Durables and Size-Dependence in the Marginal Propensity to Spend

Martin Beraja (MIT & NBER) **Nathan Zorzi** (Dartmouth)

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We know little about the effectiveness of stimulus checks as they become larger

$2,000 could be barely more effective than $300 if households spend less and less of each additional dollar

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- Relevant quantity for policy: **total** spending, including **durables** (large share of MPX)
- