Development Approval Timelines, Approval Uncertainty, and New Housing Supply: Evidence from Los Angeles

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Abstract

We provide credible estimates of the effect of local regulatory approval time and uncertainty on the rate of housing production. The analysis derives from a unique dataset of development timelines for all multifamily housing projects permitted in the City of Los Angeles between 2010 and 2022. As a lower bound, we estimate that a 25% reduction in approval times would increase the rate of housing production by 11% simply by pulling forward in time the completion of already started projects. If we additionally take into account the effect of incentivizing new development, we estimate that the 25% reduction in approval time would increase the rate of housing production by a full 26%. Both the expected value and the uncertainty in approval times are shown to matter, with uncertainty mattering more for the incentive effect and expected value mattering more for the pull-forward effect. The results provide new evidence that local approval processes are a significant driver of housing supply and reinforce the notion that municipal regulatory reform is housing reform.

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1 Introduction

Substantial academic research and policy debate have focused on the housing market effects of local government land-use regulation (see, for example, Quigley and Raphael (2005), Turner et al. (2014), Gyourko et al. (2021)). Local regulatory regimes often include growth management ordinances or other explicit mechanisms designed to achieve fiscal or environmental goals. While such instruments have been broadly popular and widely utilized in efforts to limit local provision of affordable and low-income housing, other less explicit and even unintended mechanisms may result in similar outcomes. Indeed, substantial bureaucratic delay and related uncertainty in the granting of local development approvals may effectively depress local supply of affordable housing. Whether consistent with or contrary to local policy goals, constraints on development imposed by municipal approval processes may be highly salient to affordable housing outcomes.

Concerns regarding inadequacy of affordable housing supply are broadly evident in Los Angeles. As the least affordable of major cities in the U.S., Los Angeles has long failed to address issues of housing inadequacy. A full one-third of Los Angeles households are severely affordability constrained, defined as spending more than one-half of their income on rent.[1] Shortages of affordable housing factor negatively into the shelter prospects of the roughly 47,000 homeless persons living in the city.[2] Further, limited housing supply serves to depress household and firm location choice and related economic competitiveness of the Los Angeles area (Gabriel and Painter (2020)). By all estimates, the city will fall far short of the State of California Regional Housing Needs Assessment (RHNA) goal of 457,000 new housing units for the 2021-2029 period, which comprise a five-fold increase in production over the roughly

[1] American Community Survey, 2019 ACS Estimates.

[2] The Greater Los Angeles Homelessness Count, Los Angeles Homelessness Authority, June 2023.

84,000 units produced from 2010-2019.[3]

In this paper, we quantify and assess the role of local regulatory approval timelines and uncertainty in new housing supply. To do so, we compile multiple administrative datasets that allow us to track development time for the universe of multi-family projects permitted by the City of Los Angeles between January 2010 and November 2022. We identify specific elements of the approvals and entitlements process and provide new estimates of their incremental effect on approval and construction times. We model the distribution of approval and construction times and use these models to simulate housing production outcomes if approval times were reduced. To our knowledge, this is the first paper to use detailed administrative data on actual approval times to estimate robust and credible effects of approval time on housing production.

Our research findings provide new estimates of the effect of approval time on the rate of housing production. Over the 2010-2022 sample timeframe, approval times comprised roughly 45 percent on average of the nearly 4 years required to complete a multi-family project in the City of Los Angeles. As a lower bound, results suggest that a 25 percent reduction in approval times could increase the rate of housing production by 11 percent simply by pulling forward in time the completion of already started projects. If we further take into account the effect of incentivizing new development, we estimate that this same 25 percent reduction in approval times would increase the rate of housing production by a full 26 percent. We show that both the expected value and the uncertainty in approval times matter, with uncertainty mattering more for the incentive effect and expected value mattering more for the pull-forward effect. Our paper provides robust and credible quantitative evidence that approval policy is a significant driver of the rate of housing production. The analysis further reinforces

[3] Los Angeles City Planning 2021-2029 Housing Element

the notion that development process reform is housing reform.

The plan of the paper is as follows. The following section describes the data and institutional context of the study. Section 3 specifies models of development approval and construction time and reports on the salience of specific factors to the estimated timelines. Given model estimates, section 4 simulates the effects of reductions in approval times on project completions. Section 5 estimates the effect of both expected value and volatility in approval times on new construction. In section 6, we provide concluding remarks.

2 Data and Institutional Background

Housing development in Los Angeles

To build new housing in Los Angeles, the developer must first obtain a permit from the Los Angeles Department of Building and Safety (DBS). In addition, if the project requires exceptions to zoning codes or meets other criteria that trigger discretionary review, then the project must also obtain entitlements from the Los Angeles Department of City Planning. Examples of discretionary review include Site Plan Review, which is triggered for projects that add 50 or more dwelling units, and Environmental Impact Review, which is triggered by California CEQA rules. A developer can submit their DBS permit application before all entitlements are approved, but the entitlements generally must be approved before the DBS permit can be issued. Construction can begin once the DBS permit is issued. When construction is finished and the project is fit for habitation and meets all other requirements, DBS issues a Certificate of Occupancy (CofO).

Permits data from Department of Building and Safety

To study the role of approval times in housing development, we compiled a rich dataset containing the universe of all multifamily housing projects permitted by DBS between January 2010 and November 2022. The dataset contains detailed information about each project, including the dates of permit application and issuance, the date of CofO issuance, the application and approval dates of all related entitlements, physical characteristics of the project (height, square footage, number of units), and geographic characteristics (address, City Council District).

The main data source is a publicly available dataset provided by DBS and made available on Los Angeles's open data portal.[4] This dataset contains information *all* new building permits issued by DBS between January 2010 and November 2022, including single-family, multi-family, commercial, and mixed-use buildings. To focus only on multi-family, we extracted the multi-family housing projects using a combination of the permit subtype and the project use description.[5] The dataset contains both complete and incomplete projects, where "complete" is defined as having been issued a CofO as of November 28th, 2022. To focus only on projects that were either completed or in active development, we excluded any projects with a closed or expired permit.

