.011*	-0.011*	-0.012**			
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)			
LT	-0.001***	-0.001***	-0.002***	-0.001***	-0.001***	-0.001***			
	(0.0004)	(0.0004)	(0.0004)	(0.0003)	(0.0003)	(0.0003)			
Ever foreclosed		0.015***	0.016***	0.019***	0.021***	0.023***	0.019***	0.021***	0.024***
		(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Ever HX		0.056***	0.056***	0.054***	0.054***	0.046***	0.054***	0.054***	0.046***
		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Older		-0.007	-0.008	-0.009**	-0.010**	-0.013***	-0.010**	-0.011**	-0.015***
		(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Neigh quality				0.098***	0.098***	0.092***	0.098***	0.097***	0.091***
				(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Block foreclosure					-0.018**	-0.021***		-0.012	-0.013*
					(0.007)	(0.007)		(0.008)	(0.008)
SHX						0.202***			0.206***
						(0.017)			(0.017)
Neigh foreclosure							-0.045***	-0.038***	-0.046***
							(0.012)	(0.013)	(0.012)
Neigh forecl. $\times$ *ST*							-0.012**	-0.011*	-0.012**
							(0.006)	(0.006)	(0.006)
Neigh forecl. $\times$ *LT*								-0.001**	-0.001**
								(0.0003)	(0.0003)
Tract	y	y							
Year	y	y							
Tract $\times$ Year			y	y	y	y	y	y	y
R^2	0.759	0.761	0.771	0.779	0.779	0.782	0.780	0.780	0.782

The table shows regression estimates of equation (1). The dependent variable is log sales price. The models include property characteristics as listed in Table 1. See Appendix for variable definitions. Models include location and time fixed effects. Robust standard errors clustered at census block in parentheses with *** , **, * indicate significance at 1%, 5% and 10%, respectively. The estimation sample is 2016-2019:Q2. Number of observations is 38,417 sale (Anenberg and Kung 2014). We find that the coefficient on the variable measuring the number of cumulative foreclosures before 2013, *LT*, is negative and statistically significant. The estimate indicates that a one-unit increase in the number of foreclosures before 2013 is associated with a 0.12 percent discount in local house prices over 2016–2019:Q2. This finding is consistent with the notion that foreclosures open previously inaccessible neighborhoods to a much wider range of buyers, as well as lead to changes in the mix of owner-occupied and rental properties.[7]

Model (2) adds controls for properties which have foreclosed (*Ever foreclosed*) or have been owner-occupied in the past (*Ever HX*). Adding these terms does not meaningfully affect the transitory or legacy effects estimates. Recall that we add these additional variables to control for possibly correlated unobservables that may bias our foreclosure price effects. The positive *Ever foreclosed* coefficient is consistent with new owners of foreclosed properties updating or refurbishing before reselling (Harding et al. 2012). The positive *Ever HX* coefficient is consistent with the notion that feasible rental properties tend to have unobservable configurations or characteristics that are not valued as highly in the market (Halket et al. 2020). Interestingly, adding a control for the relative age of the house (*Older*) does not appear to affect our earlier findings. Model (3) uses census tract and time interaction fixed effects in place of the separate sets of fixed effects to allow for neighborhood-specific dynamics. Clearly, nothing of consequence changes.

The other models reported in Table 2 incorporate our measure of neighborhood quality (*Neigh quality*). Model (4) shows that adding this term changes none of our earlier transitory or legacy effect conclusions. Models (5) and (6) use an additional control for neighborhood differences, a dummy variable *Block foreclosure*, to indicate census blocks with at least one foreclosure ever. While neighborhood effects are present, nothing of consequence changes in the parameters of interest. Model (6) includes an explicit control for the proportion of owner-occupied houses in the census block. Not surprisingly, the coefficient on *SHX* indicates higher values in neighborhoods with higher percentages of owner-occupied properties. Including this control does not appreciably affect the foreclosure legacy effect estimate.

Models (7)-(9) take an alternative approach to measuring transitory and legacy effects, using a dummy variable *Neigh foreclosure*, indicating properties with at least one foreclosure within one-tenth mile in the past to control for the possibility that such local neighborhoods have different characteristics when compared with neighborhoods with no foreclosures ever. The coefficient on the interaction term with *ST* in all three models indicates a transitory foreclosure effect in line with that found in the earlier models. The coefficients on the interaction term with *LT* in models (8) and (9) indicate a legacy foreclosure effect that is also in line with our earlier estimates. Model (9) shows that these estimates are not sensitive to the inclusion of our measure of owner-occupied properties in the neighborhood.

[7] We have also replaced the measure of cumulative foreclosures before 2013 with the number of cumulative foreclosures up to 90 days before sale. The transitory effect and legacy effects remain unchanged.

