On Commercial Construction Activity's Long and Variable Lags

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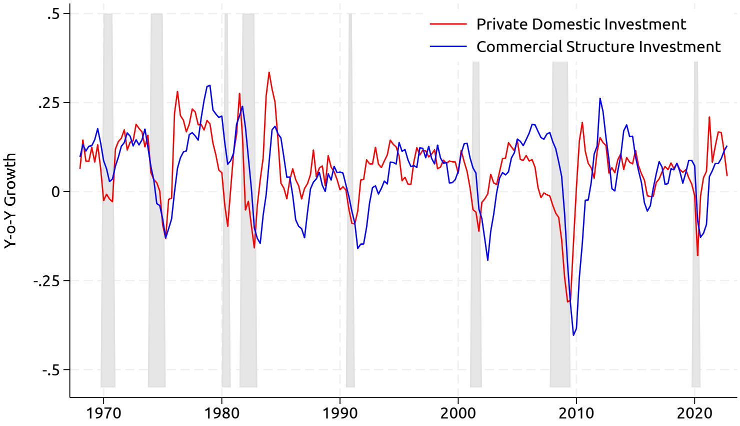
Commercial Construction Activity Lags



- Commercial construction about 20% of total investment
- Not as well studied, in part because Census does not put out as much data as on residential construction
- Commercial construction lags total investment ▶ Hours chart

The Role of Planning

- Commercial construction lags other investment (Edge, 2007), due to long planning horizons (Millar et. al., 2016)
- Developers have option to halt investment if conditions deteriorate (Majd & Pindyck, 1987) so planning stage also critical to *whether* construction occurs
- Abandoned projects are often not tracked, so project planning and abandonment dynamics not well understood

This Paper

- Panel data for over 200,000 construction projects from 2004-2022 to document a few facts
  - Long planning phase (1.5 years for completed projects)
  - Abandonments out of planning phase common (40% of projects)
  - Very few projects under construction are abandoned
  - Abandonments are state dependent
- Develop a model consistent with dynamics
- Model testable implication: Stock of projects in planning matters for responsiveness of activity to economic shocks
  - Validate with local projections
- Calibrated DSGE model for counterfactuals

Phase Data

- CBRE-EA SupplyTrack (via Dodge Data Analytics) microdata on phases of construction from 2004-2022
- Geography, property type, (expected) project cost, building size
- The planning process for construction
    - Planning: Pre-planning, Planning, Final Planning, Bidding
    - Under construction
    - Completed, Abandoned
    - Deferred

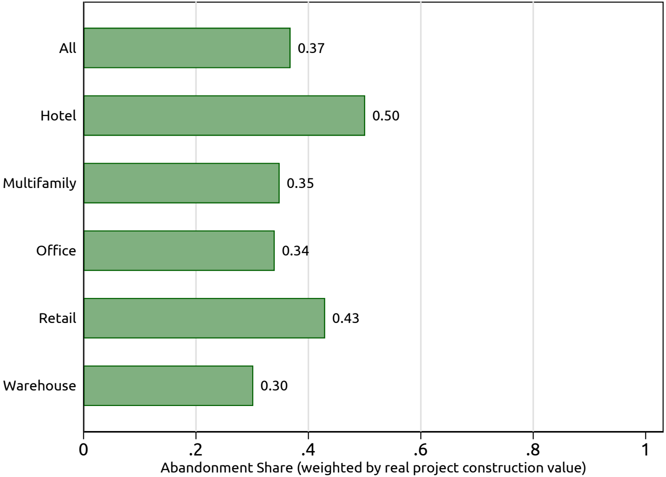
Phase Transitions: Most Abandons Happen in Planning Phase

	phase[t+1]					
phase[t]	**Planning**	**Under construction**	**Completed**	**Deferred**	**Abandoned**	**Total**
	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

- $\approx$ 93% of projects in planning stay in planning.
- Most abandons out of planning phase
    - Deferrals are most likely to be abandoned
- 99% of projects under construction are completed

▸ Summary Statistics

Abandonment Shares out of Planning are High



- About 60% of projects ultimately go under construction while 40% are abandoned
- Heterogeneous across property types but all 30% or more