For each project, we determined the number of income-restricted units (i.e. "affordable" units) using the permit work description. An affordable unit is a unit that the project owner has agreed to set aside for residents within an income threshold,

[4] A live link to the public dataset can be found here: `https://data.lacity.org/City-Infrastructure-Service-Requests/New-Building-Permits-2010-to-Present/46r2-n9vp`. We accessed and downloaded this data on November 28th, 2022.

[5] The permit subtype can be "1 or 2 Family Dwelling", "Apartment", or "Commercial". We excluded permits with the "1 or 2 Family Dwelling" subtype. We included all permits with the "Apartment" subtype. We included "Commercial" permits only if its use description indicated some residential usage.

usually determined as a percentage of the area median income. The city provides incentives for developers to set aside affordable units, typically in the form of density bonuses or other exceptions to the zoning code. We classified projects into three groups: "market-rate", "mixed-income", and "100%-affordable". A project was classified as "100%-affordable" if all its units except one or two manager units were affordable units. A project with no affordable units was classified as "market-rate". All other projects were classified as "mixed-income".

The resulting dataset contained 2,677 projects representing 120,213 total dwelling units, of which 102,897 were market-rate and 17,316 were affordable. 1,712 projects were completed (issued a CofO) as of November 28th, 2022, and 965 projects were unfinished as of November 28th, 2022. The full breakdown of counts by project type are reported in Table 1.

Entitlements data from City Planning

In that one of our primary goals is to assess the speed of housing production, it is important that we use a meaningful and consistent definition of project start date. The date of DBS permit application is not always a good measure of start date because the process of obtaining entitlements can start many years prior to the submission of plans to DBS. This is especially true of projects that require long discretionary reviews, such as projects requiring Environmental Impact Reviews (EIRs). Therefore, a conceptually appealing measure of start date requires that we observe both the permit submission date *and* the entitlement application dates.

The DBS data described above does not contain information on entitlements. To obtain information on entitlements, we took advantage of the Los Angeles Zoning Information and Map Access System (ZIMAS) and the Department of City Planning's

Planning Document Information System (PDIS).[6,7] ZIMAS allows users to input an address, assessor parcel number (APN), or parcel identification number (PIN) and retrieve zoning information about the parcel, including relevant Planning Department case numbers. PDIS, a system maintained by the Planning Department, allows users to retrieve case information by inputting a case number. The information retrieved by PDIS on entitlement cases includes both the application date and the approval date of the entitlement request.

We link DBS permits to entitlement cases using a three-step procedure. First, we take the primary address and associated PINs of each project in the DBS data and use ZIMAS to retrieve all Planning Department cases associated with those parcels. Second, we use PDIS to retrieve information about each of those linked cases. Third, we determine whether each linked case was relevant to the development project. Using this procedure, we linked 1,389 projects to at least one entitlement case. 1,288 projects were not linked to any case. Of the projects that were linked to at least one case, the average number of cases linked was 2.7.[8]

With the additional data on entitlements, we were able to measure the start date of a project based on the date of the first seen entitlement or permit application.

Electrical data from Department of Water and Power

In addition to the data on entitlements, we also sought data on new power service installations from the Los Angeles Department of Water and Power (DWP). This was motivated by our conversations with industry professionals who identified long timelines for electrical service installation as a major bottleneck.

To obtain this data, we provided DWP with the primary site address for each

[6]ZIMAS: https://zimas.lacity.org.

[7]PDIS: https://planning.lacity.org/pdiscaseinfo/search.

[8]We discuss the rules used to determine relevancy and the quality of the linkage in the appendix.

project in the permits data. DWP then returned, for each project, all new power service work requests associated with that address from 2010 to present. We filtered out any work requests that were entered before the project start date or after the project's CofO date.

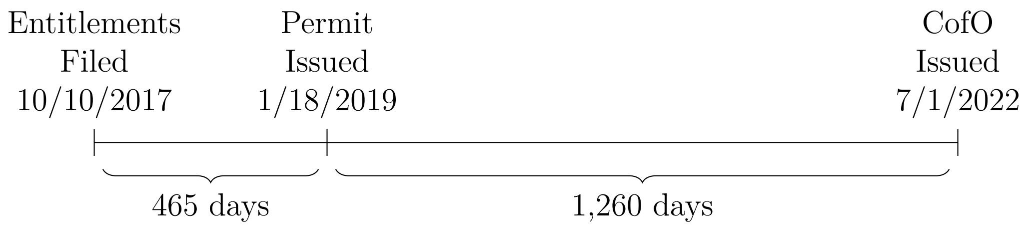
In total, we received data on 70,114 work requests for 2,324 projects.[9] The vast majority of these work requests were for new meter installations. We ignore new meter installations in our analysis because they are required on almost every project. Instead, we focus on work requests for the design and installation of new overhead and underground circuits and service voltage. There were 808 overhead work requests and 1,291 underground work requests. In our empirical analysis, we considered the impact of a project requiring *any* new overhead or underground installations on project timelines.

Example project: Florence Towne Apartments

To provide readers with an example of a project in our data, we consider the Florence Towne Apartments. The Florence Towne Apartments is a 51-unit affordable housing development located at 410 E. Florence Ave. in South L.A. It was entitled under Planning Department cases DIR-2017-4059-TOC and ENV-2017-4060-CE. Both cases were submitted on October 10th, 2017 and approved on February 6th, 2018. The new building permit application was submitted to DBS on March 1st, 2018 and issued on January 18th, 2019. The Certificate of Occupancy was issued on July 1st, 2022.

[9] For the projects that we did not receive DWP data for, it was likely because of an error in finding matching addresses. Addresses are not standardized between the DBS and DWP databases, leading to an imperfect matching process. In our empirical work, we assume that projects without DWP data did not require any overhead or underground circuit installations, but the results are similar if we drop any projects without DWP data.

Figure 1: Florence Towne Apartments: Project Timeline



We define a project's "approval" time as the number of days between the first seen entitlement or permit application (i.e. the start date) and the date in which the DBS permit is issued. We define a project's "construction" time as the number of days between the permit issuance and the CofO issuance.[10] Based on these definitions, the Florence Towne Apartments spent 465 days in the approval period and 1,260 days in the construction period. Out of the 465 days in the approval period, 119 days were spent in entitlement and 323 days were spent in permitting, with a few weeks in between. The developer cited issues with DBS and COVID as the primary causes of delay.

