Stuck at Home: Housing Demand During the COVID-19 Pandemic

ONLINE APPENDIX

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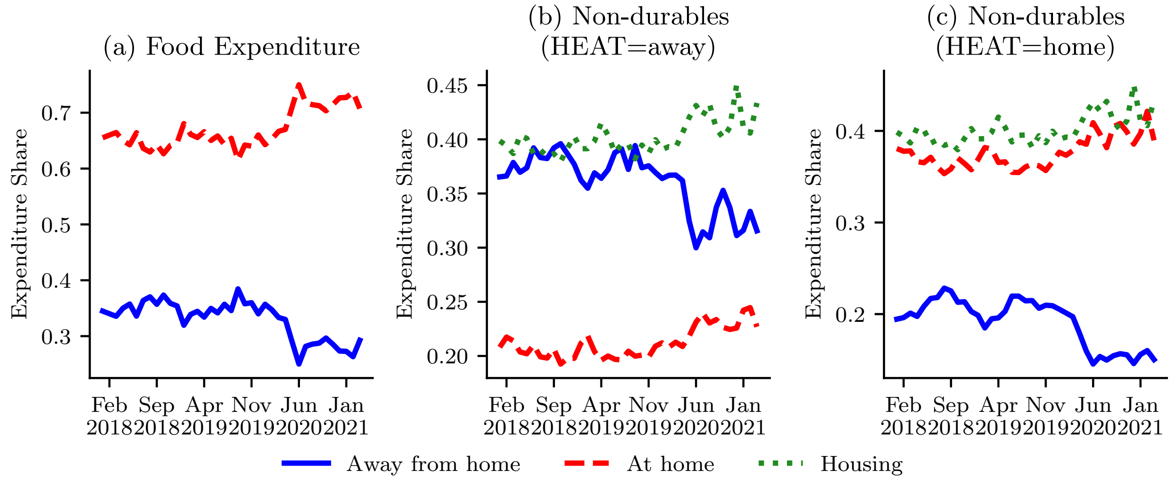
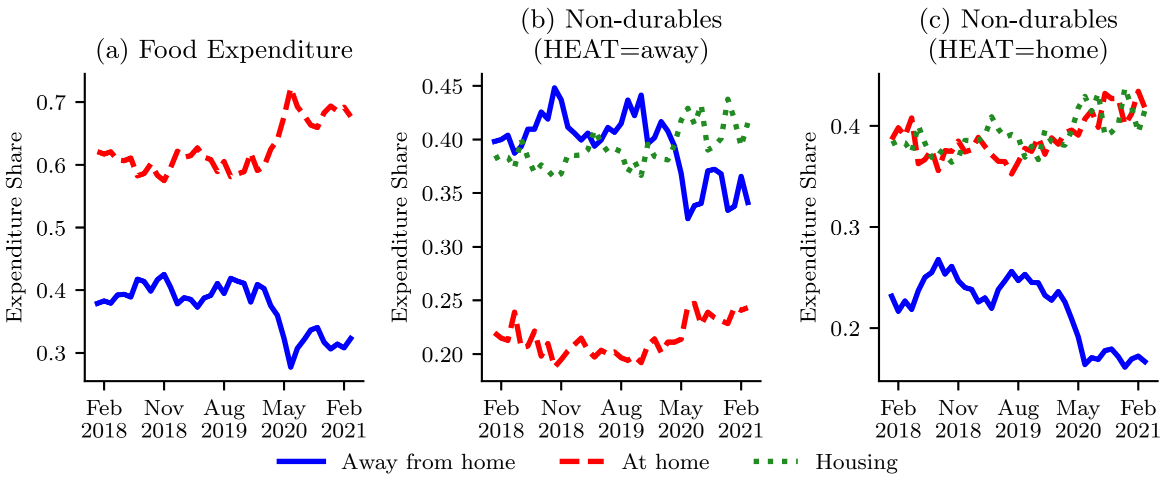
A. Additional Motivating Evidence

