Federal Reserve Bank of Cleveland Working Paper Series

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Working Paper No. 24-14

June 2024

Suggested citation: Glancy, David, Robert Kurtzman, and Lara P. Loewenstein. 2024. "On Commercial Construction Activity's Long and Variable Lags." Working Paper No. 24-14. Federal Reserve Bank of Cleveland. https://doi.org/10.26509/frbc-wp-202414.

Federal Reserve Bank of Cleveland Working Paper Series
ISSN: 2573-7953

On Commercial Construction Activity's Long and Variable Lags*

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Federal Reserve Board Federal Reserve Board Federal Reserve Bank of Cleveland

June 18, 2024

Abstract

We use microdata on the phases of commercial construction projects to document three facts regarding time-to-plan lags: (1) plan times are long—about 1.5 years—and highly variable, (2) roughly 40 percent of projects are abandoned in planning, and (3) property price appreciation reduces the likelihood of abandonment. We construct a model with endogenous planning starts and abandonment that matches these facts. The model has the testable implication that supply is more elastic when there are more "shovel ready" projects available to advance to construction. We use local projections to validate that this prediction holds in the cross-section for US cities.

Keywords: commercial real estate, construction, time-to-plan

JEL Classification: R33, E22, E32, L74

*Thanks to the audiences at the Federal Reserve Board's R&S workshop and the Federal Reserve Bank of Cleveland brownbag series for their helpful comments and suggestions. The views expressed in this paper are solely those of the authors and do not necessarily reflect the opinions of the Federal Reserve Board, the Federal Reserve Bank of Cleveland, or the Federal Reserve System.

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1. INTRODUCTION

Commercial construction accounts for a sizable portion of private domestic investment (about 20 percent) and is an important driver of investment fluctuations.[1] It is also well known that commercial construction investment responds slowly to economic shocks (Edge, 2007), due in part to its long planning horizons (Millar et al., 2016). Indeed, Figure 1 demonstrates that commercial structure investment is more volatile and slower to respond to business cycle fluctuations than investment as a whole. A consequence of these planning lags is that economic conditions can change notably over the planning horizon and prompt developers to abandon projects before starting construction. Existing work on such effects is limited, due in part to difficulties measuring construction activity that does not occur.

In this paper, we use unique panel microdata on the phases of US commercial construction projects—including planning, construction, and abandonment or completion—to examine how planning lags affect construction dynamics. We present three stylized facts. First, commercial construction projects have long planning horizons. The average time spent in planning for projects that make it to construction is about 1.5 years, roughly similar to average construction times. Second, a significant number of projects in planning (around 40 percent on a value-weighted basis) are abandoned before beginning construction. Almost all abandonments happen during the planning stage: of the projects that make it to the construction phase, over 99 percent are completed. Third, whether projects advance from planning to construction is state dependent. Specifically, higher commercial property price growth at the onset of a project increases the probability of the project being completed.

We then present a tractable time-to-plan model of building production that matches these facts. In the model, developers optimally choose how much to invest in planning starts and whether to proceed with construction when planning is completed. Projects in planning are options to engage in construction that developers choose to exercise based on prevailing property values and building costs at the conclusion of planning. In addition to rationalizing the three stylized facts, the model also has an important implication for the supply of commercial buildings: the near-term response of construction activity to price appreciation depends on the availability of projects in planning. Price

[1] The source is the Bureau of Economic Analysis. The numerator is the sum of nonresidential and multifamily structures investment (FRED series B009RC1Q027SBEA and C292RC1Q027SBEA), while the denominator is FRED series GPDI. Note that nonresidential structures include structure types other than those in the microdata in this paper, such as manufacturing and power.

appreciation can affect construction activity by both stimulating planning starts and causing more projects in planning to advance to construction. Because planning starts are slow to translate into construction activity, this second channel is the main driver of short-term supply elasticities and is dependent on the availability of "shovel ready" projects that can immediately begin construction.

We test this model implication by empirically examining cross-sectional differences in the response of construction activity to price appreciation. Specifically, we use local projections to trace out the response of construction starts to commercial price appreciation for metropolitan statistical areas (MSAs) with different initial stocks of projects in planning.[2] We demonstrate that construction starts are increasing in price growth, and this response depends importantly on the stock of projects in planning, as predicted by the model. As further validation, we find similar results for employment growth for the sectors most engaged in commercial construction activity.

In the final part of the paper, we embed the model of commercial planning and construction into an otherwise standard DSGE model. Relative to the partial equilibrium model, the calibrated DSGE model allows us to quantitatively examine the model's dynamics and to account for the endogenous determination of property values and planning stocks. We show that endogenous abandonment speeds up the response of construction activity to shocks (compared to an equivalent model with exogenous abandonment). Additionally, we confirm the empirical finding that the elasticity of building supply depends on the availability of projects in planning. Overall, we find that though plan times are long, investment still responds quickly to shocks so long as there are projects already underway that are on the margin of advancing to construction.

The first contribution of this paper is to analyze cross-sectional determinants of building supply elasticities. Related work on this topic has mostly focused on residential housing, showing that regulatory (Mayer and Somerville, 2000; Glaeser et al., 2006) and geographic (Saiz, 2010; Baum-Snow and Han, 2024) constraints to development affect housing supply elasticities. We show that for commercial construction—which has longer planning horizons than residential—the availability of ongoing projects in planning affects supply elasticities more than land availability.

Our second contribution is to lay out new facts regarding the development process for commercial buildings. Again, existing work on the construction process mostly involves residential housing

[2]We construct the measures of price appreciation and construction starts relative to the building stock by property type and MSAs using a combination of data from CoStar, Real Capital Analytics (RCA), and CBRE SupplyTrack.

construction (see, for example, Glaeser et al. 2005, 2008). Regarding commercial construction, Millar et al. (2016) use similar data to examine the determinants of planning lags for completed projects, highlighting the role of regional differences in land use regulation. Del Boca et al. (2008) provide firm-level evidence that investment in structures is subject to longer time-to-plan and time-to-build effects than investment in equipment. We add to this work by demonstrating the important role abandonment plays in the process.

Finally, we contribute to the literature on time-to-build. In seminal work in this area, Kydland and Prescott (1982) lay out an investment technology that incorporates time-to-build and integrate it into a macroeconomic model, demonstrating the relevance of this technology for matching key business cycle facts. Christiano et al. (1996) extend the model to incorporate a planning phase—a period of less-resource-intensive investment—and discuss its role in explaining business cycle facts. More recent work builds on Majd and Pindyck (1987) to analyze how the option value of delaying investment (Oh and Yoon, 2020) or discount rate shocks (Fernandes and Rigato, 2023) affect build times. Additionally, contemporaneous work by Oh et al. (2024) shows that long development timelines in residential housing make the short-run housing supply inelastic and affect the business cycle properties of housing. We demonstrate that abandonment affects construction dynamics in time-to-build models; abandonment makes the short-run supply of commercial real estate more elastic as price changes affect new construction by altering abandonment decisions faster than they affect construction through the initiation of new projects.

The remainder of the paper proceeds as follows. In Section 2, we describe the data and establish the facts on commercial construction that we will use to discipline the model. In Section 3, we present a partial equilibrium model of the commercial construction process that can match these facts and derive how the short-term elasticity of building supply depends on the stock of projects in planning. In Section 4, we test this prediction and demonstrate that the responsiveness of construction activity to changes in prices is indeed a function of the planning stock. In Section 5, we embed the PE model from Section 3 in a calibrated DSGE model and examine its quantitative implications. In Section 6, we conclude.

2. FACTS ON COMMERCIAL BUILDING CONSTRUCTION

In this section, we first describe the data.[3] We then provide an overview of typical planning and construction timelines, including how often and under what circumstances projects are abandoned. Finally, we summarize the key stylized facts that will discipline the model.

2.1. Construction Phase Data and Other Data Details

The data from CBRE-EA/SupplyTrack rely on information collected from Dodge Data & Analytics (DD&A).[4] Construction starts from DD&A are used by the US Census as part of its methodology for estimating monthly construction spending.[5] Millar et al. (2016) document time-to-plan in this data set through 2010; our sample goes through the end of 2022.

The data include monthly information on the construction phase for each project, where the phases are: pre-planning, planning, final planning, bidding, underway, completed, deferred, and abandoned. According to CBRE, these phases are generally defined as follows. Planning stage projects have generally already hired an architect who has started to draw up plans. The first month of the under-construction phase (the start) occurs after a contract has been signed between a general contractor and the developer. At this point, permits would typically be secured and the project should break ground within the next six months. A project can be deferred indefinitely from any phase in the data. The data do not include information on the reason for the deferral, but possible reasons include going over budget, market conditions worsening, or financing being pulled. A final state for a project is either completed or abandoned. For our analysis, we group projects in pre-planning, planning, final planning, and bidding together.[6] We treat deferred projects as a separate category unless we state otherwise.

Along with the phases, the data include information on the property's type, its square footage, the

[3]Additional details on the data are available in Appendix A.

[4]These data are now available directly from DDA.

[5]Our data include data on construction starts along with the pre- and post-start phases for multifamily, hotel, office, retail, and warehouse properties. The monthly Census construction spending data provides estimates of all construction spending in the US, not just the property types considered in this paper. Note that the Census uses other data sources and methods as well. The methodology for the survey can be found at https://www.census.gov/construction/c30/methodology.html.

[6]Pre-planning projects have not yet hired an architect, but there has typically been some concept for the build that has been announced, while final planning projects are typically very close to approval for moving to construction. Bidding occurs after the plans are approved and the project is looking for a contract with a general contractor.

total cost of construction for the project (or an estimate for that spend for projects in planning or bidding), and detailed geographic information.

To examine commercial real estate supply elasticities, we also use information on commercial property price appreciation from CoStar. The data use CRE transactions to estimate price indexes at the property-type CBSA level. Since some of our outcomes (e.g., construction employment growth) are at the market level, we take the average price appreciation across property types, weighting by their respective building stock in the market. A few large cities have prices reported by metropolitan division; in these cases, we take the average price appreciation in an MSA, weighting by the building stock in each submarket.

2.2. *Project-level Summary Statistics*

In Table 1, we show information on the roughly 260,000 projects in our sample. The top panel presents information for the whole sample, while the lower panels disaggregate by property type.