Summary statistics

Table 2 lists the variable names and definitions from our data. Table 3 shows summary statistics for each of these variables across project types. Of special note is the project timelines. Our data show that the average approval time across all projects was 652 days (1.8 years) and the average construction time was 863 days (2.4 years).[11] The

[10] Note that not all the time in "construction" is necessarily spent on physical construction. There may be various approvals and compliance checks that the project must undergo even after the issuance of a permit by DBS.

[11] Approval time is measured for all projects. Completion time is measured only for completed projects.

average total development time was 1,413 days (3.9 years).[12] Since larger projects take longer to complete, the completion time of the average dwelling unit is even longer than for an average project. The average dwelling unit took 1,784 days (4.9 years) to complete.

In addition to long average timelines for project development, there is also a significant amount of uncertainty. The 25th percentile for total development time was 946 days (2.6 years) and the 75th percentile was 1,739 days (4.8 years). Thus, 1 in 4 of the multifamily housing developments built in Los Angeles between 2010 and 2022 took 4.8 or more years to complete, from first permit or entitlement application to CofO. The variability in total development time is not simply due to predictable factors. Using a simple OLS model of completion time on observable characteristics, we found that the observed characteristics could only explain 25.8% of the variation in total development time.[13] There is thus a significant amount of remaining uncertainty in development time that is not explainable by the variables in our dataset.

3 Models of Development Time

To assess the role of approval times in housing development, we first develop statistical models of approval and construction times. The models allow us to estimate the mean and variance of approval times and construction times after controlling for project characteristics. Crucially, the models allow us to estimate the distribution of project completion times, which is a latent variable in our data since not all projects were completed. This in turn allows us to simulate how changes in approval time affect project completion rates within a fixed time period.

[12] Total development time is measured only for completed projects.

[13] See Table 2 for a list of the variables used.

Approval Time. We statistically model approval time according to the following equation:

$$AT_i = X_i\beta + \epsilon_i \tag{1}$$

AT_i is the approval time, measured in days, for project i. X_i is a set of project i structural characteristics, including the number of units, building height, building square footage, the project type (market-rate, mixed-income, or 100%-affordable), and whether the project required any entitlements. Table 2 shows the full list of features that we consider in the model. The error term, ϵ_i, is modeled as a logistic distribution with mean 0 and an unknown scale parameter.

Construction Time. Construction time is modeled according to the following equation:

$$CT_i^* = X_i\gamma + \nu_i \tag{2}$$

CT_i^* is the latent construction time, in days, for project i. As above, X_i is a set of project structural characteristics. The error term, ν_i, is again modeled as a logistic distribution with mean 0 and an unknown scale parameter.

For simplicity, we assume the independence of ϵ_i, ν_i, and X_i. This may not hold in practice. There may be unobserved factors in ϵ_i and ν_i that are correlated with observed factors in X_i. Moreover, it is likely that ϵ_i and ν_i are correlated as more complex projects may have both unexpectedly long approval times and unexpectedly long construction times. We therefore cannot interpret (1) and (2) as structural equations. However, our simulation results in Sections 4 and 5 do not require a structural interpretation of equations (1) and (2) since they rely on the reduced form distributions of AT_i and CT_i^*.

In estimating our model for construction time, it is important to note that CT_i^* is not observed for the unfinished projects. For these projects, we only know that CT_i^* is larger than the number of days between November 28th, 2022 and the permit issuance date. The model for construction time is therefore an accelerated failure time model for which standard estimation techniques have been developed.[14]

Regression Results. Although we are not primarily interested in the causal effects of X_i on AT_i and CT_i^*, it is both interesting and informative to examine their relationships in the reduced form. Table 4 reports our coefficient estimates. Council District fixed effects were included in the model but the results are omitted for space. We comment on selected results below.

Physical Characteristics. Out of the three physical measurements available in our data—number of units, height, and square footage—height was the most statistically significant variable in the model. The results show that every 10 feet of height (about one story) is associated with 4 additional days in approval time and 12.1 additional days in construction time.

Project Types. The results show that there is significant variation in approval and construction times by project type, even after controlling for project characteristics and required entitlements. 100%-affordable projects had shorter approval and construction times than market-rate projects, whereas mixed-income projects had longer approval times than market-rate projects. The faster development times for 100%-affordable projects may be due to city policies that prioritize affordable housing

[14]See Kalbfleisch and Prentice (2002).

development, whereas the slower developmentment times for mixed-income projects may be due the increased complexity of such projects.

CEQA. There are three entitlement case types related to CEQA (the California Environemntal Quality Act): Categorical Exemption (CE), Mitigated Negative Declaration (MND), and Environmental Impact Report (EIR). According to the State of California:

> "CEQA requires state and local government agencies to inform decision-makers and the public about the potentially significant environmental effects of a proposed project, ways to minimize those effects, and to indicate alternatives to the project. If a project subject to CEQA will not result in potentially significant adverse effects to the environment, the Commission may adopt a document known as a Negative Declaration or a Mitigated Negative Declaration. If the project may cause adverse environmental effects, the Commission will prepare a more detailed informational document called an Environmental Impact Report (EIR). An EIR contains information on potential effects, measures to mitigate those effects, and an analysis of alternatives to the project. A key feature of the CEQA review process is the opportunity for the public to provide input on Negative Declarations, Mitigated Negative Declarations, and EIRs."[15,16]

Our results show how entitlements related to CEQA affect development time. Unsurprisingly, projects requiring an EIR had significantly longer approval times, by 504 days on average. By contrast, projects using a MND did not have significantly

[15] `https://www.slc.ca.gov/ceqa/`. Accessed January 2nd, 2023.

[16] In our data, we observed very few Negative Declarations and mostly Mitigated Negative Declarations. In the few instances where a Negative Declaration was observed, it was lumped together with Mitigated Negative Declaration.

longer approval or construction times than projects not subject to CEQA. Projects that were categorically exempt from CEQA had longer construction times but no significant difference in approval times.