Figure A.1: Median Consumption Expenditure Shares



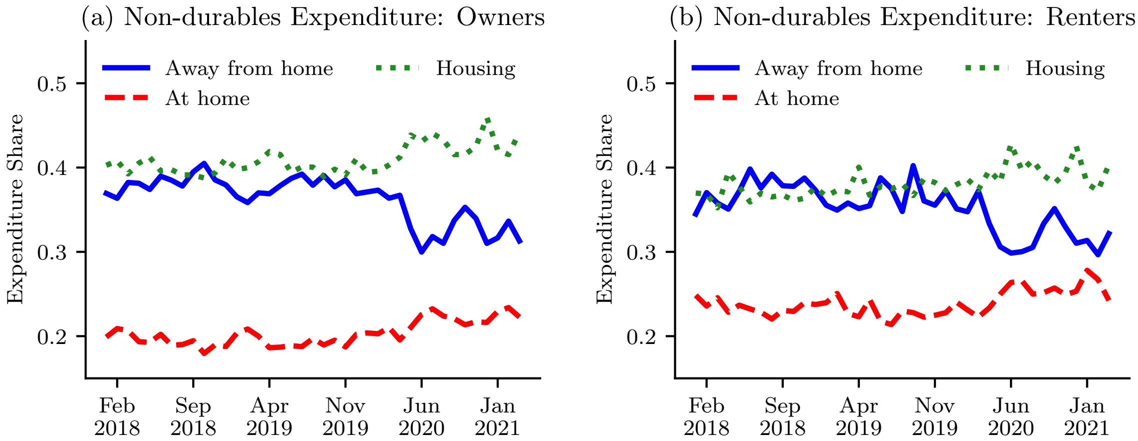
Notes: Median consumption expenditure shares for food only (a), non-durables and housing services ((b) and (c)). In panel (b) spending on health, education, alcohol, and tobacco is allocated to spending away from home. In panel (c) spending on health, education, alcohol, and tobacco is allocated to spending at home.
Source: Authors' calculations using data from the CEX.

Figure A.2: Aggregate Consumption Expenditure Shares



Notes: Aggregate consumption expenditure shares for food only (a), non-durables and housing services ((b) and (c)). In panel (b) spending on health, education, alcohol, and tobacco is allocated to spending away from home. In panel (c) spending on health, education, alcohol, and tobacco is allocated to spending at home.
Source: Authors' calculations using data from the CEX.

Figure A.3: Median Consumption Expenditure Shares for Homeowners and Renters



Notes: Median consumption expenditure shares non-durables and housing services. Panel (a) reports shares for homeowners, panel (b) reports shares for renters. In each panel, spending on health, education, alcohol, and tobacco is allocated to spending away from home.
Source: Authors' calculations using data from the CEX.

B. Additional Empirical Results

Table B.1: House Price Response to Changes in Local Mobility: Alternative Instruments

	Real 12-month house price growth							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δ Time At Home	0.457***		0.507***		0.127***		0.827***	
	(0.116)		(0.088)		(0.029)		(0.243)	
Δ Visits to Retail, Recreation		−0.128***		−0.151***		−0.052***		−0.286***
		(0.036)		(0.026)		(0.012)		(0.101)
Δ Employment	0.220***	0.108***	0.249***	0.136***	0.028	0.017	0.435***	0.299**
	(0.064)	(0.040)	(0.049)	(0.031)	(0.025)	(0.024)	(0.143)	(0.127)
ln(Population)	0.006***	0.004***	0.006***	0.003***	0.008***	0.007***	0.005**	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)
ln(Income Per Capita)	−0.027***	−0.018***	−0.029***	−0.020***	−0.015***	−0.014***	−0.041***	−0.028**
	(0.005)	(0.005)	(0.005)	(0.006)	(0.004)	(0.005)	(0.010)	(0.012)
Land Unavailability	−0.009	−0.004	−0.008	−0.002	−0.014**	−0.011	−0.003	0.011
	(0.006)	(0.008)	(0.006)	(0.007)	(0.006)	(0.007)	(0.008)	(0.013)
$\mathbb{1}(t \leq$June 2020$)$	−0.009***	−0.009***	−0.009***	−0.010***	−0.007***	−0.008***	−0.011***	−0.013***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.003)	(0.004)
Observations								
Total	13,890	13,890	13,890	13,890	13,890	13,890	13,890	13,890
Counties	1,442	1,442	1,442	1,442	1,442	1,442	NULL	1,442
Method	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
Instrument	Deaths	Deaths	Cases	Cases	Lockdown	Lockdown	Vote Share	Vote Share
State Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
State-Clustered Standard Errors	Y	Y	Y	Y	Y	Y	Y	Y
First Stage F-statistic	15.21	34.96	6.22	8.21	442.06	186.72	4.25	9.55