We start by reporting information on time-to-plan (time from planning start to construction start), time-to-build (time from construction start to completion), and time-to-complete (time from planning start to construction completion).[7] The data show that plan times are roughly comparable to construction times. On a value-weighted basis, the average time in construction and in planning (for projects that make it to construction) are about 1.5 years each. These timelines tend to be longer for larger projects, causing the average time-to-plan and time-to-build to be a bit under a year each on an unweighted basis. Plan times are also much more variable than build times. The standard deviation of time-to-plan is about 16 months, compared with about 12 months for time-to-build on a value-weighted basis. Planning phases for projects that are ultimately abandoned (planning start to abandonment) are longer at a bit above two years, likely reflecting the option value of delays for projects whose economic viability is in question.

We have two further pieces of information on the project: its estimated cost and square footage. The median real project cost is about 3 million (2012) dollars and the median building size about 32,000 square feet, with the averages being higher (at about 13 million dollars and 107,000 square feet, respectively) due to the right-skewed nature of the distributions of project sizes and valuations.

Average plan times vary moderately across property types, largely reflecting differences in typical

[7] Here, we just collect all planning phases together into planning.

project sizes. Retail and warehouse properties have the shortest average planning horizons at 11 and 12 months, while hotel and multifamily properties have the longest at 18 and 19 months. Office properties have average plan times that are in the middle, with an average horizon of 15 months. The other broad patterns discussed for the full sample also hold across property types: the average construction time is always within 4 months of the average planning time, and the average plan time for abandoned projects is always longer than for those that advance to construction.

Figure 2 shows the share of plans that are abandoned by property type. For those projects that conclude by the end of the sample (i.e., either finish construction or get abandoned), 37 percent are abandoned (31 percent on an unweighted basis). Across property types, the abandonment rate ranges from 30 percent for warehouses to 50 percent for hotels. This result demonstrates that the initiation of a commercial construction project should not be viewed as an investment that will invariably add to the building stock (with some uncertain delay). Instead, entering the planning phase is an option that developers may choose to not exercise depending on what they learn about either the specific project or broader market conditions over the course of the planning period.

Figure 3 presents a decomposition of factors changing the stock of projects across time. The number of projects in planning in a given year is increased by the number of new plan starts and decreased by the number of projects that leave planning due to construction or abandonment. The figure shows that the number of projects fell notably during the financial crisis due to a contraction in planning starts (which fell by over half) and a rise in abandonments (which exceeded construction starts in 2009 and 2010). The planning stock then rose through most of the recovery due to a steady increase in planning starts before contracting during the COVID-19 pandemic as the rate of planning starts slowed.

2.3. Phase Transitions

Table 2 provides more detail on the dynamics with which projects advance through various phases of construction. Specifically, it shows a transition matrix where each cell (i, j) gives the probability that a project that starts in phase i in month t transitions to phase j in month $t+1$. The statistics pertain to the full sample of projects that start in 2004 or later. The statistics are unweighted, so they correspond with a probability that a particular project changes status. Consequently, the implied plan spells differ somewhat from the weighted summary statistics emphasized from Table 1.

The first row shows the transitions for projects that enter the period in the planning phase. About 93 percent of projects in planning in a given month remain in planning the following month. This implies that projects on average remain in the planning stage for over a year, about 15 months in expectation.[8] About 4 percent of projects in planning advance to under construction in the following month, with about 2 percent of projects in planning being deferred or abandoned each month.

The transition matrix shows that outcomes in the planning stage are uncertain; more than a third of projects exiting planning are deferred or abandoned instead of proceeding with construction. Construction outcomes are much more certain; only 0.1 percent of projects under construction are deferred the next month and next to none are abandoned. About 11 percent of projects transition from under construction per month, with almost all of those projects getting marked as completed. This implies a typical time-to-build of about 9 months, close to the unweighted average construction time in Table 1.

Deferred projects tend to remain deferred, though 1 percent of projects eventually return to planning, construction, or are eventually completed. That said, about 3 percent of deferred projects are abandoned, meaning that deferral is normally a precursor to abandonment.

2.4. Determinants of Project Abandonment

To study what causes projects to fail to advance to construction, we collapse the data to the project level and create an indicator for whether the project ever moves from planning to construction. We then look at how commercial property price appreciation over the first year of the project affects the likelihood of advancing to construction.

Specifically, we run the following linear regression:

$$\text{Ever Completed}_{i,m,t} = \beta \ln\left(\frac{\text{CPPI}_{m,t+1}}{\text{CPPI}_{m,t}}\right) + \gamma X_{i,m,t} + \varepsilon_i, \quad (1)$$

where Ever Completed_i is an indicator for whether project i is ever completed, $\ln(\frac{\text{CPPI}_{m,t+1}}{\text{CPPI}_{m,t}})$ is growth in CoStar's commercial property price index for the project's market m in the year following the start of planning t. X_i is a vector of project-level controls including the log of the building square footage and the real project cost, as well as MSA, property type, and year-quarter fixed effects.

[8] The expected time remaining in a given stage can be obtained by taking 1/(1-.932).

Standard errors are clustered by MSA.

The main object of interest is the relationship between price appreciation and the probability the project is ever completed. We see a positive and significant relationship in Table 3. In column (1), we see that a 10 percentage point increase in property prices at the onset of the plan start leads to a 5.7 percent increase in the probability that a project eventually advances to construction. In column (2) we add in the property type, MSA, and quarter fixed effects, which increases the estimated coefficient from 5.7 to 10.4 percent. In column (3) we add controls for project size and cost, which results in the estimate to rising to 11.8 percent. These results are consistent with advancement to construction (and conversely abandonment) varying with economic conditions.

2.5. A Summary of the Facts

Although the construction data contain an array of interesting patterns and information, we see the following facts as most relevant for disciplining a model where building a commercial building requires planning and construction.

- Projects spend about 1.5 years in planning before construction begins.
- Projects are frequently abandoned, typically during the planning phase.
  - About 60 percent of projects eventually advance to construction, while about 40 percent are abandoned.
  - 99 percent of projects under construction are completed.
- Abandonments vary with economic conditions.

3. PLANNING MODEL WITH ABANDONMENTS

Our goal is to build a model consistent with the facts outlined in Section 2.5.

In the model, time is discrete, labeled as $t = 0, 1, 2, \ldots$. There is a representative building producer who optimally decides how much to invest in planning and construction starts. For now, the builder takes as given a particular sequence of interest rates (r_t), rental rates of buildings (r_t^b), and costs of planning starts (ι_t). In Section 5, we will embed this section's model into a general equilibrium business cycle model, and these variables will be endogenously determined by households' consumption/savings decisions, the supply and demand for space, and planning stock adjustment costs, respectively.

The production of buildings is subject to two frictions. First, there is a stochastic time lag before building construction occurs. Specifically, firms can invest in planning projects, but only a share λ of these projects can advance to construction in a given period. When the planning horizon is completed, firms draw a cost $\kappa \sim F$ and can choose whether or not to pay κ to produce a unit of building. Firms choose the maximum amount they are willing to pay for a project κ_t^*, resulting in the construction of $\lambda P_{t-1} F(\kappa_t^*)$ buildings, where P_{t-1} is the planning stock chosen in the previous period. Projects with costs above this threshold are abandoned.

Second, firms face adjustment costs in starting projects. The cost of initiating a planning start at time t, denoted ι_t, is increasing in the amount of planning investment, denoted I_t^p. We assume these adjustment costs are external to the firm (reflecting factors such as the supply of permits rather than internal capacity constraints) and thus reflected in the cost of planning starts, which are taken as exogenous to the developer.

Consequently, the problem of the developer is as follows:

$$\max_{\{I_{t+s}^p, \kappa_{t+s}^*\}_{s=0}^{\infty}} \quad \mathbb{E}_t \sum_s \left(\prod_{i=0}^{s} \frac{1}{1+r_{t+i}} \right) \left(\underbrace{r_{t+s}^b B_{t+s-1}}_{\text{Rental Income}} \underbrace{- \iota_{t+s} I_{t+s}^p - \lambda P_{t+s-1} \int_0^{\kappa_{t+s}^*} \kappa dF(\kappa))}_{\text{Planning \& Construction Expenditure}} \right),$$

subject to the laws of motion for the planning and building stock:

$$\begin{aligned} P_{t+s} &= (1-\delta_p-\lambda) P_{t+s-1} + I_{t+s}^p \\ B_{t+s} &= (1-\delta_b) B_{t+s-1} + \underbrace{\lambda P_{t+s-1} F(\kappa_{t+s}^*)}_{I_{t+s}^b}, \end{aligned} \tag{2}$$

where δ_p and δ_b are the depreciation rates for the planning and building stock, respectively. This problem has the solution:

$$
\begin{aligned}
&\kappa_t^* = q_t^b \\
&q_t^b = \mathbb{E}_t \frac{1}{1+r_{t+1}} \left(r_{t+1}^b + (1-\delta_b) q_{t+1}^b \right) \\
&\iota_t(I_p^t) = q_t^p \\
&q_t^p = \mathbb{E}_t \frac{1}{1+r_{t+1}} \left(\lambda \int_0^{\kappa_{t+1}^*} (q_{t+1}^b - \kappa) dF(\kappa) + q_{t+1}^p (1-\delta_p - \lambda) \right),
\end{aligned} \tag{3}
$$

where q^p and q^b are the Lagrange multipliers on the planning and building accumulation constraints, reflecting the values of a unit of the planning and building stock.

The first line shows that developers proceed with construction when the cost of construction is less than q_t^b, which is defined in the second line to be the present discounted value of future rental income (i.e., the value of a unit of B_t). The third line says that developers will invest in planning starts until the value of a unit of the planning stock, q_t^p, is equal to the cost of a start. q_t^p is defined in the last row as the present discounted value of the surplus (building value net of construction costs) expected to be received when the planning stage ends.

With this model, we can obtain the following proposition. The first two items show that the model can match the key facts described in the previous section and the third is an additional testable implication regarding how construction activity responds to price shocks.