Although EIRs add significant delays to a project's approval time, we note that not many projects required an EIR. Only 28 projects in the data required an EIR, affecting a total of 8,311 dwelling units.

Power installation. In our conversations with developers and city officials, the length of time for DWP to complete a circuit installation was often cited as a bottleneck. Our model results are consistent with that sentiment. The results show that requiring a new overhead circuit installation adds 117 days to the construction time, whereas requiring a new underground circuit installation adds 69 days to the approval time and 176 days to the construction time.

Other Entitlements and By-Right. The results show the effect of various other types of entitlements on approval and construction times. For example, the results show that projects requiring approval by the City Planning Commission had 193 days longer approval times and 125 days longer construction time. Projects requiring Site Plan Review had 106 days longer approval time, but no statistically significant difference in construction times.

Even after controlling for a number of different entitlement types, the results show that projects requiring *no entitlements* (i.e. "by-right" projects) had lower approval times by an average of 197 days.[17] In other words, requiring any entitlements added, on average, 197 days to the approval time, even after controlling for the types of entitlements we observe in the data.

[17] By-right projects still require approval from DBS, so their approval times are not zero.

Scale Parameters. In addition to the coefficient estimates, Table 4 also shows our estimated scale parameters for ϵ_i and ν_i. The estimated scale parameter for ϵ_i (the residual of approval time) is 208.6, which implies a standard deviation of 378 days.[18] The estimated scale parameter of ν_i (the residual of construction time) is 331.7, which implies a standard deviation of 602 days.

Salience of Factors. Although some factors have a large effect on approval or construction time, such as EIR on approval time and CPIOC on construction time, these factors may not apply to many projects. To measure the overall salience of a factor on development time, we computed its combined effect on approval time and construction time and multiplied that by the total number of dwelling units in projects affected by that factor. The salience of each factor is reported in Figure 3. Salience is measured in unit-years. A salience of x means that if the marginal contribution of that factor were completely eliminated, an additional x units would have been completed one year sooner. Thus, Figure 3 shows that if all not-by-right projects were instead made by-right, then 48,085 unit-years in development time would have been saved. If all projects requiring new underground circuit installations instead did not require it, then 46,957 unit-years of development time would have been saved. By-right and underground power installation are the two most salient factors, followed by City Planning Commission and Site Plan Review.

[18]The standard deviation of a logistic distribution is $s\pi/\sqrt{3}$, where s is the scale parameter.

4 The Impact of Approval Time on Project Completions

To assess the impact of approval times on project completions, we consider the following thought experiment. Suppose the expected approval time or the uncertainty in approval times was reduced by X%. Taking as given the set of projects started between January 2010 and November 2022, how many additional units would have been completed by November 2022 if approval times had been reduced in this way? Note that in this counterfactual, the newly completed units must come from projects that in the baseline *did not* complete by November 2022. Thus, to conduct this exercise, we need to simulate the distribution of latent completion times for the unfinished projects. We describe the simulation procedure below.

First, let $\hat{\beta}$ be the estimated coefficients for the approval time model given in equation (1), let $\hat{\epsilon}_i$ be the residual, and let $\hat{s}_A$ be the estimated scale parameter. By definition, $AT_i = X_i\hat{\beta} + \hat{\epsilon}_i$. Let $\hat{\gamma}$ be the estimated coefficients for the construction time model given in equation (2) and let $\hat{s}_C$ be the estimated scale parameter. Let T_i^0 be the start date of project i, which we take to be exogenous, and let $\bar{T}$ be November 28th, 2022, the censoring date. Finally, let c_i be an indicator equal to 1 if project i was completed by November 28th, 2022 and 0 otherwise. By definition,

$$c_i = \begin{cases} 1 \text{ if } T_i^0 + AT_i + CT_i^* \leq \bar{T} \\ 0 \text{ otherwise} \end{cases}$$

We now describe a procedure for simulating ν_i, the latent residual in the construction time model. When $c_i = 1$, CT_i^* is observed and we can estimate ν_i using the equation $\nu_i = CT_i^* - X_i\gamma$. When $c_i = 0$, CT_i^* is not observed. Instead, it is only known that $C_T^* > \bar{T} - T_i^0 - AT_i$. Thus, when $c_i = 0$, we only know that $\nu_i \geq \bar{T} - T_i^0 - AT_i - X_i\gamma$. We can therefore obtain an estimate for the residual, $\hat{\nu}_i$, using the following formula:

$$\hat{\nu}_i = \begin{cases} CT_i^* - X_i\hat{\gamma} & \text{if } c_i = 1 \\ R \mid R > \bar{T} - T_i^0 - AT_i - X_i\hat{\gamma} & \text{if } c_i = 0 \end{cases}$$

where R is a random variable distributed according to the logistic distribution with mean 0 and scale $\hat{s}_C$.

The intuition for $\hat{\nu}_i$ is quite straightforward. For projects completed by November 28th, 2022, $\hat{\nu}_i$ is simply the difference between the observed construction time and the model's predicted construction time. For projects that were unfinished as of November 28th, 2022, $\hat{\nu}_i$ is drawn from the estimated distribution of ν_i, conditional on being large enough so that the latent completion time is past the censoring date, as is consistent with the data.

We now describe how to calculate the number of units added in the counterfactual. Suppose approval times are changed in such a way that every project receives a new approval time, AT_i'. We assume that in the counterfactual, latent construction times remain unchanged. Let $\hat{c}_i$ be an indicator for whether project i would have been completed by November 28, 2022 in the counterfactual:

$$\hat{c}_i' = \begin{cases} 1 \text{ if } T_i^0 + AT_i' + X_i\hat{\gamma} + \hat{\nu}_i \leq \bar{T} \\ 0 \text{ otherwise} \end{cases}$$

We can therefore calculate the number of units added in the counterfactual by adding up the number of units in projects that were not completed in the baseline but completed in the counterfactual:

$$\# \text{ Units Gained} = \sum_i w_i(1 - c_i)\hat{c}_i \tag{3}$$

where w_i is the number of dwelling units in project i.