Notes: All specifications using instruments for mobility constructed from the share of workers most easily able to work from home interacted with state-level measures of pandemic intensity over time. Columns (1) and (2) use the baseline instrument that interacts WFH with the confirmed number of COVID deaths over time. Columns (3) and (4) use an instrument that interacts WFH with the confirmed number of COVID cases over time. Columns (5) and (6) use an instrument that interacts WFH with the stringency of lockdowns over time. Columns (7) and (8) use an instrument that interacts Republican vote shares in the 2016 presidential election with the confirmed number of COVID deaths over time. All standard errors and first-stage F-statistics clustered at the state level.

Sources: Authors' calculations using data from BLS, Census, Dingel and Neiman (2020), MIT Election Data and Science Lab (2018), Google Mobility Reports, Hale et al. (2021), Lutz and Sand (2019), Zillow

Table B.2: House Price Response to Changes in Local Mobility: Alternative Specifications

	Real 12-month house price growth				
	(1)	(2)	(3)	(4)	(5)
Δ Time At Home	0.457***	0.465***	0.789*	0.541*	0.581***
	(0.116)	(0.118)	(0.429)	(0.299)	(0.137)
Δ Employment	0.220***	0.223***	0.307*	0.171***	0.283***
	(0.064)	(0.065)	(0.168)	(0.051)	(0.079)
ln(Population)	0.006***	0.007***	0.009***	0.010***	0.006***
	(0.001)	(0.001)	(0.003)	(0.003)	(0.002)
ln(Income Per Capita)	−0.027***	−0.024***	−0.034**	−0.027**	−0.028***
	(0.005)	(0.004)	(0.015)	(0.010)	(0.006)
Land Unavailability	−0.009	−0.009	−0.002	−0.011	−0.005
	(0.006)	(0.006)	(0.008)	(0.008)	(0.006)
Δ Time At Workplace (mean, 2022)		0.038**			
		(0.016)			
$\mathbb{1}(t \leq$June 2020)	−0.009***	−0.009***	−0.013***		−0.009***
	(0.002)	(0.002)	(0.002)		(0.002)
$\mathbb{1}(t \geq$Jan 2021)			0.006		
			(0.010)		
Observations					
Total	13,890	13,890	24,879	7,824	12,979
Counties	1,442	0	1,453	1,392	1,354
Method	2SLS	2SLS	2SLS	2SLS	2SLS
Specification	Baseline	Long run WFH	2020-2021	Jun-Dec 2020	Excl. NY, WA
State Fixed Effects	Y	Y	Y	Y	Y
State-Clustered Standard Errors	Y	Y	Y	Y	Y
First Stage F-statistic	15.21	14.69	3.85	3.41	7.14
Adjusted R-squared	0.15	0.15	0.06	0.26	0.04

Notes: All specifications using instruments for mobility constructed from the share of workers most easily able to work from home (Dingel and Neiman, 2020) interacted with state-level confirmed COVID deaths over time. Column (1) is the baseline specification. Column (2) includes controls for the medium-run mean of time spent at work. Column (3) uses data from both 2020 and 2021. Column (4) restricts the sample from June to December 2020. Column (5) excludes data from the states of New York and Washington. All standard errors and first-stage F-statistics clustered at the state level.