Proposition 1. *Given the model described in this section, we can obtain the following:*

(i) the average time-to-plan is $\frac{1}{\lambda}$,

(ii) share $1 - F(q_t^b)$ *of potential construction starts are abandoned, i.e., not all projects in planning go to construction and whether they do depends on property prices, and*

(iii) $\frac{\partial \frac{I_t^b}{B_{t-1}}}{\partial q_t^b} = \lambda \frac{P_{t-1}}{B_{t-1}} f(q_t^b)$, *i.e., the response of construction investment to price appreciation depends on the planning stock.*

Proof. (i) follows immediately from the fact that projects complete planning with constant hazard

λ.[9]

(ii) comes from the fact that $\kappa > q_t^b$. That is, the probability of abandonment is the probability that the realized construction cost exceeds the value of a new building. When buildings are more valuable, this probability necessarily falls.

(iii) comes from normalizing the expression $I_t^b = \lambda P_{t-1} F(q_t^b)$ by the initial building stock and then differentiating the expression with respect to q_t^b . □

From (i), we see that we can calibrate to any time-to-plan by setting the appropriate hazard of completing planning. From (ii), we see that the model incorporates abandonments *and* that they are state dependent (depending on property values). Also note that since construction is instantaneous, over 99 percent of projects (100 percent in this case) will advance from construction to being a building. In turn, we can match the facts described in Section 2.5.

In the next section, we will take the testable implication described above in (iii) to the data.

4. MODEL VALIDATION USING LOCAL PROJECTIONS

This section tests the proposition that the response of construction investment to price appreciation depends on the initial stock of projects in planning. We first outline the methodology, then describe the data used, and lastly present the results.

4.1. Methodology

The goal is to test whether the response of construction activity to commercial price appreciation depends on the availability of projects in planning, as was implied by item (iii) of Proposition 1. The planning stock is measured by the ratio of the number of projects in planning to the number of commercial buildings in the market at the time (Plan Rate$_{i,t-1}$). Because construction occurs slowly over time, we look at the cumulative effects on construction starts using local projections. The dependent variable is either cumulative construction starts (as a fraction of the initial building stock) or MSA-level construction employment growth. We measure price appreciation with the CoStar price indexes (described in Section 2), and we measure the stock of projects in planning as the ratio of the number of projects currently in planning to the number of buildings in the MSA.

[9] $\frac{1}{\lambda}$ is the expected value of an exponentially distributed random variable.

Specifically, we estimate the equation:

$$\frac{\text{Construction Starts}_{i,t,t+h}}{\text{Building Stock}_{i,t}} = \beta^h \Delta \ln(\text{Comrcl. Price Index}_{i,t})$$
$$+ \delta^h \Delta \ln(\text{Comrcl. Price Index}_{i,t}) \times \text{Plan. Rate}_{i,t-1}$$
$$+ \gamma^h X_{i,t} + \eta_i^h + \tau_t^h + \varepsilon_{i,t}^h,$$

where $\{\beta^h\}$ traces out the estimated cumulative construction response for an MSA with no projects in planning at time $t-1$, and $\{\delta^h\}$ traces out how much more responsive MSAs with a higher initial planning stock are. η_i^h and τ_t^h are MSA and quarter fixed effects. The vector of controls $X_{i,t}$ includes the Plan Rate and the under construction rate (ratio of projects under construction to the initial building stock) in MSA i at time t, lagged price appreciation, an indicator for whether the MSA has an average time-to-plan of less than a year, the logarithm of commercial construction employment, the Saiz elasticity, and four lags of all independent variables.[10] Standard errors are two-way clustered by MSA and year-quarter t.

4.2. Data Details

We use the planning and construction start data from CBRE-EA SupplyTrack, aggregated to the MSA level to construct our planning stock and construction start measures.

We also use data from CoStar Suite (US) and Real Capital Analytics to construct building stock measures. Specifically, CoStar has estimates of the stock of buildings by property type and CBSA, but the data for most markets begin in 2008. RCA provides information on transactions back to 2001 but only above a $2.5 million threshold. We use information on the cumulative number of properties in RCA constructed over time to impute the building stock before 2008.[11] Last, we use information from the Quarterly Census of Employment and Wages to obtain information on employment growth

[10] For details on the Saiz elasticity, see Saiz (2010). The data were downloaded from the Urban Economics Lab.

[11] Specifically, we regress the logarithm of the CBRE property stock in a given quarter on the logarithm of the number and value of properties in RCA built as of that time and CBSA fixed effects. We use the prediction from this regression to measure the building stock. In essence, this procedure takes the building stock from CBRE and imputes the stock before 2008 by removing properties built between that quarter and the start of CBRE reporting. The regression has an R^2 of 99.99 and a within-R^2 of 75, meaning the regression estimates are indistinguishable from the observed property stock and the RCA variables successfully capture changes in the property stock over time.

for the industries most related to commercial construction.[12] Though our construction data are monthly, we consider changes at a quarterly frequency to match the frequency of the employment data.

The left panel of Figure 4 shows quartiles (across MSAs) of the plan rate over time. The plan rate in a market measures the growth in the building stock that could be achieved if all projects in planning advance to construction. There is significant heterogeneity over time and across markets; the median plan rate rose from under 0.5 percent in the aftermath of the financial crisis to over 1.5 percent in 2022. The plan rate was depressed across most markets after the financial crisis, with a 25th percentile plan rate just under 0.5 and a 75th percentile only slightly above 0.5, but became more dispersed after the recovery. By 2022, the 25th and 75th percentile plan rates were around 0.5 and 1.75 percent, respectively. The right panel provides more detail on this dispersion; it plots kernel densities for the plan rate in 2011 and then in 2019. We see that in 2011, in the aftermath of the GFC—a time when many plans had been abandoned—the distribution is concentrated between 0 and 1 percent. In 2019, after a long business cycle expansion, the distribution shifts to the right and becomes more dispersed, with significant mass in the 1 to 2 percent range. Altogether, this figure demonstrates that there is significant spatial and temporal variation in the planning rate.

4.3. Local Projection Results

What do these differences in projects in planning mean for construction activity? If projects in planning mechanically advance to construction and completion, these projects in planning will measure future additions to supply. To the extent that these projects are options, these projects in planning affect the *elasticity* of building supply, as they will add to the building stock if commercial property prices warrant it.

We present the cumulative response of construction starts relative to the building stock (columns 1-3) and employment growth (columns 4-6) over the first three years following a change in commercial property prices in Table 4. We also present figures that show the cumulative effects over time for construction starts relative to the building stock and employment growth in commercial construction, in Figures 5 and 6, respectively. Though these figures show the response to price appreciation (left

[12] We aggregate employment from NAICS codes 5413 (architects, engineering, and related services), 2362 (commercial construction), 236116 (multifamily construction), along with all 6-digit codes pertaining to commercial construction contractors (238112, 238122, . . . , 238912, 238992).

panels) and then the interaction of the planning rate with price appreciation (right panels) and how it grows with time, it is useful to focus on the results in the table when assessing the economic magnitudes of the effects.

In the table, the main coefficients of interest are those on price growth (column 1) and price growth interacted with the planning rate (column 2). In column 1, we see that for each percentage point of price growth, we get about a 3.5 basis point increase in construction starts as a share of the building stock. As projects under construction are essentially always completed, this would also mean a 3.5 basis point increase in the building stock once construction was completed. That is, the coefficient estimate can be thought of as a measure of the short-term elasticity of building supply. A more natural way of interpreting this effect is that it implies that you need about 30 percent higher appreciation to increase construction starts by 1 percent of the building stock.

In column 2, we interact the planning rate with the price growth measure and find a coefficient estimate of about 2.5 (which is significant at the 1 percent level). As the standard deviation of the planning rate is about 0.5, this means that a one standard deviation increase in the plan rate raises the supply elasticity about 1.25 basis points.

In the third column, we add additional controls: the ratio of projects under construction to the building stock (reflecting previous construction starts), an indicator for whether the region has an average plan time under a year, the Saiz elasticity in the region (measuring geographic constraints to supply), and the size of the market in terms of year 2000 employment. For each control, we also include as controls their interactions with price appreciation. The coefficient on the interaction of interest rises somewhat to 3 with the inclusion of these additional controls. Regarding the other coefficients on the controls, larger markets respond more to price appreciation, but planning speed, the share of projects under construction, and geographic constraints to housing supply are insignificant or only marginally significant.

The next three columns repeat this exercise for commercial construction employment growth. The economic effects are directionally similar. The coefficient of 3.4 on price growth in column 4 implies that a 10 percent commercial price appreciation increases commercial construction employment about 3.4 basis points over the course of the following three years. In column 5, the interaction of price growth and the planning stock is still significant at the 1 percent level but is proportionally weaker. While a one standard deviation higher plan rate raised the elasticity for construction activity 1.25 basis points (relative to an overall elasticity of 5 basis points), it raises the elasticity for construction employment 0.5 basis points (relative to an overall elasticity of 3.4 basis points). The effect falls further once more controls are added in column 6. One explanation for this result is that, while the initial plan rate might matter for construction activity, it might matter less for construction-related employment because such employment also covers planning-related activities. In other words, even if a dearth of "shovel ready" projects restricts the near-term response of construction starts, developers might expand employment as they begin the process of initiating planning starts.

Regarding the timing involved in these effects, Figures 5 and 6 show the response of construction starts and construction employment growth to commercial price appreciation over time. The left panels plot estimates of β^h from the specification without the interaction term (reflecting the average elasticity with respect to price appreciation), and the right panels plot estimates of δ^h, reflecting how much this elasticity varies with the plan rate. Figure 5 shows that cumulative construction activity rises fairly linearly over the five years following price appreciation. As shown in Table 4, the elasticity is around 3.5 basis points three years out and this rises to about 6 basis points five years out. The effect does not appear to be leveling off, but we have limited ability to extend the estimation beyond this horizon due to the relatively short sample panel.

The right panel of Figure 5 shows that the effect of having more projects in planning rises fairly linearly for about two and a half years and then levels off, declining modestly, after that. The figure indicates that the availability of projects in planning matters most at short horizons. After three years, the initial planning stock no longer affects marginal construction starts and there might be some catch-up for regions that had lower initial planning stocks. This timeline is consistent with projects typically having a plan horizon of a few years; after these first few years, there is time for projects to be newly initiated and go to construction, making the initial planning stock of less importance to construction activity.