Simulating a 25% reduction in expected approval times. We now turn to a simulation in which the mean approval time is reduced by 25%, but the amount of uncertainty stays the same. The counterfactual approval times are defined by:

$$AT_i' = 0.75X_i\hat{\beta} + \hat{\epsilon}_i$$

Under this counterfactual, we find that a 25% reduction in expected approval time increases the number of units produced by 7,430, a 10.4% gain over the baseline of 71,532.

Simulating a 25% reduction in the uncertainty of approval times. To simulate a reduction in the uncertainty in approval times, we define the counterfactual approval times by:

$$AT_i' = X_i\hat{\beta} + 0.75\hat{\epsilon}_i$$

In this counterfactual, the expected approval times conditional on project characteristics remain the same, but the standard deviation is reduced by 25%. This has the effect of compressing the distribution of approval times, making some projects take longer to approve but also reducing the size of the long tail. We find that reducing the uncertainty in approval times by 25% leads to an increase in the number of units produced by 2,590, a 3.6% gain over the baseline.

Simulating a total reduction of 25% in approval times. Lastly, we simulate the effect of reducing total approval time by 25%. This reduces both the mean and the variance of approval times. In other words, we let:

$$AT_i' = 0.75AT_i$$

Under this counterfactual, we find that a 25% reduction in total approval time increases the number of units produced by 7,851, a 11.0% gain over the baseline.

Discussion. The exercises above show how reductions in approval time translate to increased housing production through a single channel: the pulling forward in time of project completions. We therefore call this effect the "pull-forward" effect. The estimate of the pull-forward effect relies on few assumptions other than the distribution of the construction time residuals.[19] The estimated pull-forward effects can therefore be considered both robust and conservative estimates of what is possible through the reduction in approval times. The estimates are robust because the pull-forward effect relies only on a distributional assumption and is robust to different choices of said distribution. The estimates are conservative because they allow reductions in approval time to operate through only one channel. In reality, a reduction in approval time would also incentivize new development, a channel we turn to in the next section.

Full response spectrum. The above exercises can be repeated for a range of approval time reductions, producing a spectrum of effects. This spectrum is shown in Figure 4 and gives a sense of the bounds of possibility through just pull-forward

[19] In unreported results, we verified that the estimated pull-forward effects are robust to different choices of the distribution of ν_i.

effect. If all approval times were reduced to zero (clearly not a possibility in real life), then our model suggests that housing production would increase by 40.1% due to the pull-forward effect. If approval times were reduced by 50%, housing production would have increased by 22.0% due to the pull-forward effect. The spectrum gives policymakers a sense of what reductions in approval time would be needed to achieve different rates of increased housing production. Overall, the results suggest that the pull-forward effect by itself is economically significant in magnitude and thus it is worthwhile for policymakers to target approval time reductions.

5 The Impact of Approval Time on Project Starts

Note: The work in this section is very preliminary. Please do not cite the results as they are subject to change.

We now turn to estimating the effect of approval times on project starts. Risk-averse developers experience high holding costs and opportunity costs due to delayed development. We therefore expect that reductions in both the expected value and the volatility of approval times would be associated with increased project starts.

To investigate this effect, we exploit variation in the mean and variance of approval times across time and across Los Angeles's 15 council districts. We run panel regressions of the number of projects in council district j started in time period t on the backward looking mean and volatility of approval times for projects in that district. Let n_{jt} be the log of the number of projects started in council district j between the dates of $t-h$ and $t+h$. Let μ_{jt} be the mean of log approval times for projects permitted in council district j between the dates of $t-2h$ and t. Let σ_{jt} be the standard deviation of log approval times for projects permitted in council district

j between the dates of $t - 2h$ and t.

We run regressions of the form:

$$n_{jt} = \theta_0 + \theta_1 \mu_{jt} + \theta_2 \sigma_{jt} + \delta_j + g(t) + \varepsilon_{jt} \tag{4}$$

θ_1 can be interpreted as the elasticity of project starts with respect to approval time, and θ_2 can be interpreted as the elasticity of project starts with respect to the volatility of approval time. Council district fixed effects, δ_j, capture baseline differences between the districts, and a flexible function of time, $g(t)$, allows for common time trends.

In our specification, we calculate n_{jt}, μ_{jt}, and σ_{jt} on a monthly basis, using the first of each month as the base time period. To ensure a large enough sample size to calculate mean and volatility, we use a bandwith of $h = 2$ years. Table 5 shows the results of regression (4). We show two specifications. In column 1, $g(t)$ is chosen to be a quadratic in time t. In column 2, $g(t)$ is captured using year fixed effects.

The results show that both mean and volatility in approval times are negatively correlated with project starts. Using specification 2, the results suggest that a 25% reduction in the expected value of approval times increases project starts by 6.15%, whereas a 25% reduction in the standard deviation of approval times increases project starts by 7.68%. If both the mean and the standard deviation of approval times are reduced by 25%, the model suggests that project starts would increase by 13.8%.[20] We call this effect the incentive effect because it operates through developers' decisions to start new projects in response to lower expected approval times and reduced uncertainty in approval times.

[20] Our estimates are slightly larger but on the same order of magnitude as those presented in Casey et al. (2022). Casey et al. used a financial model to estimate that reducing approval times in Los Angeles by 25% would result in 9.8% additional housing units becoming financially feasible for development.

Combined incentive and pull-forward effects. To combine the incentive effect with the pull-forward effect, we apply the incentive effect to the number of units started at any given point in time, assuming the distribution of project start times remains the same as in the data. With this assumption, the combined incentive and pull-forward effect can be calculated as $z = (1 + x)(1 + y) - 1$, where x is the percent gain in project starts due to the incentive effect and y is the percent gain in project completions due to the pull-forward effect. z is the percent gain in the number of units that would have been completed between January 2010 and November 2022.

Our estimated incentive effect to a total 25% reduction in approval time was 13.8% and our estimated pull-forward effect was 11.0%. We therefore estimate a combined effect of 26.3%. In other words, we estimate that if the mean and volatility of approval times were both reduced by 25%, then 26.3% additional units would have been completed between January 2010 and November 2022, relative to the baseline number of 71,532.

