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Razing San Francisco: The 1906 disaster as a natural experiment in urban redevelopment

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ABSTRACT

Urban developers face frictions in the process of redeveloping land, the timing of which depends on many economic factors. This timing can be disrupted by a large shock that destroys thousands of buildings, which could then have substantial short-run and long-run effects. Studying the impact of an urban disaster, therefore, can provide unique insight into urban dynamics. Exploiting the 1906 San Francisco Fire as an exogenous reduction in the city's building stock, this paper examines residential density across razed and unburned areas between 1900 and 2011. In prominent residential neighborhoods, density increased at least 60 percent in razed areas relative to unburned areas by 1914, and a large density differential still exists today. These outcomes suggest that thriving cities face substantial redevelopment frictions in the form of durable buildings and that large shocks can greatly alter the evolution of urban land-use outcomes over time.

1. Introduction

As clusters of durable capital, cities can be slow in adapting their forms and structures to changing economic conditions. Buildings, which are costly to remove and replace, act as frictions that delay redevelopment, the timing of which is dependent upon many economic factors. This timing can be disrupted by a large shock, which could then have substantial short-run and long-run effects. Thus, studying the impact of a localized disaster that lays bare much land can provide unique insight into urban dynamics that would be difficult to obtain otherwise. Using the destruction from the 1906 San Francisco Fire as a laboratory in which thousands of buildings were destroyed, this study compares development across razed and unburned areas both before and after the disaster and seeks to understand two facets of urban redevelopment: the role of durable buildings in delaying redevelopment in the face of growing demand, and the extent to which exogenous shocks to the timing of redevelopment last through time. All else equal, a significant difference in San Francisco's form upon reconstruction implies that the durability of urban capital is an important friction in redevelopment. Furthermore, a long-lived impact of the fire suggests that shocks can greatly alter the evolution of urban land-use outcomes over time.

Historically, great fires have had many implications for urban land use in growing cities. The 1872 Fire in Boston resulted in higher land values in burned areas and offered the opportunity to build higher quality buildings, where developers overcame redevelopment frictions through simultaneous reconstruction efforts (Hornbeck and Keniston, 2014). Fires in Baltimore, Chicago, and San Francisco also provided an impetus for change along various dimensions of land use, although previous studies of these events have focused largely on short-run post-disaster outcomes rather than causal effects and long-run implications (Fales and Moses, 1972; Rosen, 1986; Douty, 1977).[1] This study estimates the causal effect of the fire in San Francisco on residential density—a measure of land-use intensity in urban economic models—over six time periods between 1900 and 2011, with pre-disaster periods in 1900 and 1905, and post-disaster periods in 1914, 1931, 1950, and 2011. Employing a differences-in-differences (DID) approach across both time and space, evidence of a significant post-disaster increase in

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[1] Fales and Moses (1972) study the distribution of population and industry in Chicago only after the 1871 Fire. Rosen (1986) looks at the impact of fires in Chicago, Baltimore, and Boston, focusing largely on the political dynamics that played out in each case. In a study on the 1906 disaster in San Francisco, Douty (1977) looks at various aspects of the city's redevelopment and reconstruction.

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density is found in areas razed by the fire relative to unburned areas, an effect which persists to the present day.[2]

In the monocentric city model developed by Alonso (1964), Mills (1967) and Muth (1969), changes in a city's population size produce costless and instantaneous changes in the equilibrium structure of a city. However, as Brueckner (2000) notes, city capital—which is housing in the monocentric model—is not so malleable and a realistic picture is given by dynamic models which account for varying degrees of housing durability (Anas, 1978; Brueckner, 1980; Fujita, 1982; Wheaton, 1982b; Glaeser and Gyourko, 2005).[3] This durable housing makes the reorganization of a city's structure a costly endeavor and thus delays redevelopment. Hence the dynamic model, with its emphasis on building durability and the costs associated with tearing down and rebuilding, predicts a slower response to changes in population and housing demand. As an exogenous source of thousands of simultaneous tear-downs, the fire reduced many redevelopment frictions associated with the presence of durable buildings. In this way, the further the city's deviation from its pre-disaster form upon reconstruction, the larger redevelopment frictions must have been prior to the fire.

As a large shock, the fire greatly disrupted the timing of redevelopment in San Francisco. For some cities, shocks may have little long-run impact on development patterns (Davis and Weinstein, 2002; Brakman et al., 2004; Glocker and Sturm, 2013), thus suggesting that natural location-specific attributes dictate long-run urban growth.[4] Other cities may thrive because of self-reinforcing agglomeration economies. Evidence for this phenomenon is seen in cases where urban areas that were initially developed for reasons that no longer matter can persist for long periods of time, thus perpetuating development patterns even well after original advantages are gone (Bleakley and Lin, 2012; Jedwab and Moradi, forthcoming; Jedwab et al., 2015). Aside from the spatial and temporal patterns that arise through the dynamic process of development and redevelopment, these forces may also determine density patterns at the neighborhood level over the long run. For instance, Brooks and Lutz (2014) find persistence in density patterns in Los Angeles around old streetcar stops, which are now defunct. Over time, neighborhood dynamics may be determined by local amenities (Lee and Lin, 2013) or the characteristics of a city's housing stock (Rosenthal and Homes, 2008; Brueckner and Rosenthal, 2009).[5] While many forces may be at play in San Francisco after the fire, a long-lasting effect on residential density would suggest that large shocks can greatly influence urban land use, and potentially neighborhood dynamics, over time.