The effects on construction employment in Figure 6 display less time variation. The steady rise in construction starts shown in Figure 5 requires a steady flow of construction labor. Therefore, construction employment jumps immediately following the price appreciation and remains elevated over the following five years. The jump in employment is initially most pronounced in areas with a high initial plan rate, but the difference starts to revert after a couple of years as construction activity in low plan regions catches up.

Altogether, we see that the local projection exercises presented in this section validate the prediction of the model that the level of the planning stock matters for the short-term elasticity of building supply.

5. QUANTITATIVE MODEL AND RESULTS

In the previous section, we validated the dynamics of the model presented in Section 3. In this section, we provide some insights into the quantitative implications of the model. We do so through the lens of a real business cycle model that incorporates the non-standard elements of the model in Section 3.

First, we describe the DSGE model. Second, we outline how we calibrate the model. Third, we perform an experiment that shows how differences in the plan stock affect the elasticity of building supply, demonstrating that the calibrated DSGE model generates the dynamics of the local projections. Last, we discuss the role of endogenous (relative to exogenous) abandonment in the model.

5.1. DSGE Model

The model has the following agents: households, capital producers, building producers (whose problem was defined in Section 3), final goods producers, and a government. Although most of the problem outside of building production is standard, we review their problems in that order for completeness.

5.1.1. Households

At time t, a representative household maximizes lifetime utility—which is assumed to be separable and isoelastic—over consumption (of the final good), C_t, and its labor supplied, L_t:

$$\mathbb{E}_t \sum_s \beta^s \left(\frac{C_{t+s}^{1-\gamma}}{1-\gamma} - \frac{\omega}{1+\nu} L_{t+s}^{1+\nu} \right),$$

where $\omega > 0$, $\nu > 0$, and $\gamma > 0$. The household maximizes utility subject to a budget constraint:

$$D_{t+s}^h + C_{t+s} = (1+r_{t+s})D_{t+s-1}^h + w_{t+s}L_{t+s} + \Pi_t - T_t, \tag{4}$$

where D_t^h is government debt held by households at time t; r_t is the one-period real return on government debt; w_t is the real wage they are paid for their labor; Π_t are any net profits returned by firms—developers, capital producers, and final goods producers—which households wholly own; and T_t are net taxes paid to the government.

The solution to the household problem thus implies standard labor-income and Euler equations:

$$w_t - \omega C_t^{\gamma} L_t^{\nu} = 0$$
$$C_t^{-\gamma} - \beta \mathbb{E}_t C_{t+1}^{-\gamma}(1 + r_{t+1}) = 0.$$

5.1.2. Capital Producer Problem

Capital depreciates at rate δ_k and is rented to firms at rental rate r_t^k. There is thus a representative capital producer that solves the following problem:

$$\max \quad \mathbb{E}_t \sum_s \left(\prod_{i=0}^{s} \frac{1}{1 + r_{t+i}}\right)(r_{t+s}^k K_{t+s-1} - I_{t+s}^k),$$

subject to the capital accumulation equation:

$$K_{t+s} = (1 - \delta_k) K_{t+s-1} + I_{t+s}^k. \tag{5}$$

Given there are no adjustment costs to capital investment, the first-order condition (FOC) from the capital producer's problem implies the standard rental rate of capital:

$$r_t^k = r_t + \delta_k. \tag{6}$$

5.1.3. Final Good Sector

A continuum of competitive firms produce output Y_t by hiring labor L_t at wage w_t and renting capital and buildings, K_{t-1} and B_{t-1}, respectively, with technology:[13]

$$Y_t = Z_t K_{t-1}^{\alpha} B_{t-1}^{\eta} L_t^{1-\alpha-\eta}, \tag{7}$$

where Z_t is firm productivity, $\alpha \in (0,1)$, and $\eta \in (0, 1-\alpha)$. As in Section 3, buildings are constructed with a separate investment process from capital.

Firms choose the amount of labor to use in production and the amount capital and buildings to rent in order to maximize profits (which are zero in equilibrium):

$$\mathbb{E}_t \sum_s \left(\prod_{i=0}^{s} \frac{1}{1+r_{t+i}}\right)\left(Y_{t+s} - w_{t+s}L_{t+s} - r^k_{t+s}K_{t+s-1} - r^b_{t+s}B_{t+s-1}\right).$$

We thus obtain the following FOCs:

$$\begin{aligned} w_t &= (1-\alpha-\eta) Z_t K_{t-1}^{\alpha} B_{t-1}^{\eta} L_t^{-\alpha-\eta} \\ r^k_t &= \alpha Z_t K_{t-1}^{\alpha-1} B_{t-1}^{\eta} L_t^{1-\alpha-\eta} \\ r^b_t &= \eta Z_t K_{t-1}^{\alpha} B_{t-1}^{\eta-1} L_t^{1-\alpha-\eta}. \end{aligned} \tag{8}$$

5.1.4. Government, Clearing, and Equilibrium

The government comes into the period with a level of debt D_t, which is all held by households. Government spending, G_t, is exogenously specified and is financed with taxes and new debt issuance. The government thus faces budget constraint:[14]

$$D_t(1+r_t) + G_t = D_{t+1} + T_t. \tag{9}$$

[13]We follow the convention that variables are dated as of when they are determined. Buildings and capital used at time t are chosen at time $t-1$.

[14]We make the standard assumption of non-explosive government debt.

Government debt issuance is equal to household bond holdings such that:

$$D_t = D_t^h. \tag{10}$$

Given a sequence of productivities and government policies ($\{Z_{t+s}, G_{t+s}, T_{t+s}\}_s$) and a set of initial conditions (B_t, P_t, K_t, D_t), a competitive equilibrium is a sequence of prices $\{r_{t+s}, r^k_{t+s}, r^b_{t+s}, w_{t+s}\}_s$ and quantities $\{C_{t+s}, L_{t+s}, Y_{t+s}, K_{t+s}, B_{t+s}, P_{t+s}, \Pi_{t+s}, D_{t+s}, D^h_{t+s}\}_s$ such that households and the producers of capital buildings and final goods all solve their respective maximization problems, households' labor supplied equals firm labor demanded, capital and buildings supplied by capital and building producers are equal to capital and buildings demanded, respectively, building and capital accumulation follow equations (2) and (5), and bond markets clear following equation (10).[15]

5.2. Calibration

We present the calibrations for the model parameters in Table 5. The table's parameters are grouped first by the standard macro parameters and then by the novel construction-related parameters.

We calibrate the relative utility weight on labor, ω, and productivity in the steady state, Z, so that aggregate labor supply, L, and aggregate output, Y, are normalized to 1, leading to values of 0.91 and 0.49, respectively. We set government spending, taxes, and government debt to zero. For most of the other standard macro parameters, we follow Gertler and Karadi (2013). Specifically, following their work, we calibrate β to hit a 2 percent interest rate, leading to a value of 0.995 (quarterly), the inverse Frisch elasticity, ν, to 0.276 (which implies a Frisch elasticity of about 3.6), and the capital depreciation rate, δ_k, to 0.025. We set the relative risk aversion parameter, γ, to 1 following Chetty (2006).

Given that we introduce buildings as a second capital input into production, we set the sum of α and η so that the capital share of income (inclusive of both K and B) is the standard value of 1/3. We set the relative income shares to match the estimate from Ghent et al. (2019) that real estate is about 30 percent of a firm's book assets (i.e., we set these variables to satisfy $\frac{q^b B}{K} = \frac{3}{7}$); this condition gives

[15] We write all budget constraints as binding, but if these were written as inequalities, they would also need to hold in equilibrium.

us that $\alpha = 0.287$ and $\eta = 0.046$.[16]

The other key building and planning parameters are calibrated as follows. We set the hazard from planning to construction, λ, to 0.167 to have a six-quarter average time-to-plan. We set the building depreciation rate, δ_b, to be 0.0062 to match the annual depreciation rate for office buildings used in the national income and product accounts (NIPAs).[17] δ_p is not separately identified from λ and the parameters pertaining to the distribution of construction costs, so we just set it to the same value as δ_k.[18]

We assume the following functional form for the costs to planning starts: $\iota_t = \iota + \frac{1}{\phi}(\frac{P_t - P_{t-1}}{P_{t-1}})$. This specification implies that costs are quadratic in the number of starts, with ι measuring the steady-state cost of a plan start and ϕ the elasticity of starts with respect to q^p.[19] We set ι to normalize q^b to 1 and set ϕ to 1. ϕ does not affect the steady state but affects how quickly the planning stock responds to shocks. This ϕ implies that a 50 percent reduction in P would have a half-life of six years, which is roughly consistent with the post-GFC recovery shown in Figure 4.

We take the distribution for construction costs to be Pareto distributed: $F(\kappa) = 1 - (\frac{s}{\kappa})^a$, where s is the minimum possible cost of construction and $a > 1$ determines how much mass is around this minimum. This makes the probability of abandonment $1 - F(q_b) = (\frac{s}{q_b})^a$ and the expected construction expenditure (if construction goes ahead) equal to $s^a \frac{a}{1-a}(q^{1-a} - s^{1-a})$. We calibrate s and a so that the probability of abandonment is 37 percent (matching the value-weighted abandonment share in Figure 2) and construction costs are 85 percent of building values.[20]

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[16] See Figure 3 in Ghent et al. (2019).

[17] The annual depreciation rate for office buildings is 0.0247, which is around the middle of the range of depreciation estimates for private nonresidential structures. See https://apps.bea.gov/national/pdf/BEA_depreciation_rates.pdf.

[18] A higher depreciation rate is equivalent to having a combination of a higher λ, but also an increase in the probability that draws are unfavorable.

[19] The first-order condition that $q_p = \iota_t$, combined with the planning accumulation equation, implies that $I_t^p = P_{t-1}(\phi(q^p - \iota) + \lambda + \delta_p)$.

[20] We assume that "soft costs" as a share of building value are similar to those in the NAIOP's report on the economic impacts of commercial real estate investment. The NAIOP estimates that in 2018 developers incurred 31.71 billion dollars in soft costs relative to total expenditure of 207.77 billion dollars. See Table 2 here: https://www.naiop.org/globalassets/research-and-publications/report/economic-impacts-of-commercial-real-estate-2019-edition/researchreportnaiop-2019-fuller-report-online-version.pdf.