Figure 5 shows the full response spectrum for the combined pull-forward and incentive effects. The upper bound is that if approval times were to zero, housing production would have increased by 118% taking into account both the effect on project starts and the effect on project completions. If approval times were reduced by 50%, we estimate that housing production would have increased by 55.7%.

Discussion. Our estimates show that reductions in approval time can have a large effect on housing production. As a lower bound, we estimate that a 25% reduction in approval time would increase the rate of housing production by 11%, simply by pulling forward in time the completion of already started projects. When we additionally take into account the incentive effect, we estimate that a 25% reduction in approval time would increase the total rate of housing production by 26.3%.

We are agnostic as to whether or not a 25% reduction in approval time is a realistic objective for the City of Los Angeles. We leave that question to city officials and agency heads to figure out. We do note, however, that our estimated combined effect of 26.3% is a partial equilibrium estimate and therefore assumes a number of things that may not hold true in reality. We list some of the limitations of our counterfactual exercise below.

Behavioral response. The counterfactual exercise does not consider the behavioral response of development opponents. For example, even if the city was able to reform its processes so that approval times were reduced by 25%, opponents to development may find other means to extend, delay, or even cancel projects during the construction phase. We rule out such behavioral responses in our counterfactual simulations.

General equilibrium effects. The counterfactual exercise similarly does not account for second order general equilibrium effects operating through prices and resource allocations in the broader economy. If a reduction in approval times drastically increases the rate of housing production, this would cause an increase in the demand for skilled labor and construction materials. The increased demand would lead to higher prices for these input factors, which could offset some of the initial gains in incentivizing new development. Our simulations do not take into account these general equilibrium effects.

Macroeconomic environment. The counterfactual simulations use data on projects permitted between January 2010 and November 2022. These projects were started and developed under specific macroeconomic conditions that may not be reflected going forward. One major difference between the current macroeconomic environment and that of our historical data period is the substantial recent tightening of monetary policy leading to higher interest rates. As is well appreciated, real estate markets are highly sensitive to the cost of credit. Higher interest rates increase the time cost of money and make lengthy development times a greater barrier than if interest rates were low. In that sense, speeding up approval times is even more important in a high-rate environment than in a low-rate one. On the other hand, the supply of capital may be more constrained in a high-rate environment than a low-rate one. Thus, approval policy reforms implemented in the future may not have the same effects as they would have had if they had been implemented during our data period.

6 Conclusion

Using a unique dataset on the development timelines for all multifamily housing projects permitted in Los Angeles from 2010 to 2022, we were able to provide credible estimates of the effect of approval time on the rate of housing production. As a lower bound, we estimated that if approval times were reduced by 25%, the rate of housing production would increase by 11%, simply due to the pulling forward in time of projects that were already started. When we additionally account for the effect of incentivizing new development, we found that same 25% reduction in approval time would increase the rate of housing production by a full 26.3%.

Our paper provides robust and credible quantitative evidence that approval policy is a significant driver of the rate of housing production. The effect of approval policy was shown to be quite large, even when using a conservative estimate of just the pull-forward channel. Our paper adds to the evidence that local approval processes are a significant driver of housing supply and reinforces the notion that municipal regulatory reform is housing reform.

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Table 1: Summary of the Data - Project and Unit Counts

		All Projects	Market-Rate	Mixed-Income	100%-Affordable
# Projects	Total	2,677	1,681	701	295
	Completed	1,712	1,192	351	169
	Not Completed	965	489	350	126
# Dwelling Units	Total	120,213	70,272	36,269	13,672
	Completed	71,532	47,904	15,929	7,699
	Not Completed	48,681	22,368	20,340	5,973
# Market-Rate Units	Total	102,897	70,272	32,422	203
	Completed	62,493	47,904	14,449	140
	Not Completed	40,404	22,368	17,973	63
# Affordable Units	Total	17,316	0	3,847	13,469
	Completed	9,039	0	1,480	7,559
	Not Completed	8,277	0	2,367	5,910

Notes: Multi-family housing development projects issued a new building permit by DBS between January 2010 and November 2022. "Mixed-Income" refers to projects that include both market-rate and income-restricted units. "Complete" indicates that the project was issued a Certificate of Occupancy by November 28th 2022.

Table 2: Variable Names and Definitions

Variable Name	Definition
AT	Approval time in days
CT	Construction time in days
UNITS100	Number of units in project divided by 100
HEIGHT10	Project height in feet divided by 10
SQFT10K	Square footage of project divied by 10,000
MIXEDINCOME	Project is a mixed-income project
AFFORDABLE	Project is a 100%-affordable project
BY_RIGHT	Project did not require any entitlements
CPC	Project required review by City Planning Commission
CE	Project had a Categorical Exemption to CEQA requirements
MND	Project adopted a Negative Declaration or Mitigated Negative Declaration for CEQA
EIR	Project required Environmental Impact Report for CEQA
SPR	Project required Site Plan Review
SPP	Project required Specific Plan Permit Compliance
ZAA	Project required Area/Height/Yard/Bldg line adjustments
ZV	Project required a Zone Variance
CPIOC	Project required Community Plan Implementation Overlay Clearance
OVR	Project required Overlay Review
DB	Project requested Density Bonus
POWER_OH	Project required new overhead circuit installation
POWER_UG	Project required new underground circuit installation
CDX	Whether the project is in Council District X

Table 3: Selected Summary Statistics for Variables

	All Projects	Market-Rate	Mixed-Income	100%-Affordable
Approval Time (days)				
25th pctile	308	274	449	250
Median	524	469	735	491
Mean	652	588	838	577
75th pctile	872	769	1,100	818
Construction Time (days)				
25th pctile	574	534	659	622
Median	791	804	864	692
Mean	863	862	917	757
75th pctile	1,068	1,068	1,124	839
# Units, mean	44.9	41.8	51.7	46.3
Height (ft), mean	53.2	51.9	57.1	50.7
Square Footage, mean	49,811	49,820	53,326	41,405
By Right, mean	0.481	0.609	0.211	0.397
CPC, mean	0.066	0.036	0.098	0.156
CE, mean	0.272	0.199	0.459	0.241
MND, mean	0.168	0.124	0.264	0.193
EIR, mean	0.010	0.008	0.014	0.017
SPR, mean	0.112	0.079	0.163	0.186
SPP, mean	0.103	0.108	0.096	0.095
ZAA, mean	0.043	0.049	0.029	0.041
ZV, mean	0.037	0.046	0.014	0.034
CPIOC, mean	0.027	0.012	0.026	0.108
OVR, mean	0.020	0.024	0.013	0.010
DB, mean	0.163	0.036	0.422	0.271
POWER_OH, mean	0.271	0.231	0.358	0.292
POWER_UG, mean	0.365	0.286	0.536	0.407