Table 3 Second stage constrained estimation results, 2016-2019:Q2

	(1)		(2)	
ST	-0.022	***	-0.021	***
	(0.007)		(0.007)	
LT	-0.004	***	-0.004	***
	(0.001)		(0.001)	
Ever foreclosed			0.006	
			(0.004)	
Ever HX			0.068	***
			(0.004)	
Older			0.009	
			(0.007)	
Observations	38,417		38,417	
R^2	0.556		0.561	
Property characteristics	y		y	
Tract fixed effects	n		n	
Year fixed effects	y		y	

Dependent variable is log sales price. Estimates based on equations (2) and (3) in the text. Bootstrapped standard errors clustered at census block in parentheses with *** , **, * indicate significance at 1%, 5% and 10%, respectively

Next, Table 3 reports the second-stage parameter estimates for (3). Recall that this approach is designed to remove census tract fixed effects that are not driven by the foreclosure history of the neighborhood. Looking at the results across all three models reported in the table and comparing them to Table 2, we can observe that nothing of consequence changes. Both the transitory and legacy marginal effects are somewhat larger, but the transitory effect is still much larger than the legacy effect. The coefficient on the *Ever foreclosed* variable in model (3) is now insignificant. This model implies no discount or premium associated with formerly foreclosed houses; either this variable no longer seems to be picking up the effects of unobservables associated with previously foreclosed houses, or the unobservables effects net to zero when using the two-stage method to control for neighborhood effects not driven by foreclosures.

Finally, Table 4 reports repeat sales estimates. The repeat sales sample includes all sales for which the second sale occurs in 2016 or later.[8] While the sample has fewer total observations, this method controls for unobserved heterogeneity related to time-invariant property and neighborhood specific characteristics. Our data comprises 20,581 repeat sales observations. Appendix provides these descriptive statistics. Table A3 indicates an average price appreciation of 8.13 percent across the repeat sales. The average age difference between the sales is 8.3 years with a standard deviation of 5 years. Furthermore, our repeat sample shows that more properties become rental units over time: the mean change

[8] Note that the previous sale, P_{it-1}, is not restricted to sales after 2015.

Table 4 Repeat sample estimates, 2016-2019: Q2

	(1)		(2)		(3)		(4)	
ΔAge	-0.029	***	-0.029	***	-0.024	***	-0.024	***
	(0.001)		(0.001)		(0.001)		(0.001)	
ΔHX			0.030	***	0.027	***	0.028	***
			(0.004)		(0.004)		(0.004)	
ΔST					-0.081	***	-0.082	***
					(0.006)		(0.006)	
ΔLT					-0.008	***	-0.008	***
					(0.001)		(0.001)	
ΔSHX							-0.023	
							(0.027)	
Constant	0.322	***	0.319	***	0.308	***	0.309	***
	(0.005)		(0.005)		(0.005)		(0.005)	
Observations	20,581		20,581		20,581		20,581	
R^2	0.130		0.133		0.148		0.148	

Dependent variable is log $salesprice_t$ - log $salesprice_{t-1}$ in real dollars per sq.ft. Estimates based on equation (4) in the text. Robust standard errors in parentheses with *** , **, * indicate significant at 1%, 5% and 10%, respectively

in homestead exemption status ΔHX is -0.049, while the average change in the homeownership rate on the census block level ΔSHX_{block} is -0.029. It is also noteworthy that the number of recent foreclosures declined on average, as ΔST, the number of foreclosures within one-tenth mile and 90 days before sales date is negative (-0.0678); this pattern is not surprising in light of Fig. 2 discussed earlier.

Table 4 reports estimation results. Model (1) is a simple framework that captures the effect of house age on price appreciation. The estimated filtering rate using changes in house prices for repeat sales is 2.98 percent per year, larger than the 0.5 percent for the U.S. between 1985 and 2011, as reported by Rosenthal (2014), and lower than the 7 percent reported by Smith (2004). Rosenthal (2014) argues that filtering varies inversely with house price inflation, so that the effect we find might not be unreasonable, given that units tend to also filter into rental houses over time. Many single family detached units became rental units in Orange County, Florida over our period of observation.[9]

Model (2) controls for changes into and out of owner-occupied status. The coefficient estimate for ΔHX reveals that a transition from owner-occupied to rental yields a substantial reduction in house price appreciation (i.e., when $\Delta HX = -1$), a pattern consistent with the broader rental discount literature (Harding et al. 2000; Iwata and Yamaga 2008; Turnbull and Zahirovic-Herbert 2012; Ihlanfeldt and Mayock 2016). Lastly, models (3) and (4) add our main variables of interest. The pattern of

[9] Average homestead exemption for transacted units dropped from 62 to 45 percent in our sample from 2000 through 2019.

coefficients is consistent with the hedonic results reported in Tables 2 and 3. We find a significant marginal legacy discount that, once again, is about one-tenth the size of short-run transitory effects. For these variables of interest, the repeat sales approach yields the same qualitative conclusions as the hedonic approach.

Drawing the results together, we find weaker legacy effects than transitory effects, but legacy effects do exist. Past neighborhood foreclosures leave long-term legacy effects. We find marginal discounts ranging from 0.14 percent in the single stage hedonic model, 0.41 percent in the two-stage hedonic model, to 0.79 percent in the repeat sales model. The larger marginal discounts found in the two-stage hedonic and repeat sales approaches suggest that unobservables may be biasing downward the single stage hedonic legacy effects discount, and that the true marginal legacy effects are anywhere between 0.41 percent and 0.79 percent.

Conclusion

This paper considers the extent to which differences in house prices are associated with differences in the number of recent and past foreclosures. Foreclosures lead to lower house prices in the short run, but may also have long-term or legacy effects on neighborhood house prices. The transitory foreclosure effects are well documented in the literature; properties may have been poorly maintained or left vacant for an extended period, which, along with the increased supply of houses for sale after foreclosure, reduced prices in the surrounding neighborhood. This study examines the long-term consequences of these effects, whether driven by sustained decreases in housing quality, changes in the mix of rental vs. owner-occupied properties, or the possibility that short-term price discounts or increased supply of rental housing create opportunities for different types of households to move into the neighborhood.

Using data from Orange County, Florida, one of the foreclosure hot spots during the financial crisis, we find transitory foreclosure effects in line with previous studies. We also give evidence of legacy foreclosure effects consistent with long-term changes in neighborhood composition. Not surprisingly, the legacy effects lead to house price discounts that are more modest than transitory effects, about one-tenth the size of the transitory effects. Nonetheless, both transitory and legacy effects are robust and do not appear to be driven by unobservable bias. Evidence presented here suggests that foreclosures have left long-term changes in the affected neighborhoods.

While this study provides evidence of foreclosure legacy effects in this market, it does not identify the source of these effects. The task of weighing or testing the relative importance of the various factors discussed here and elsewhere in the literature remains for future research. Finally, while statistically significant, our best estimates of the marginal legacy effects of foreclosures are between 0.41 percent and 0.79 percent. These modest marginal effects on surrounding property values are not large enough to motivate policy discussions.

Appendix

Table A1 Variable definitions

P_{it}	Sales price property *i* at time *t*
$Living\ area_{it}$	Living area in sq. ft.
$Bedrooms_{it}$	Number of bedrooms
$Baths_{it}$	Number of baths
$Walls\ of\ concrete\ stucco_{it}$	Dummy 1 if made of concrete stucco, 0 otherwise
$Pool_{it}$	Dummy 1 if private pool, 0 otherwise
Age_{it}	Age of property (in years)
$Parcel\ size_{it}$	Parcel size (in acres)
$CBD\ distance_{it}$	CBD distance relates to the distance to Central Blvd and Orange Ave., Orlando Fl.
HX_{it}	Dummy 1 if unit i has a homestead exemption at time t
ST_{it}	Total number of foreclosures within 1/10 mile and 90 days before transaction date
LT_i	Total number of foreclosures within 1/10 mile (Jan 1, 2000 - Dec 31, 2012)
$Neigh\ foreclosure_i$	Dummy 1 if ever a foreclosure within 1/10 mile
$Block\ foreclosure_i$	Dummy 1 if ever a foreclosure within Census block (definition 2010 Census block)
$Older_i$	Dummy 1 if older than median age in Census block
$Neigh\ quality_i$	Neighborhood quality index based on first eigen-vector from Principle Component Analysis of neighborhood quality variables.
$Ever\ foreclosed_i$	Dummy 1 if unit ever foreclosed
$Ever\ HX_i$	Dummy 1 if unit ever had a homestead exemption
$SHX_{block\ t}$	Share of units with homestead exemption per Census block in calendar year

Table A2 Principal Component Analysis of neighborhood characteristics

Coefficient on first eigenvector:		Proportion explained:		
Variable	Coefficient	Eigenvector	Eigenvalue	Proportion
Median household income	0.561	1	1.957	0.65
Percentage highschool graduates	0.606	2	0.597	0.20
Percentage black households	-0.564	3	0.446	0.15

This table reports Principal Component Analysis (PCA) results. We check adequacy for PCA using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. The value of KMO is 0.669, suggesting that PCA is acceptable

Table A3 Repeat sample statistics

	Mean	St.dev.
Δ *P*	0.081	0.412
Δ *HX*	-0.049	0.675
Δ *Age*	8.300	4.995
Δ *LT*	5.079	5.505
Δ *ST*	-0.068	0.464
Δ *SHX*	-0.029	0.110
Number of repeat sales	20,581	

Summary statistics for repeat sales sample with most recent $sale_t$ between 2016 and 2019:Q2. Note that the previous $sale_{t-1}$ is anywhere after Jan 1, 2000. Variables are in first differences. Δ *P* is log $sales\ price_t$ - log $sales\ price_{t-1}$ in real dollars per sq.ft.

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