5.3. Building Supply Elasticities and the Planning Stock

We now present the quantitative results from the model. In Section 4, we showed that construction responds more to commercial price appreciation in localities with a greater stock of projects in planning. We now demonstrate equivalent dynamics in the calibrated model.

Figure 7 plots the response of construction to a 1 percent TFP shock that decays at a rate of 20 percent per quarter in two economies differing only in their initial levels of planning stock. The orange line shows the effect of the shock in a market starting at the steady state, whereas the blue line shows the response for an economy starting at only half of the steady-state level of P.[21] The 1 percent TFP shock initially raises building production by about a quarter of a percentage point in the steady state, but only by about half this amount for the low planning economy.[22] The effect of the TFP shock on construction then grows over time as developers start to build up the planning stock, resulting in more construction starts over time. However, this process is delayed for the economy with a low planning stock; construction activity does not peak until six years after the shock (compared with four years under the steady-state initial conditions).

Since TFP shocks drive changes in both building values and construction activity, we can also present these impulses along the lines presented in Figure 8. In Figure 8, we plot the cumulative response of building construction as a share of the building stock, $\left(\sum_{i=0}^{s}\left(I^b_{t+i}(\{Z'\}) - I^b_{t+i}(\{Z\})\right)\right)/B$, normalized by the price appreciation caused by the shock, $\left(q^b_t - q^b\right)/q_b$. The left panel plots the cumulative elasticity of construction starts with respect to price appreciation for the low-plan-rate and steady-state economies, while the right panel plots the difference in elasticities.

The effects of the shocks are qualitatively similar to the local projection estimates displayed in Figure 5. The cumulative effect of the price shock rises steadily over time, as in the data, with the effect starting to level off after about six years.[23] The rise in construction is slower for the economy with the lower initial planning stock, but the difference levels off after about five years. Altogether,

[21] Since the economy with a low P would have transitional dynamics even absent the shock, the effect of the shock is $\left(I^b_{t+s}(\{Z'\}; P_t = .5P) - I^b_{t+s}(\{Z\}; P_t = .5P)\right)/I^b$, where $I^b_{t+s}(\{Z'\}; P_t)$ and $I^b_{t+s}(\{Z\}; P_t)$ are construction levels that would occur with and without the shock, and I^b and P are steady-state building investment and plan levels.

[22] The increase in the probability that a project advances to construction is roughly similar in both economies, so the difference is that the low planning economy has only half as many planning projects available to advance.

[23] We cannot compute similar estimates of longer horizons in the data, as we have a short time series and thus quickly lose degrees of freedom.

the calibrated model is broadly consistent with the patterns in the local projections, though the model estimates supply as more elastic; in the data, construction rises 3.5 basis points (relative to the building stock) over the three years following a 1 percent price shock, whereas in the model the increase is about 10 times this effect.[24]

5.4. *Endogenous vs. Exogenous Abandonments*

For our final exercise, we analyze the role endogenous abandonment plays in the model. In Figure 9, we present impulses of construction in response to a 1 percent TFP shock in the baseline calibrated model and an alternative model without endogenous abandonment. In this alternative model, there is just a fixed probability that projects completing planning are abandoned and a fixed cost to undertaking construction. We set this abandonment probability and construction cost equal to the steady-state abandonment probability and (average) construction cost so that the steady states of the two models are identical.[25]

The main takeaway from this exercise is that endogenous abandonment speeds up the response of construction to demand shocks. In the exogenous abandonment model, there is no mechanism to increase construction immediately: construction is just a constant share (the hazard of completion multiplied by the exogenous probability of construction) of the predetermined planning stock. This means that construction only rises because of the initiation of new projects in planning, which eventually translate into new construction. In contrast, with endogenous abandonment, construction rises immediately because of a reduction in the number of projects in planning being abandoned.

[24]There are a couple of factors that might contribute to this difference in elasticities outside of model misspecification. First, empirical estimates of the supply elasticity would be biased downward to the extent that price changes reflect supply shocks (movements along the demand curve). Second, price appreciation is measured with error since the CRE market is illiquid enough that the price index is based on appraisals rather than transactions.

[25]This exogenous abandonment model can be thought of in terms of the baseline model but with a discrete distribution of construction costs: the cost is arbitrarily high with the probability of abandonment and equal to the average cost of construction otherwise. The important difference between the models is thus whether or not there are projects that are at the margin of being abandoned.

6. CONCLUSION

The planning phase for commercial construction is long. Using microdata on the phases of development for CRE construction projects, we show that a significant share of projects are ultimately abandoned and that most abandonments occur during the planning phase and vary with economic conditions. Incorporating these dynamics into a time-to-plan model implies that the response of construction activity to price appreciation depends on the stock of projects in planning. Using a local projections methodology, we find that this relationship also holds in the data. This model validation motivates us to solve a business cycle model with these time-to-plan and abandonment dynamics. In aggregate, endogenous abandonment speeds up the response of activity to shocks. The calibrated model also naturally creates “pushing on a string” effects, as construction activity is more difficult to stimulate in a weak environment due to a dearth of projects in planning.

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All Projects	Weighted			Unweighted			
	Mean	Std	p50	Mean	Std	p50	N
Planning Start to Construction Start (months)	16.7	15.9	12	10.7	11.7	7	152573
Construction Start to Completion (months)	17.5	12.0	15	8.8	6.5	7	149552
Planning Start to Abandonment (months)	26.2	21.2	21	23.6	20.2	18	43407
Planning Start to Completion (months)	32.7	20.5	28	19.1	14.2	15	146482
Project Construction Value (millions of 2012 USD)				12.6	60.7	3	260195
Building Area (1000s of Sq. Ft.)				107.4	985.8	32	260195
Hotel	Weighted			Unweighted			
	Mean	Std	p50	Mean	Std	p50	N
Planning Start to Construction Start (months)	17.6	16.1	13	12.6	12.3	9	7896
Construction Start to Completion (months)	20.3	10.8	19	13.1	7.6	12	7581
Planning Start to Abandonment (months)	23.1	18.9	18	24.4	19.6	19	2662
Planning Start to Completion (months)	36.9	20.5	32	25.2	14.8	21	7303
Project Construction Value (millions of 2012 USD)				22.0	89.4	8	15132
Building Area (1000s of Sq. Ft.)				146.8	540.6	67	15132
Office	Weighted			Unweighted			
	Mean	Std	p50	Mean	Std	p50	N
Planning Start to Construction Start (months)	15.3	14.4	11	8.7	10.0	6	29280
Construction Start to Completion (months)	19.3	12.6	17	8.3	5.2	8	29407
Planning Start to Abandonment (months)	26.6	21.5	20	22.2	20.0	16	7998
Planning Start to Completion (months)	33.4	20.4	29	17.1	12.1	13	28837
Project Construction Value (millions of 2012 USD)				12.9	81.7	2	47992
Building Area (1000s of Sq. Ft.)				71.7	297.4	18	47992
Retail	Weighted			Unweighted			
	Mean	Std	p50	Mean	Std	p50	N
Planning Start to Construction Start (months)	10.7	12.6	6	7.6	8.8	5	49520
Construction Start to Completion (months)	8.6	6.8	7	5.6	3.0	6	49913
Planning Start to Abandonment (months)	26.5	22.0	20	24.6	22.0	18	13517
Planning Start to Completion (months)	19.1	15.3	14	13.4	9.9	10	49469
Project Construction Value (millions of 2012 USD)				4.2	39.1	1	77972
Building Area (1000s of Sq. Ft.)				44.5	334.2	12	77972
Warehouse	Weighted			Unweighted			
	Mean	Std	p50	Mean	Std	p50	N
Planning Start to Construction Start (months)	12.2	13.3	8	9.1	10.4	6	17790
Construction Start to Completion (months)	9.0	6.3	8	5.5	3.7	5	17604
Planning Start to Abandonment (months)	25.6	22.5	21	23.4	19.4	18	6371
Planning Start to Completion (months)	20.8	15.4	17	14.7	11.9	11	17422
Project Construction Value (millions of 2012 USD)				10.9	36.2	3	33163
Building Area (1000s of Sq. Ft.)				152.9	463.1	45	33163
Multifamily	Weighted			Unweighted			
	Mean	Std	p50	Mean	Std	p50	N
Planning Start to Construction Start (months)	19.2	16.9	15	15.3	13.9	12	48087
Construction Start to Completion (months)	20.2	12.0	17	13.1	7.9	11	45047
Planning Start to Abandonment (months)	27.1	20.9	23	23.4	18.7	19	12859
Planning Start to Completion (months)	37.7	20.1	33	27.7	15.7	24	43451
Project Construction Value (millions of 2012 USD)				19.1	63.4	8	85936
Building Area (1000s of Sq. Ft.)				159.9	1627.6	73	85936

Table 1: SUMMARY STATISTICS FOR PROJECTS. *Note:* This table shows summary statistics for the projects in our sample on a weighted (by real project value) and unweighted basis, also broken out by property type. *Source:* Authors' calculations using CBRE EA-SupplyTrack.

phase[t]	Planning	Under construction	Completed	Deferred	Abandoned	Total
			phase[t+1]			
	Row %	Row %	Row %	Row %	Row %	Row %
Planning	93.2	4.4	0.0	1.1	1.2	100.0
Under construction	0.0	88.7	11.2	0.1	0.0	100.0
Deferred	0.3	0.5	0.2	96.2	2.7	100.0
Total	56.6	23.3	2.6	16.3	1.2	100.0

Table 2: TRANSITION MATRIX FOR PHASE DATA. *Note:* This table shows a transition matrix for the sample of projects considered in this paper. We combine the pre-planning, planning, final planning, and bidding phases into one phase, which we denote as "Planning." *Source:* Authors' calculations using CBRE EA-SupplyTrack.

	Project Ever Moves to Construction		
	(1)	(2)	(3)
Cum. Price Growth$_{i,t0,t0+4}$	0.57**	1.04**	1.18**
	(0.08)	(0.10)	(0.10)
Log Real Project Cost			0.10**
			(0.00)
Log Building Square Footage			-0.12**
			(0.00)
Fixed effects	no	yes	yes
R^2_a	0.046	0.080	0.102
Observations	246264	246264	246263

Table 3: EARLY PROJECT LIFE PRICE GROWTH AND THE RELATIONSHIP WITH WHETHER A PROJECT MOVES TO CONSTRUCTION. *Note:* This table estimates a linear probability model predicting whether a project in planning eventually advances to construction based on the commercial price growth in the year after the plan is initiated. Price appreciation is measured by CoStar's commercial property price index for the given market. Column (2) adds in MSA, property type, and quarter-of-plan start fixed effects, and Column (3) additionally adds controls for project cost and building size. Standard errors are clustered by MSA. +,*,** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively. *Source:* Authors' calculations using data from CoStar and CBRE-EA SupplyTrack.