Unweighted

Whether a Project is Ever in Construction is a Fn. of Conditions in Planning

	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_a^2	0.046	0.080	0.102
Observations	246264	246264	246263

- Higher commercial price appreciation $\implies$ project more likely to be completed (i.e., fewer abandons)
- SEs clustered by MSA
- Fixed effects: MSA, quarter of plan start, and property type

Model of Developers:

- Developers rent out buildings (B_t) at rent r^b and invest in planning and construction starts.
- Developers face cost ι_t to initiate a plan start (generating a unit of P)
- Planning ends with constant hazard λ, giving option for developer to proceed with construction (at a cost $c \sim F$ realized at the end of planning)
- Developers optimize planning investment (I_t) and the threshold cost below which construction occurs (κ_t^*)
  - New construction: $\lambda P_{t-1} F(\kappa_t^*)$

DSGE model later to endogenize r_t^b, ι_t, r_t

Problem of the Developer

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

s.t.

$$P_{t+s} = (1-\delta_p-\lambda)P_{t+s-1} + I^p_{t+s}$$

$$B_{t+s} = (1-\delta_b)B_{t+s-1} + \underbrace{\lambda P_{t+s-1} F(\kappa^*_{t+s})}_{I^b_{t+s}},$$

Solution:

$$\kappa^*_t = q^b_t = \mathbb{E}_t \frac{1}{1+r_{t+1}} \left(r^b_{t+1} + (1-\delta_b) q^b_{t+1} \right)$$

$$\iota_t(I^t_p) = q^p_t = \mathbb{E}_t \frac{1}{1+r_{t+1}} \left(\lambda \int_0^{\kappa^*_{t+1}} (q^b_{t+1} - \kappa) dF(\kappa) + q^p_{t+1}(1-\delta_p-\lambda) \right),$$

where q^p and q^b are the Lagrange multipliers on the planning and building accumulation constraints

Relationship to Empirical Results

1. Commercial construction projects have long planning times

$$\text{Steady State Average Time to Plan} = \frac{1}{\lambda}$$

2. Not all projects in planning advance to construction and abandonments are state dependent

Share $1 - F(q_t)$ of potential construction starts are abandoned

3. Testable implication: Response of construction investment to price appreciation depends on planning stock

$$\frac{\partial \frac{I_t^c}{B_{t-1}}}{\partial q_t} = \lambda \frac{P_{t-1}}{B_{t-1}} f(q_t)$$

Planning Rate Measure by Geography

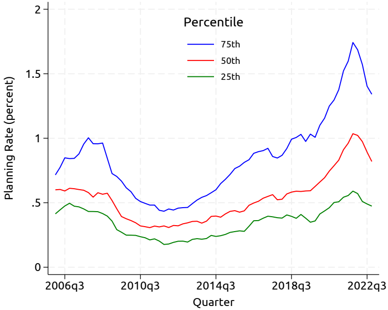
Measure of planning rate by region:

$$\text{Planning Rate}_{i,t} = \frac{\text{Projects in Planning}_{i,t}}{\text{Building Stock}_{i,t}} \times 100$$

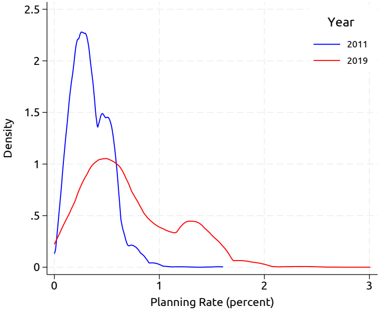
- Projects in planning is from CBRE-EA
- Building stock measures constructed from Costar and RCA data

Planning Rates Vary over Space and Time

Figure: Distribution of Planning Rates over Time



(a) Time Series of Planning Rates



(b) Distribution of Planning Rates

Notes: Time series of various quantiles of planning rates on left. Histogram of distribution in 2011 and 2019 on right. MSAs weighted by number of commercial properties.