Sources: Authors' calculations using data from BLS, Census, Dingel and Neiman (2020), Google Mobility Reports, Hale et al. (2021), Lutz and Sand (2019), Zillow

Table B.3: Rental Rate Response to Changes in Local Mobility

	Real 12-month rental rate growth			
	(1)	(2)	(3)	(4)
Δ Time At Home	0.088***		0.011	
	(0.025)		(0.510)	
Δ Visits to Retail, Recreation		−0.017		−0.002
		(0.012)		(0.115)
Δ Employment	−0.007	−0.042*	−0.062	−0.066
	(0.025)	(0.025)	(0.386)	(0.202)
ln(Population)	−0.006**	−0.006**	−0.005**	−0.005
	(0.002)	(0.003)	(0.002)	(0.003)
ln(Income Per Capita)	−0.032***	−0.030***	−0.029	−0.028**
	(0.004)	(0.004)	(0.024)	(0.011)
Land Unavailability	−0.042*	−0.044*	−0.045	−0.045
	(0.025)	(0.024)	(0.042)	(0.037)
$\mathbb{1}(t \leq$June 2020$)$	−0.006	−0.005	−0.005	−0.005
	(0.004)	(0.004)	(0.007)	(0.006)
Observations				
Total	2,421	2,421	2,421	2,421
Counties	221	221	221	221
Method	OLS	OLS	2SLS	2SLS
State Fixed Effects	Y	Y	Y	Y
State-Clustered Standard Errors	Y	Y	Y	Y
First Stage F-statistic	–	–	5.68	48.81
Adjusted R-squared	0.18	0.18	0.18	0.18

Notes: Columns (1) and (2) are OLS regressions, and Columns (3) and (4) are 2SLS regressions. The instrument for mobility is the interaction between the county-level share of workers most easily able to work from home with state-level confirmed COVID deaths over time. All specifications include county-level controls for employment growth rates, population, per-capita income, land unavailability, in addition to a dummy for months prior to July 2020, and state fixed effects. All standard errors and first-stage F-statistics clustered at the state level.
Sources: Authors' calculations using data from BLS, Census, Dingel and Neiman (2020), Google Mobility Reports, (Hale et al., 2021), Lutz and Sand (2019), Zillow

C. Additional Model Details

C.1. Static Model

In this section we use a simple one-period model with the preferences defined in Section 3.1 to analytically explore the effect of stay-at-home shocks on housing demand and house prices. As in the quantitative model, assume that utility is a CES composite of away-from-home consumption and the home bundle:

$$u(c_a, c_h, s) = \left[\alpha c_a^{1-\vartheta} + (1-\alpha) x_h(c_h, s)^{1-\vartheta}\right]^{\frac{1}{1-\vartheta}}$$

Since this is a one period model, we drop the outer CRRA structure. Again, the home bundle is a Cobb-Douglas combination of consumption at home c_h and housing services s:

$$x_h = c_h^{\phi} s^{1-\phi}.$$

The static budget constraint is:

$$c_a + c_h + Ps = W$$

where c_a and c_h have prices normalized to one, P is the price of housing services, and W is available resources. The first order conditions of the household problem yield the demand functions:

$$c_a = \frac{\Omega W}{1+\Omega}, \quad c_h = \frac{\phi W}{1+\Omega}, \quad s = \frac{1}{P}\frac{(1-\phi)W}{1+\Omega}$$

where $\Omega = \phi \left(\frac{\alpha}{\phi(1-\alpha)}\right)^{1/\vartheta} \left(\frac{\phi P}{1-\phi}\right)^{(1-\phi)(1/\vartheta-1)}$.

A stay-at-home pandemic shock is modelled as a decline in preferences for consumption away from home α or, equivalently, as an increase in the preference to consume at home $(1-\alpha)$. In our simple setup, this change in preferences results in both an increase in demand for non-durable consumption at home c_h and housing services s. With fixed housing supply in the short-run, the price of housing services increases with the decline in α. We formalize this argument in a simple proposition:

Proposition 1. Suppose $\alpha, \phi \in (0,1)$ and that the supply of housing is fixed. If the elasticity of substitution satisfies $1/\vartheta > 1$, then $\frac{\partial P}{\partial \alpha} < 0$.