	100x 3-year Construction Starts			100x 3-year Commercial Emp. Growth		
	(1)	(2)	(3)	(4)	(5)	(6)
Price Growth$_{i,t}$	3.54**	2.31**	-10.28**	3.44**	2.95**	-3.03
	(0.77)	(0.78)	(3.43)	(0.59)	(0.62)	(2.29)
× Planning Rate$_{i,t-1}$		2.52**	2.97**		1.00**	0.67
		(0.74)	(0.95)		(0.38)	(0.51)
× Under Construction$_{i,t-1}$			0.98			0.25
			(1.90)			(1.11)
× Fast Planning$_i$			-1.02$^+$			0.37
			(0.54)			(0.43)
× Saiz Elasticity$_i$			0.25			-0.07
			(0.31)			(0.19)
× ln(Employment)$_{i,00}$			0.92**			0.53**
			(0.24)			(0.17)
Lags	yes	yes	yes	yes	yes	yes
Fixed effects	yes	yes	yes	yes	yes	yes
R^2_a	0.750	0.752	0.789	0.619	0.620	0.664
Observations	13549	13549	9109	13533	13533	9104

Table 4: 3-YEAR CUMULATIVE RESPONSE OF PRICE APPRECIATION ON ACTIVITY CONDITIONAL ON THE PLANNING RATE. *Note:* This table shows the cumulative 3-year response of construction starts to the building stock in an MSA (columns (1)-(3)) and employment growth in industries related to commercial construction (columns (4)-(6)) in an MSA to MSA-level price appreciation at time t (row 1), the planning stock relative to the building stock or "plan rate" at time $t-1$ (row 2), and then additional controls that include the share of projects that were under construction in the MSA at time $t-1$, an indicator for whether the MSA has a planning rate that is faster than a year, the Saiz elasticity in the MSA, and the natural logarithm of employment in the year 2000 in the MSA (rows 3-6). We include four quarters of lags for each independent variable in all specifications, and fixed effects are by property type, MSA, and year-quarter. Standard errors are twoway clustered by MSA and year-quarter. +,*,** indicate significance at the 10 percent, 5 percent, and 1 percent levels, respectively. *Source:* Authors' calculations using data from CBRE and CBRE-EA SupplyTrack, CoStar Suite (US), Real Capital Analytics, the Quarterly Census of Employment and Wages, and the Urban Economics Lab.

Parameters	**Value**	**Description**
Macro parameters		
ω	0.907	Labor Disutility
Z	0.490	Productivity
β	0.995	Household Discount Factor
γ	1.0	Coefficient of Relative Risk Aversion
ν	0.276	Inverse Frisch elasticity of labor supply
δ_k	0.025	Capital Depreciation
α	0.287	K income share
Construction and Planning Parameters		
η	0.046	B income share
λ	0.167	Hazard of Completing Planning
δ_p	0.025	Planning Depreciation Rate
δ_b	0.0062	Building Depreciation Rate
ι	0.080	Cost of Planning Start
ϕ	1.0	Planning Adjustment Costs
s	0.752	Min. Construction Cost (Pareto dist.)
a	3.488	Pareto shape parameter

Table 5: CALIBRATION. *Note:* This table presents the calibration of the parameters for the model. From left to right, the columns provide the parameter, the calibrated value, and a description of what the parameter reflects. See Section 5.2 for further details on the calibration targets.

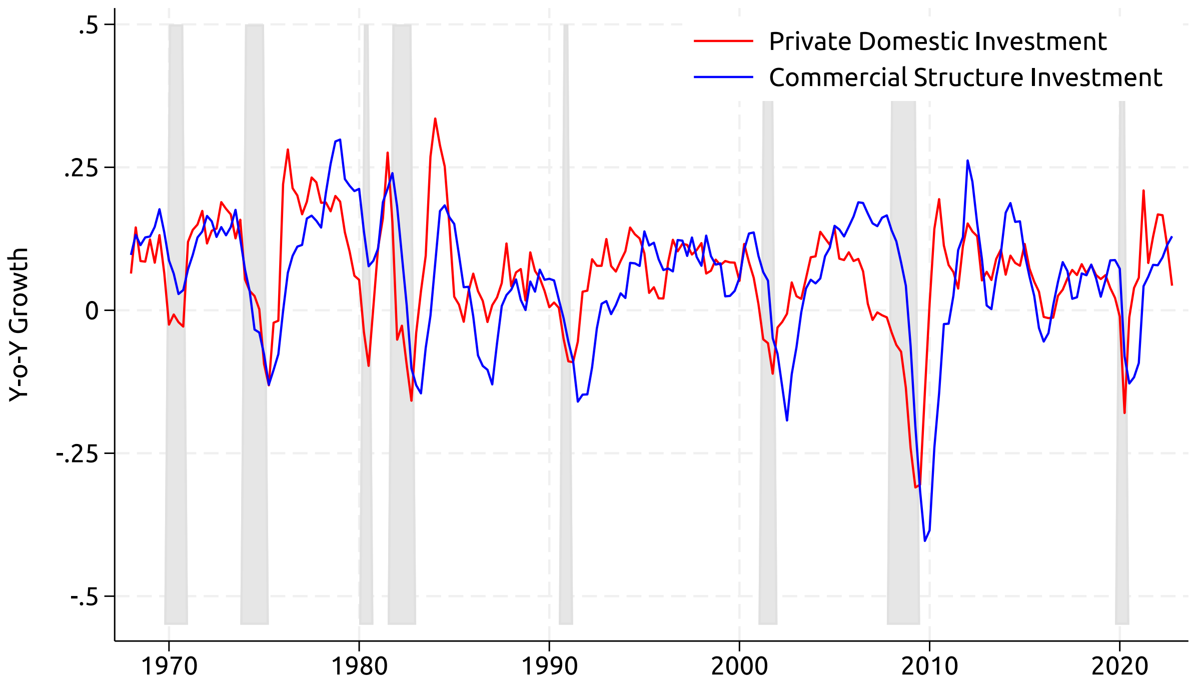

Figure 1: COMMERCIAL VS. TOTAL PRIVATE DOMESTIC INVESTMENT. *Note:* The figure shows year-over-year changes in gross private domestic investment (red) and investment in nonresidential and multifamily structures (blue), which we label as commercial structure investment. The former series is calculated from FRED series GPDI. The latter series is calculated from the sum of investment in nonresidential and multifamily structures (FRED series B009RC1Q027SBEA and C292RC1Q027SBEA, respectively). Note that nonresidential structures include structure types other than those in the microdata in this paper, such as manufacturing and power. *Source:* Authors' calculations using data from the Bureau of Economic Analysis, retrieved from FRED.

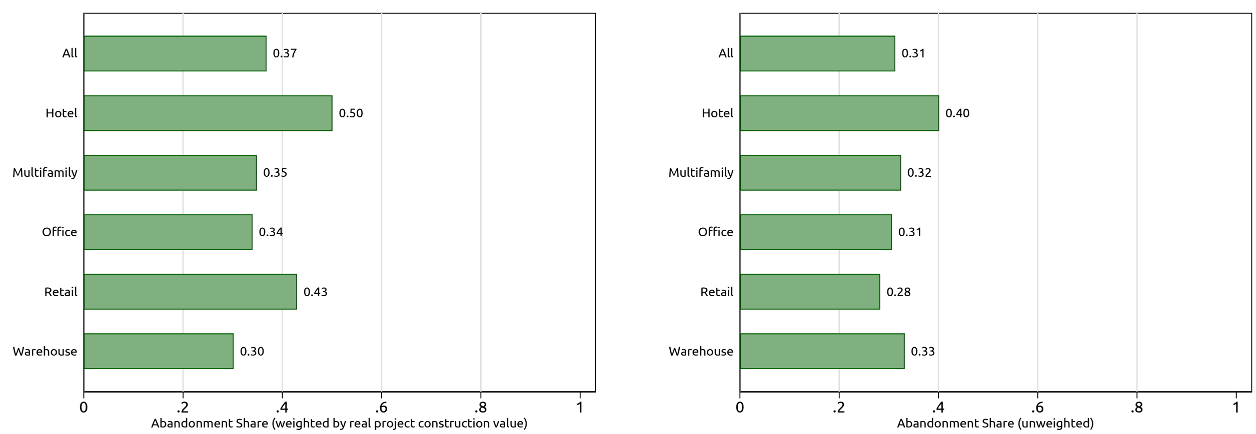

Figure 2: ABANDONMENT SHARES. *Note:* The figure plots the share of abandonments by property type on a weighted (left) and unweighted basis (right), where the weights are the real project construction value. The sample is limited to one observation per project for projects that are either completed or abandoned. *Source:* Authors' calculations using CBRE EA-SupplyTrack.

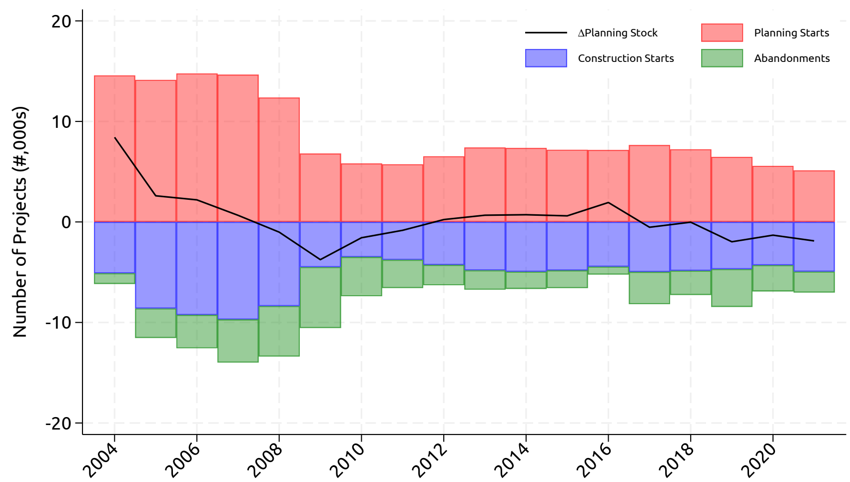

Figure 3: DECOMPOSITION OF CHANGES TO THE PLANNING STOCK. *Note:* This figure shows the components of the change in the stock of projects in planning. The black line plots the change in projects in planning, which is equal to inflows minus outflows. The red bars are inflows into the planning stock, which come from planning starts. The blue bars are outflows in the form of construction starts. The green bars are outflows in terms of abandoned and deferred projects. *Source:* Authors' calculations using CBRE EA-SupplyTrack.