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Local projections

Local projections estimates of commercial construction and employment response to price appreciation

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

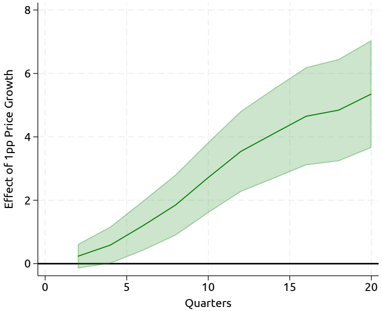
- $\{\beta^h\}$ & $\{\delta^h\}$ trace response of construction activity to price appreciation based on stock of projects already in planning
- η_i^h, τ_t^h: MSA and quarter fixed effects
- $X_{i,t}$: Includes Plan. $\text{Rate}_{i,t}$, and controls for lagged price appreciation, planning/construction intensity, and commercial construction employment.

Other data used here:

- Employment from QCEW
- Commercial construction starts constructed from Dodge microdata

Response of Construction Starts

Figure: Effect of 1pp Price Appreciation



(a) Overall Construction Response (b) Effect of 1sd increase in Planning Rate

Notes: Left figure omits interaction, right figure plots how a 1sd increase in planning rates affects the response of construction starts.

Commercial Construction Employment

Effects robust to controlling for interaction of other MSA characteristics

Table: Response to Price Appreciation

	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

- 30% price appreciation $\implies \uparrow$ construction starts by about 1% of the building stock after 3 years.
- Effect 1.3% higher for an MSA 1sd above the mean in terms of the planning rate.

DSGE Model

- Building producers (same as simple model)
- Households ▸ Households
- Capital producers ▸ Capital Producers
- Final good producers ▸ Final Good Producers
- Government ▸ Government

DSGE model endogenizes r_t^b, ι_t, r_t

- r_t^b from making B input to production
- ι_t from external planning adjustment costs
- r_t from pricing one-period government bonds

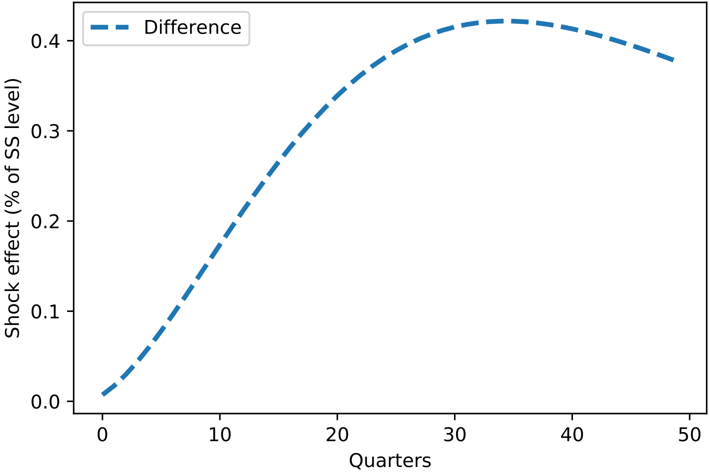
▸ Equilibrium

Calibration Table

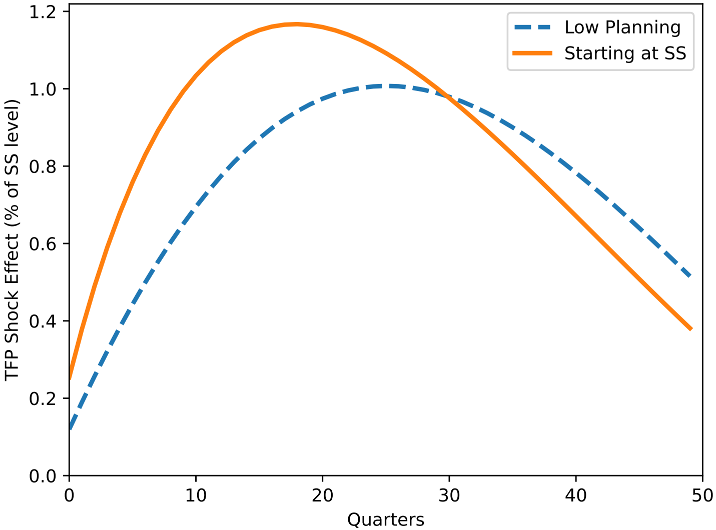
Parameters	Value	Description	Target/Citation
Standard Macro parameters			
ω	0.907	Labor Disutility	$L = 1$
Z	0.490	Productivity	$Y = 1$
β	0.995	Household Discount Factor	r =2% (annual)
γ	1.0	Coefficient of Relative Risk Aversion	Chetty (2006)
ν	0.276	Inverse Frisch elasticity of labor supply	Gertler and Karadi (2013)
δ_k	0.025	Capital Depreciation	Gertler and Karadi (2013)
α	0.287	K income share	Capital (K+B) share= $\frac{1}{3}$
Construction and Planning Parameters			
η	0.046	B income share	$\frac{q^b B}{K} = \frac{3}{7}$
λ	0.167	Hazard of Completing Planning	1.5-year plan time
δ_p	0.025	Planning Depreciation Rate	Equate to δ_k
δ_b	0.0062	Building Depreciation Rate	NIPA
ι	0.080	Cost of Planning Start	$q^b = 1$
ϕ	1.0	Planning Adjustment Costs	Post-GFC Plan Stock Recovery
s	0.752	Min. Construction Cost (pareto dist.)	15% soft costs to construction
a	3.488	Pareto shape parameter	37% abandonment from planning