Proof. Suppose the supply of housing is fixed at $\bar{s}$. We can rewrite the demand function for housing services as:

$$P = \frac{1}{\bar{s}}\frac{(1-\phi)W}{1+\Omega}$$

Via the Implicit Function Theorem:

$$\frac{\partial P}{\partial \alpha} = \frac{-\frac{\partial \Omega}{\partial \alpha}\frac{1}{\bar{s}}\frac{(1-\phi)W}{(1+\Omega)^2}}{1+\frac{\partial \Omega}{\partial P}\frac{1}{\bar{s}}\frac{(1-\phi)W}{(1+\Omega)^2}} = \frac{-\frac{\partial \Omega}{\partial \alpha}\frac{P}{(1+\Omega)}}{1+\frac{\partial \Omega}{\partial P}\frac{P}{(1+\Omega)}}$$

where the second equality uses the housing services demand function. The partial derivative in the denominator is

$$\frac{\partial \Omega}{\partial \alpha} = \frac{1}{\vartheta} \frac{\Omega}{\alpha(1-\alpha)}$$

and the partial derivative in the numerator is

$$\frac{\partial \Omega}{\partial P} = \frac{(\frac{1}{\vartheta} - 1)(1-\phi)\Omega}{P}.$$

Then the price derivative is:

$$\frac{\partial P}{\partial \alpha} = \frac{-\frac{1}{\vartheta} \frac{P}{\alpha(1-\alpha)}}{(\frac{1}{\vartheta} - 1)(1-\phi) + \Omega^{-1}}$$

Under the assumptions that $\alpha, \phi \in (0,1)$ and $\frac{1}{\vartheta} > 1$, the denominator is positive, and therefore

$$\frac{\partial P}{\partial \alpha} < 0$$

$\square$

That is, if the home consumption bundle and away-from-home consumption are substitutes, a decline in the relative taste for away-from-home consumption α will lead to an increase in the price of housing. Our quantitative model expands on this simple setup, adding realism to the simple framework described here. These additional features allow us to assess the overall importance of the stay-at-home channel for explaining the growth in house prices during the COVID-19 pandemic.

C.2. Household First Order Conditions

Here we describe the optimality conditions for households that own houses or are adjusting their housing stock. This characterization of the optimal decisions differs from the first order conditions described in Section C.1. In the simple model households make frictionless and continuous house size choices, whereas the renters and homeowners in Section 3.2 choose house sizes from a discrete grid subject to costs.

Consider a household that has already chosen a house or rental size $\tilde{h}$. Denote by $\tilde{x}$ the available cash on hand after liquid asset choices a' and any rental payments or housing adjustment costs. The first order conditions with respect to consumption away from home c_a and at home c_h yield:

$$c_a = \left(\frac{\alpha}{\phi(1-\alpha)}\right)^{\frac{1}{\vartheta}} c_h^{\phi + \frac{1}{\vartheta}(1-\phi)} \tilde{h}^{(1-\frac{1}{\vartheta})(1-\phi)}$$

Combining with the expenditure constraint and definition of cash on hand yields

$$\left(\frac{\alpha}{\phi(1-\alpha)}\right)^{\frac{1}{\vartheta}} c_h^{\phi + \frac{1}{\vartheta}(1-\phi)} \tilde{h}^{(1-\frac{1}{\vartheta})(1-\phi)} + c_h = \tilde{x}$$

We solve this non-linear equation to find the choice of home goods c_h, and in combination with the budget constraint recover the solution for away goods c_a. The solution to the consumption choices then only depends on the current state vector, the house size choice $\tilde{h}$, and the liquid asset choice a'.