Notes: Approval time is measured as the number of days from the date of the first seen entitlement or permit application to the date of permit issuance. Construction time is measured as the number of days from the date of permit issuance to the date of CofO issuance. Construction time is only measured for completed projects. Approval time is measured for all projects. All other variables are measured for all projects.

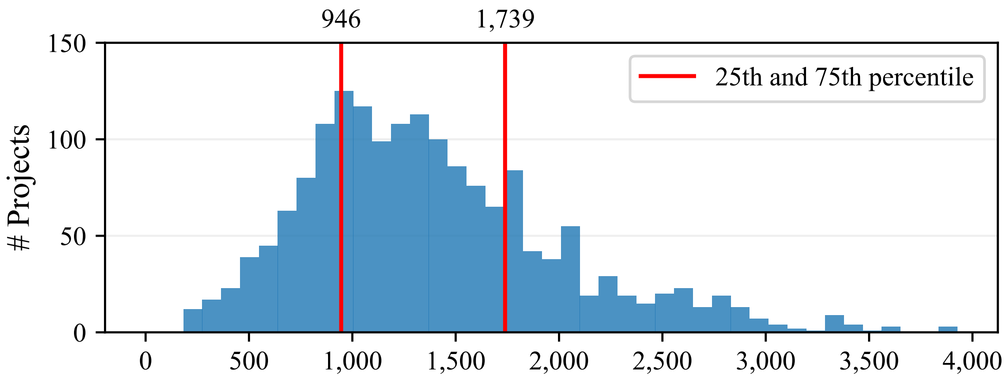
Table 4: Approval and Construction Time Model Coefficients

	AT	CT
UNITS100	-29.333	-84.513^{*}
	(24.496)	(49.798)
HEIGHT10	3.978^{*}	12.137^{***}
	(2.248)	(4.391)
SQFT10K	1.301	7.981^{*}
	(1.950)	(4.240)
AFFORDABLE	-106.183^{***}	-197.394^{***}
	(24.370)	(43.349)
MIXEDINCOME	101.500^{***}	42.589
	(19.790)	(35.920)
BY_RIGHT	-197.187^{***}	12.072
	(27.850)	(48.479)
CPC	192.589^{***}	124.885^{**}
	(36.169)	(61.694)
CE	-17.300	116.733^{***}
	(25.421)	(44.197)
MND	11.461	-72.193
	(29.350)	(48.040)
EIR	504.227^{***}	-75.983
	(85.306)	(141.370)
SPR	105.619^{***}	35.944
	(30.562)	(53.060)
SPP	125.525^{***}	-9.338
	(26.856)	(46.681)
ZAA	222.313^{***}	81.616
	(43.121)	(69.488)
ZV	84.277^{*}	157.718^{**}
	(46.821)	(75.233)
CPIOC	-77.401	530.381^{***}
	(48.929)	(138.028)
OVR	-5.876	393.497^{***}
	(54.528)	(102.124)
DB	63.089^{**}	-34.955
	(26.313)	(44.245)
POWER_OH	22.749	116.687^{***}
	(16.509)	(29.617)
POWER_UG	69.005^{***}	175.623^{***}
	(16.317)	(28.692)
Constant	676.691^{***}	966.533^{***}
	(41.982)	(73.038)
Council District FE	Y	Y
Scale Parameter	208.595	331.675
Observations	2,677	2,677
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 5: Regression of Project Starts on Mean and Volatility of Approval Time

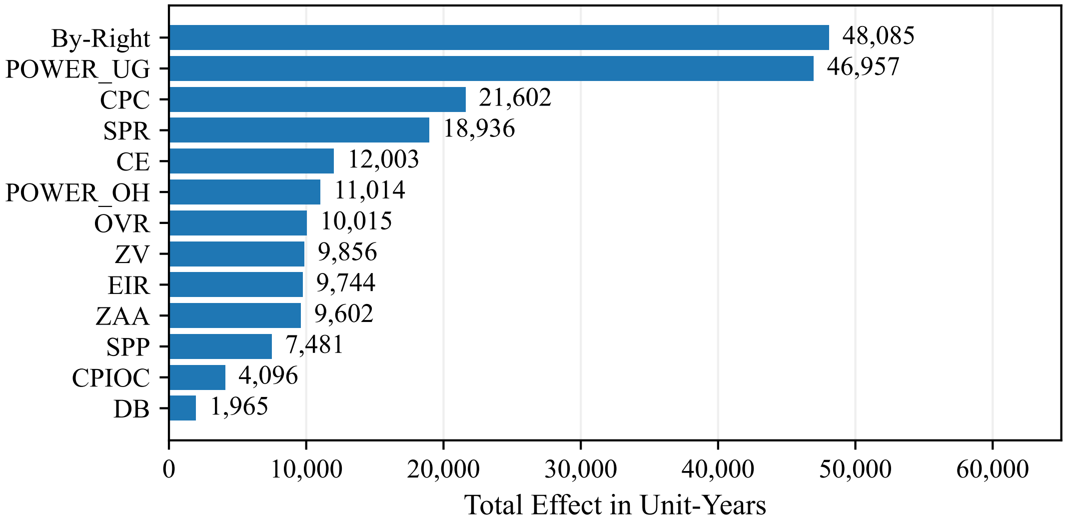
	Dependent variable:	
	log(Project Starts)	
	(1)	(2)
Mean of log(Approval Time)	-0.302^{***}	-0.246^{***}
	(0.047)	(0.047)
St.Dev of log(Approval Time)	-0.195^{***}	-0.307^{***}
	(0.064)	(0.061)
Council District FE	X	X
Quadratic Time Trend	X	
Year FE		X
Observations	1,440	1,440
R^2	0.853	0.855
Adjusted R^2	0.850	0.854
Residual Std. Error	0.233 (df = 1416)	0.231 (df = 1421)
F Statistic	356.187^{***} (df = 23; 1416)	466.948^{***} (df = 18; 1421)
Note:		*p<0.1; **p<0.05; ***p<0.01