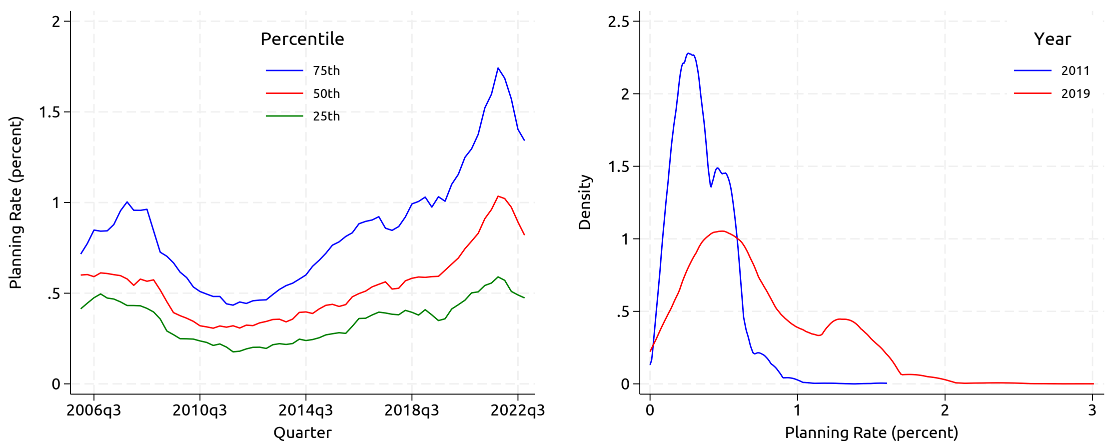

Figure 4: THE DISTRIBUTION OF PLANNING RATES OVER TIME. *Note:* In the left panel, this figure presents time series of various quantiles of planning rates. In the right panel, the figure presents kernel densities of the distribution in 2011 and 2019. MSAs are weighted by number of commercial properties. *Source:* Authors' calculations using CBRE EA-SupplyTrack.

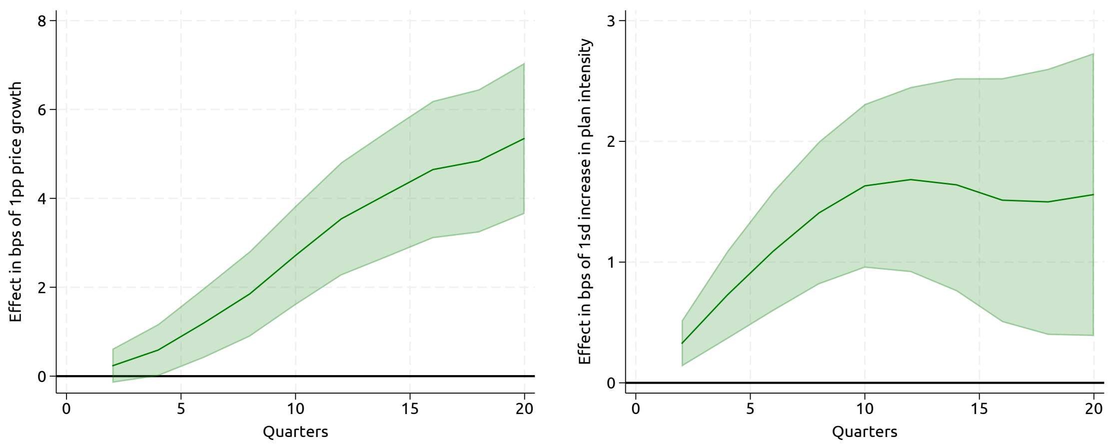

Figure 5: LOCAL PROJECTIONS SHOWING THE EFFECT OF 1PP PRICE APPRECIATION ON CONSTRUCTION STARTS RELATIVE TO THE BUILDING STOCK. *Note:* This figure shows the cumulative response of construction starts to the building stock in an MSA to MSA-level price appreciation at time t (left panel). We include 4 quarters of lags for each independent variable in all specifications, and fixed effects are by property type, MSA, and year-quarter. Controls include the share of projects that were under construction in the MSA at time $t-1$, an indicator for whether the MSA has an above-the-mean planning rate, the Saiz elasticity in the MSA, and the natural logarithm of employment in the year 2000 in the MSA. Standard errors are twoway clustered by MSA and year-quarter. The left figure omits the interaction, while the right figure plots how a 1 standard deviation increase in planning rates affects the response of construction starts. *Source:* Authors' calculations using data from CBRE and CBRE-EA SupplyTrack, CoStar Suite (US), Real Capital Analytics, and the Urban Economics Lab.

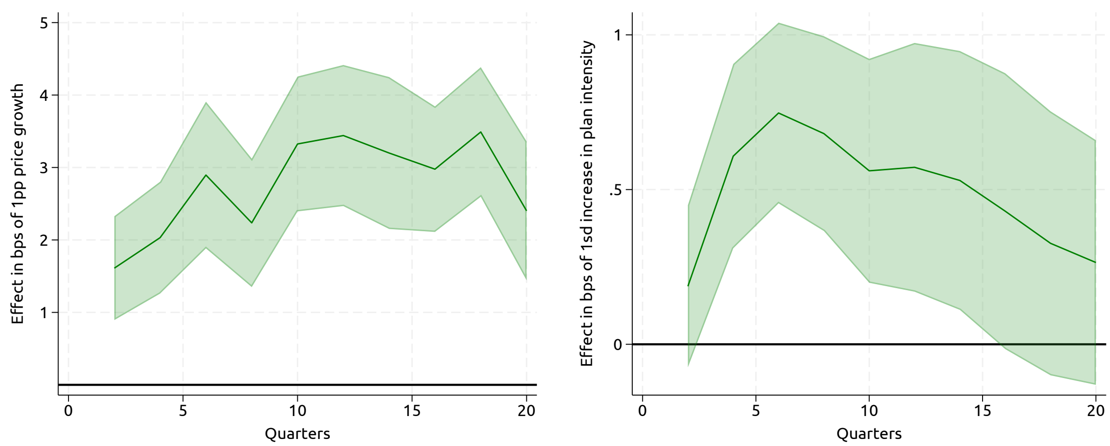

Figure 6: LOCAL PROJECTIONS SHOWING THE EFFECT OF 1PP PRICE APPRECIATION ON EMPLOYMENT GROWTH *Note:* This figure shows the cumulated response of employment growth for industries related to commercial construction in an MSA to MSA-level price appreciation at time t (left panel). We include 4 quarters of lags for each independent variable in all specifications, and fixed effects are by property type, MSA, and year-quarter. Controls include the share of projects that were under construction in the MSA at time $t-1$, an indicator for whether the MSA has an above-the-mean planning rate, the Saiz elasticity in the MSA, and the natural logarithm of employment in the year 2000 in the MSA . Standard errors are two-way clustered by MSA and year-quarter. The left figure omits the interaction, while the right figure plots how a 1 standard deviation increase in planning rates affects the response of employment growth. *Source:* Authors' calculations using data from CBRE and CBRE-EA SupplyTrack, CoStar Suite (US), Real Capital Analytics, the Quarterly Census of Employment and Wages, and the Urban Economics Lab.

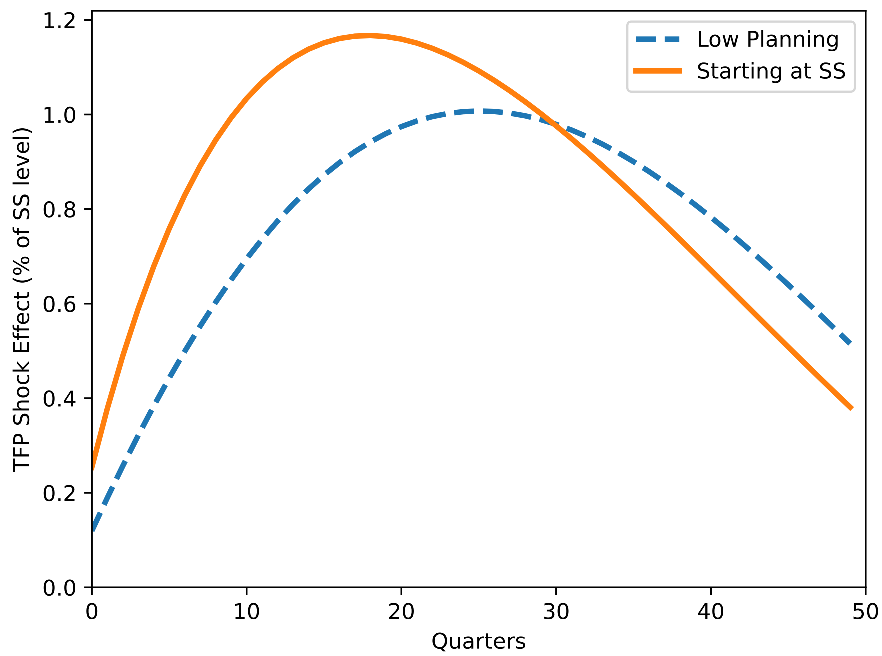

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Figure 7: CONSTRUCTION INVESTMENT RESPONSE TO A TFP SHOCK BY PLANNING STOCK
Note: This figure shows the impulse response of construction to a 1 percent positive TFP shock. The orange line plots the response in an economy starting at the steady state, while the blue line plots the effect of the shock in an economy where $P_t = .5P$. Formally, these lines plot the sequences $\left(I^b_{t+s}(\{Z'\}; P_t = .5P) - I^b_{t+s}(\{Z\}; P_t = .5P)\right) / I^b$ and $\left(I^b_{t+s}(\{Z'\}; P_t = P) - I^b\right) / I^b$, where arguments without time subscripts denote steady-state levels and $Z'_{t+s} = Z + .01 \times .8^s$