Effect of planning stock on price elasticity

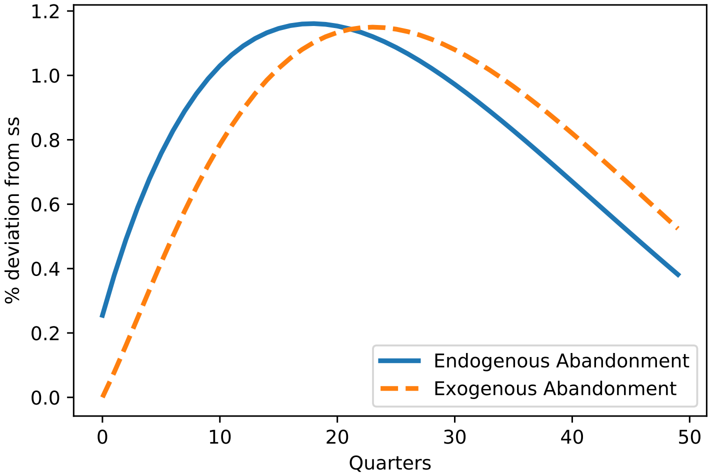
Greater cumulative construction response to TFP shock for economy at SS relative to one with a depressed initial planning stock:



Construction Investment Response to a TFP Shock by Planning Stock



Effect of Endogenous Abandonment



Conclusion

- Using phase data on construction projects, we show
  - Projects spend most of their time in planning
  - A large share of projects are abandoned from planning
  - Construction faster than planning and almost always completed
  - Abandonments from planning are state dependent
- A model consistent with these facts will implies response of activity to changes in prices is a function of the stock of projects in planning
- Validate this implication in the cross-section with local projections
- Endogenous abandoment leads to shorter, stronger responses to shocks

Appendix

Hours Worked in Construction Industry

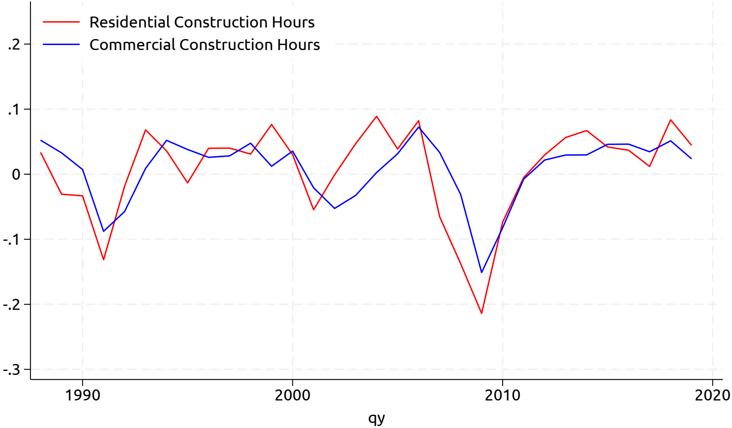


Figure: Year-over-year change in construction hours worked

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Summary Statistics for All Projections