Figure 2: Histogram of Development Time for Completed Projects (Days)



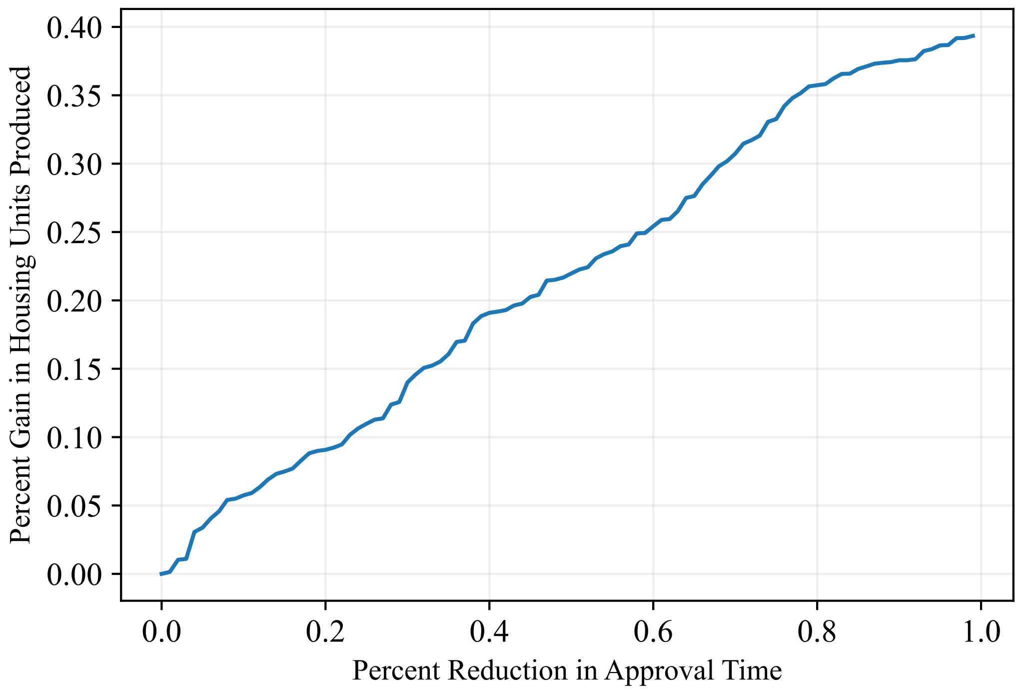
Note: Development time is measured as the number of days from the date of the first seen entitlement or permit application to the date the Certificate of Occupancy was issued.

Figure 3: Salience of Development-Related Factors



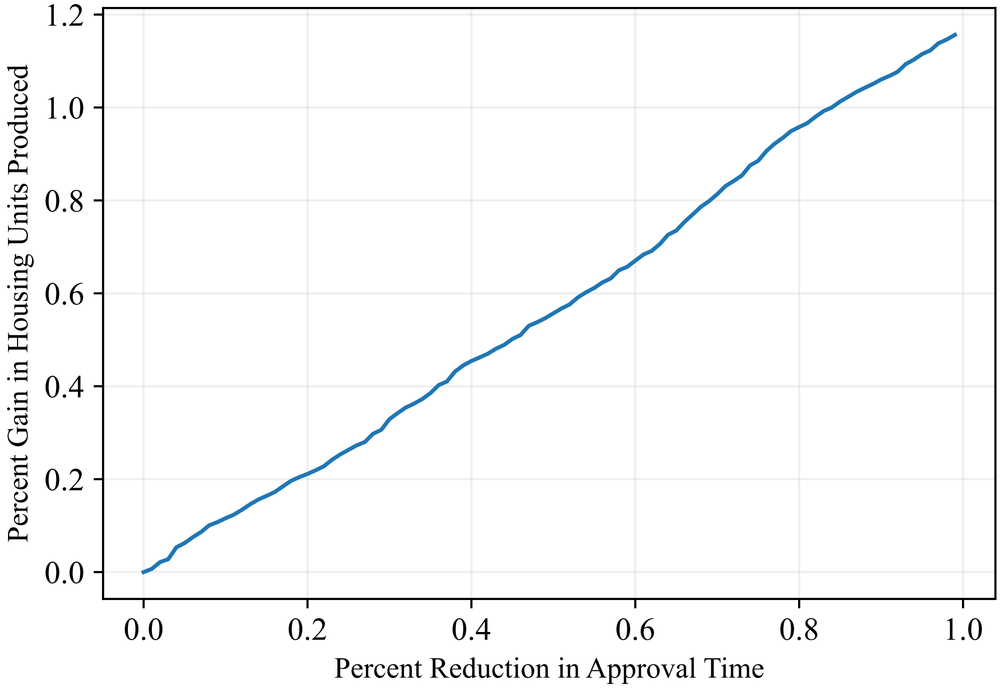
Source: Salience is measured in unit-years. It represents the number of dwelling units that would have been developed one year sooner if the marginal effect of the factor had been eliminated.

Figure 4: Pull-Forward Effects Due to Reductions in Approval Time



Note: This chart shows the number of additional units that would have been produced between January 2010 and November 2022, taking as given the projects that were started, if approval times had been reduced by X percent. The counterfactual only takes into account the effect of approval time reductions on project completions, i.e. the "pull-forward" effect.

Figure 5: Combined Incentive and Pull-Forward Effects Due to Reductions in Approval Time



Note: This chart shows the number of additional units that would have been produced between January 2010 and November 2022, if approval times had been reduced by X percent. The counterfactual takes into account both the effect on project completions (the "pull-forward" effect) and the effect on project starts (the "incentive" effect).