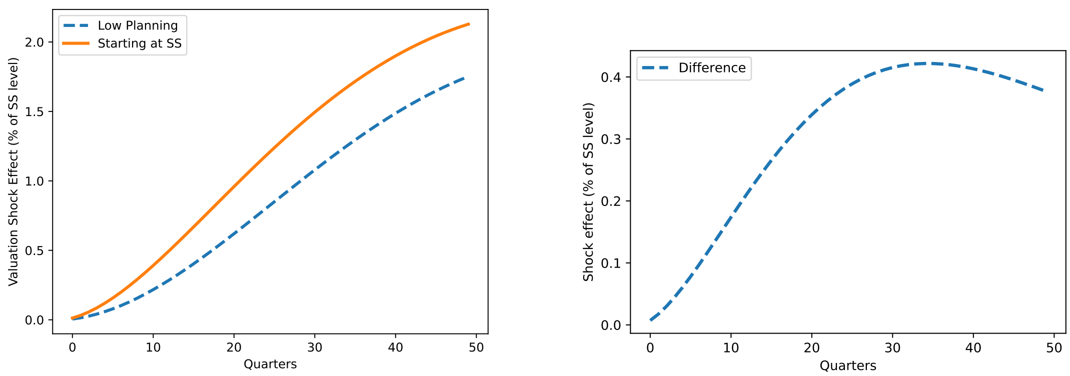

Figure 8: CUMULATIVE BUILDING RESPONSE TO PRICE APPRECIATION *Note:* This figure shows the cumulative response of building construction (as a share of the steady-state building stock) to a 1 percentage point building value shock. The left figure plots $\left(\sum_{i=0}^{s}(I^b_{t+i}(\{Z'\}) - I^b_{t+i}(\{Z\}))\right)/B$, normalized by the price appreciation caused by the shock, $\left(q^b_t(\{Z'\}) - q^b_{t-1}(\{Z\})\right)/q^b_{t-1}(\{Z\})$. $I^b_{t+i}(\{Z'\})$ and $q^b_t(\{Z'\})$ are building investment and building values i quarters after the shock to Z, and these functions with respect to $\{Z\}$ give the investment and values that would occur without the shock (which would correspond with steady-state values for the economy starting there.) These sequences are plotted for an economy starting at the steady state (orange) and one starting with a P_t of half this level (blue). The left panel shows both responses individually, while the right panel plots their difference (baseline minus low initial planning stock).

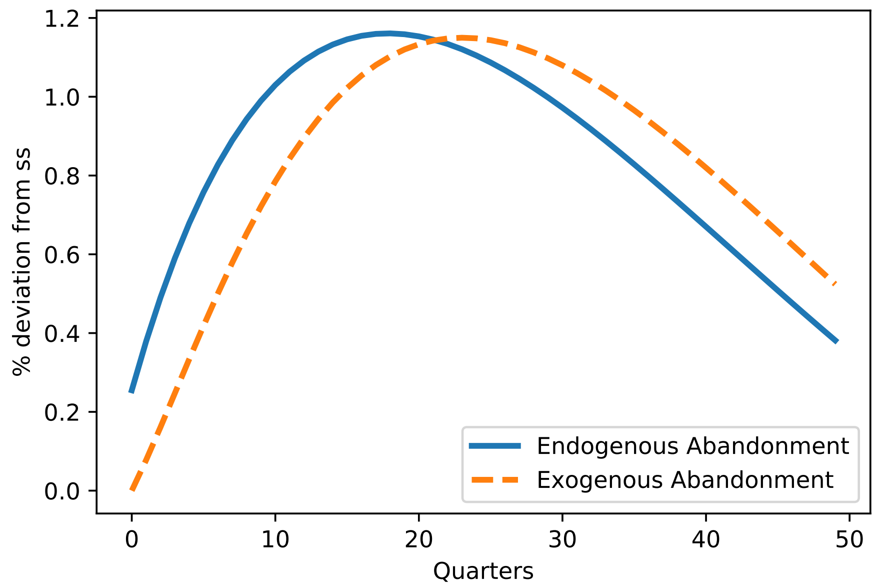

Figure 9: EFFECT OF ENDOGENOUS ABANDONMENT *Note:* This figure shows the construction response to a 1 percent TFP shock in the model with endogenous abandonment (blue) and a model with exogenous abandonment (orange). The exogenous abandonment model has fixed abandonment rates and construction costs equal to steady-state abandonment rates and average construction costs in the endogenous abandonment model.

A. APPENDIX A: DATA CLEANING AND ADDITIONAL DATA DETAILS

For most of our work except as otherwise stated, the data are cleaned as follows. We focus on new construction projects that start in 2004 or later.[26] We start the data in 2004 to avoid including a significant number of observations that had previously begun before 2003 (which is when collection begins).[27] We drop data where building area square footage or project value is missing (all other information is always non-missing). We drop any non-US projects, or those projects without five-digit zip codes that can be matched to a CBSA code.

We keep commercial real estate projects for the main property types: multifamily (which we group with apartments), hotel, office, retail, and warehouse.[28] Some projects have information on phases or sub-projects. In these cases, we only keep information for the larger master project.

We drop any projects with only one observation, and we drop projects with aberrant phase histories, in particular, those that re-enter after reaching the abandoned or completed phases or those without a construction phase. We drop any projects whose last observation was before January 2023 but has not been completed or abandoned. These projects are supposed to stay in the sample through the end of the data set but do not; we thus see these projects as potentially anomalous.[29]

Note that the construction spend is not the value of the building (or the land) but rather the estimated value to be paid to the general contractor (GC) before construction is completed, or the actual spend on the GC if construction is completed. The spend variable only includes construction costs and not design fees or other non-construction costs. We put the construction spend in 2012 dollars using the PCE price deflator.[30]

[26]Projects are required to have a "RepNum," which is the 8-digit Dodge Data & Analytics number uniquely identifying a construction project report.

[27]Of course, it is likely that some projects that enter the database starting in 2004 began well before then. We just expect this issue to be more modest with this cleaning step. We also drop projects started after 2022, as these projects are unable to be constructed within the average time-to-plan and construct windows.

[28]The dropped property types are thus single family, senior housing, and dormitories.

[29]We also drop projects that are not completed as of the sample but have been in the sample for two years, as these projects are well past the average time-to-plan without an end phase. Additionally, we drop projects that enter planning in 2022 or later, as most of these projects will not complete planning by the end of the sample.

[30]We use the PCE chain-type price index, available at https://fred.stlouisfed.org/series/PCEPI. We set the date to be the minimum date of the project being completed if it reaches overall completion, being underway if it only gets to the underway phase, bidding if it only gets to the bidding phase, and the latest stage of planning if it gets to the planning stage.

B. THEORY APPENDIX

The Lagrangian of the developer's problem that we set up in Section 3 is:

$$\mathscr{L} = \mathbb{E}_t \sum_s \left(\prod_{i=0}^{s}(1+r_{t+i})\right)^{-1} \Bigg[r^b_{t+s} B_{t+s-1} - \Big(\iota_{t+s} I^p_{t+s} + \lambda P_{t+s-1} \int_0^{\kappa^*_{t+s}} \kappa dF(\kappa) \Big)$$
$$+ q^p_{t+s} \Big(-P_{t+s} + (1-\delta_p - \lambda) P_{t+s-1} + I^p_{t+s} \Big)$$
$$+ q^b_{t+s} \Big(-B_{t+s} + (1-\delta_b) B_{t+s-1} + \lambda P_{t+s-1} F(\kappa^*_{t+s}) \Big) \Bigg],$$

where q^p and q^b are the costate variables giving the shadow value of planning stock and buildings, respectively.

This has the FOCs:

$$\frac{\partial \mathscr{L}}{\partial B_t} = -q^b_t + \mathbb{E}_t \frac{1}{1+r_{t+1}} \Big(r^b_t + (1-\delta^b) q^b_{t+1} \Big) = 0$$
$$\frac{\partial \mathscr{L}}{\partial I^p_t} = -\iota_t + q^p_t = 0$$
$$\frac{\partial \mathscr{L}}{\partial \kappa^*_t} = -\kappa^*_t \lambda P_{t-1} f(\kappa^*_t) + q^b_t \lambda P_{t-1} f(\kappa^*_t) = 0$$
$$\frac{\partial \mathscr{L}}{\partial P_t} = -q^p_t + \mathbb{E}_t \frac{1}{1+r_{t+1}} \left(\lambda \int_0^{\kappa^*_{t+1}} (q^b_{t+1} - \kappa) dF(\kappa) + q^p_{t+1}(1-\delta_p - \lambda) \right) = 0.$$

The first two expressions define the optimal investment amounts as a function of building values. $q^p_t = \iota_t$ means that investors initiate planning starts until the value of a unit of planning equals the marginal cost of a start.[31] The expression $\kappa^*_t = q^b_t$ means that developers choose to proceed with construction projects whenever the cost is less than the value of a building.

The last two expressions define the values of projects in planning and of completed buildings. Combining these conditions over time shows that these values reflect the present discounted value of

[31] This marginal cost is from the perspective of the individual developer. Since there are external adjustment costs, the marginal cost in aggregate is higher.

payouts from planning and construction. For planning, this payout is $\pi_t^p \equiv \lambda \int_0^{\kappa_{t+1}^*} (q_{t+1}^b - \kappa) dF(\kappa)$— that is, the probability of the plan being completed multiplied by the surplus expected to be received from construction, or $\mathbb{E}_t(\max(0, q_{t+1}^b - \kappa))$. For construction, the payout is the rent received on the building, r_t^b. These discounted values are:

$$q_t^p = \mathbb{E}_t \sum_s \left(\frac{1-\delta-\lambda}{1+r_{t,t+s}} \right)^s \pi_{t+s}^p$$
$$q_t^b = \mathbb{E}_t \sum_s \left(\frac{1-\delta}{1+r_{t,t+s}} \right)^s r_{t+s}^b,$$

where $1 + r_{t,t+s} \equiv \left(\prod_{i=0}^s (1 + r_{t+i})\right)^{\frac{1}{s}}$.