C.3. Additional Model Results

Figure C.1: Change in Fraction of Renters Choosing Each Rental House Size

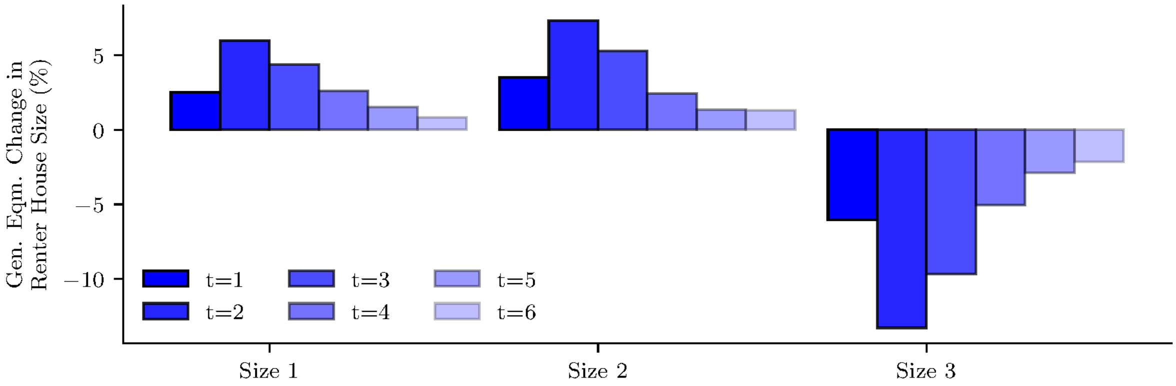


Figure C.2: Change in Fraction of Owners Choosing Each Owner-Occupied House Size

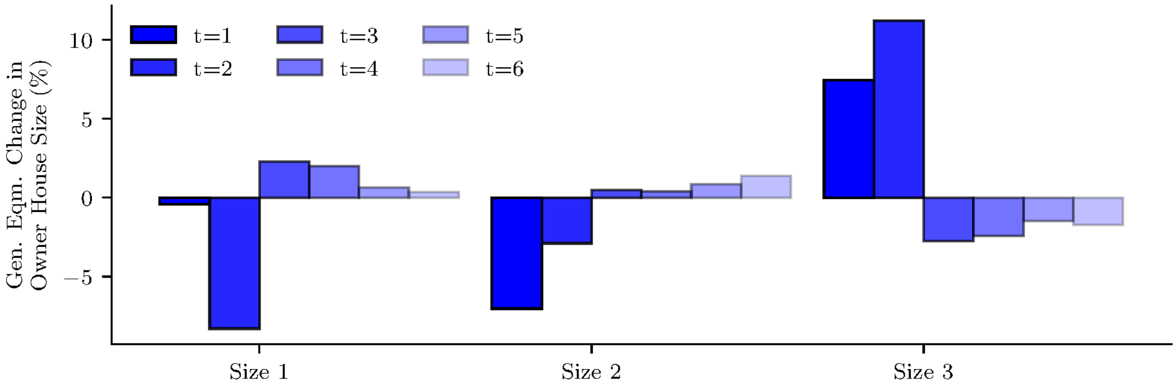


Figure C.3: Impulse Responses: Robustness to Housing and Rental Market Segmentation