2. The fire and redevelopment

San Francisco experienced significant population growth leading into the early twentieth century, thus causing housing rents to escalate in the years before the disaster.[6] Land values were also rising in the city, where land value assessments increased at an average rate of roughly 2 percent per year between 1900 and 1906 (SFMR, 1904-1916).[7] In response to these economic conditions, developers began building denser forms of housing in order to capture more income and economize on valuable land.[8] The fire helped accelerate the process of densification by offering an opportunity to redevelop large areas of land at a time of significant population growth in the city. As shown in Table 1, this growth has continued over the last century, thus suggesting that the pressure to become denser through redevelopment has not disappeared with time.

The decision to redevelop land is rigorously modeled by Brueckner (1980) and Wheaton (1982a), who develop an optimal rule whereby redevelopment occurs when the income received from redeveloped land exceeds the income from its current use by the costs of redevelopment.[9] This rule plays an important role in determining density in a growing city. The more this rule is met, the greater the rate of capital replacement and the more closely the dynamic urban model resembles the static model of instantaneous change. Additionally, new urban housing exhibits higher levels of density than the old housing it replaces when redevelopment occurs in response to favorable economic conditions (Wheaton, 1982b). In the context of housing, there is evidence that developers operate according to the redevelopment rule (Rosenthal and Helsley, 1994; Dye and McMillen, 2007).[10] These studies provide little insight, however, into the large-scale frictions developers face in reshaping cities. Urban economists and historians understand the importance of these frictions in determining urban structure over time (Hochman and Pines, 1980; Hochman and Pines, 1982; Rosen, 1986), but have not made empirical attempts to estimate their degree of influence.

Various frictions tend to delay redevelopment. While construction costs are an important outlay, durability introduces demolition costs into the redevelopment decision, which must be incurred to clear away old structures in order to construct new buildings. However, in expensive land markets—which San Francisco was quickly becoming at the time—demolition costs are likely small relative to lot value (Rosenthal and Helsley, 1994) and thus play a fairly minor role in the redevelopment decision.[11] Developers may also face substantial transaction costs in redevelopment when buildings are involved. For example, buildings may complicate the bargaining processes that would lead to beneficial real estate transactions and subsequent redevelopment. In extreme cases, developers may face holdouts, which serve to impede structural change. Issues like these can arise due to the fact that homeowners, for instance, often derive flow utility from buildings themselves, whereas developers interested in tearing them down place no value on structures. This value differential acts as a barrier to redevelopment by inhibiting transactions. Redevelopment may

[2] Although not directly related to the impact of disasters on urban land use, Koster et al. (2012) also use a differencing strategy across space by exploiting the World War II bombing boundary in Rotterdam to estimate the magnitude of housing regulation costs.

[3] A comprehensive review of such models, along with comparisons to static model predictions, is given in Brueckner (2000). In addition to these theoretical studies, an influential empirical study of urban dynamics is Harrison and Kain (1974), which emphasizes a long-term disequilibrium approach to urban growth resulting from the durable nature of residential and nonresidential capital.

[4] Barone et al. (2014) show that large earthquakes can alter regional growth rates in the long run, with particularly bad outcomes occurring in areas with poor pre-shock institutional quality. In this way, shocks can exacerbate initial economic differences across regions.

[5] In a related handbook chapter, Rosenthal and Ross (in press) discuss the evolution of economic status in neighborhoods and cities, documenting both the persistence of economic status over time, as well as its capacity for change.

[6] In May 1904, when referring to the rising housing rents in the city, one journalist for the *San Francisco Chronicle* wrote that "...it is the result of the rapid growth of San Francisco's population...with the consequent crowding of people...where they have learned that the excess of demand over supply of dwellings meant for them such expenditures for rent or board as to leave nothing from their incomes for savings."

[7] Land values dropped considerably after the fire, hitting a low in 1907. After 1907, however, the city's assessed land value grew at an average annual rate of 3.5 percent per year until 1914, at which time it stabilized for several years (SFMR, 1904-1916).

[8] Evidence of this shift into denser forms of housing is seen on the city blocks near the fire's boundary, which make up this study's sample. Near the boundary, 25 apartment buildings had been constructed by 1905 where no apartments existed in 1900. By 1914, 200 apartment buildings existed on these blocks. This shift into denser housing was also a national trend in the early part of the twentieth century (Barrows, 1983).

[9] Capozza and Helsley (1990) and Titman (1985) further introduce future price uncertainty and show that it discourages new investment, which implies land has option value.

[10] Munneke (1996) finds similar evidence in the context of commercial and industrial properties, while Cunningham (2006) shows that developers also consider real options to future buildings in their decisions to redevelop vacant land.

[11] Demolition costs are also small relative to lot value in the case of single-family dwellings (Rosenthal and Helsley, 1994). Such dwellings made up nearly one-third of the San Francisco housing stock in this study's sample in the years before the disaster.