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

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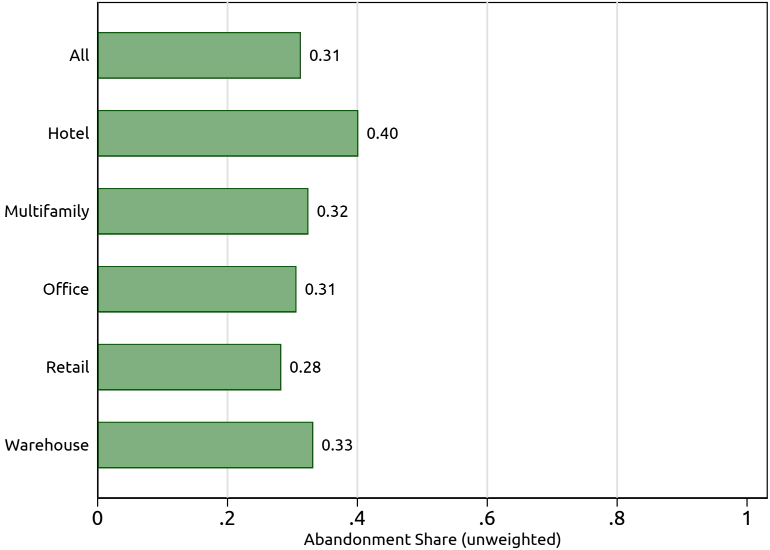
Abandonment Shares out of Planning are High (Unweighted)



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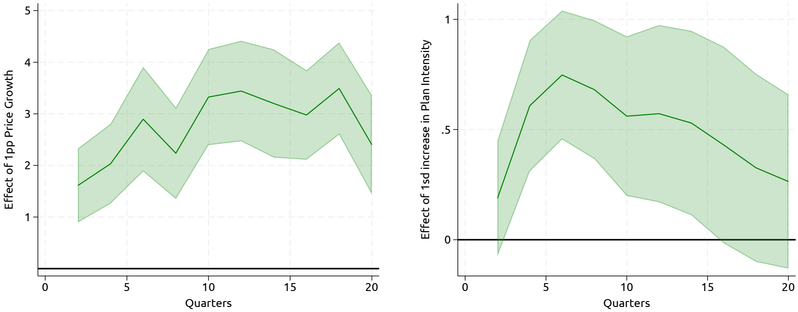
Response of Commercial Construction Employment

Figure: Effect of 1pp Price Appreciation



(a) Overall Employment Response

(b) Effect of 1sd increase in In Planning

Notes: Left figure omits interaction, right figure plots how a 1sd increase in planning rates affects the response of commercial construction employment.

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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 their 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:

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

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:

$$w_t - \omega C_t^{\gamma} L_t^{\nu} = 0$$

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

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Capital Producers

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

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

subject to the capital accumulation equation:

$$K_{t+s} \quad = (1 - \delta_k) K_{t+s-1} + I_{t+s}^k. \tag{2}$$

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:

$$r_t^k = r_t + \delta_k. \tag{3}$$

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Final Good Producers

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:[1]

$$Y_t = Z_t K_{t-1}^{\alpha} B_{t-1}^{\eta} L_t^{1-\alpha-\eta}, \tag{4}$$

where Z_t is firm productivity, $\alpha \in (0,1)$, and $\eta \in (0, 1-\alpha)$. Buildings are constructed as outlined earlier in the developer's problem.

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):

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

We thus obtain the following FOCs:

$$\begin{aligned} w_t &= (1-\alpha-\eta) Z_t K_{t-1}^{\alpha} B_{t-1}^{\eta} L_t^{-\alpha-\eta} \\ r_t^k &= \alpha Z_t K_{t-1}^{\alpha-1} B_{t-1}^{\eta} L_t^{1-\alpha-\eta} \\ r_t^b &= \eta Z_t K_{t-1}^{\alpha} B_{t-1}^{\eta-1} L_t^{1-\alpha-\eta}. \end{aligned} \tag{5}$$

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Government

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

$$D_t(1 + r_t) + G_t = D_{t+1} + T_t. \tag{6}$$

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

$$D_t = D_t^h. \tag{7}$$

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Equilibrium

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 (1) and (2), and bond markets clear following equation (7).

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