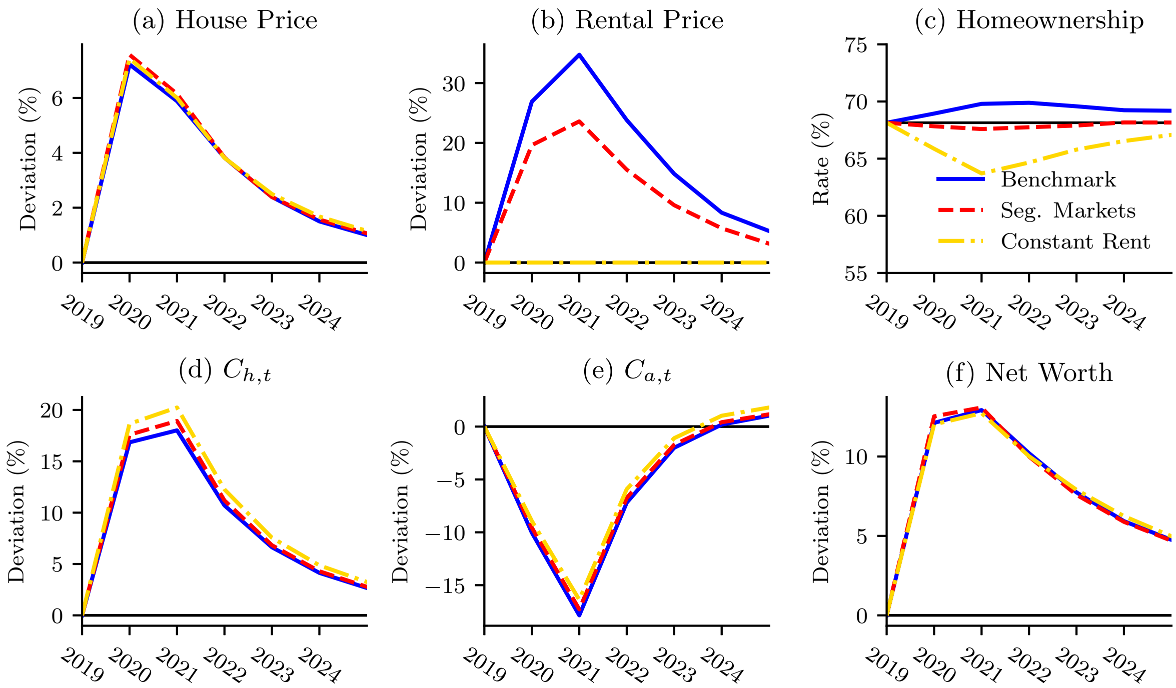
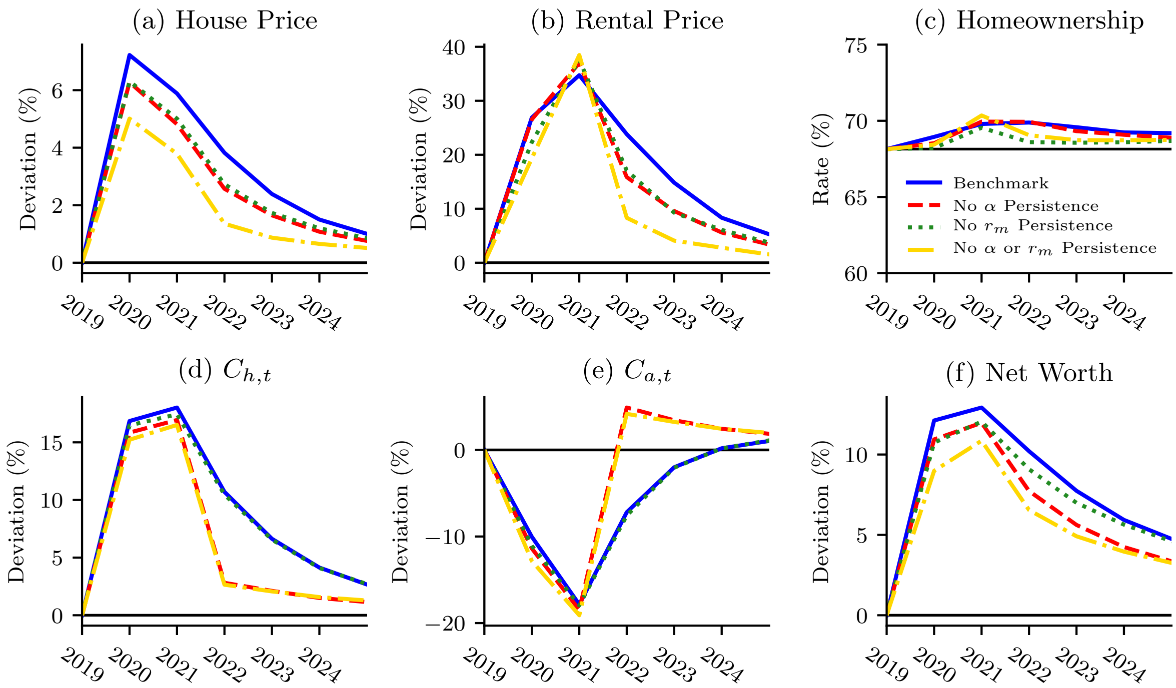


Figure C.4: Impulse Responses: Robustness to Shock Persistence



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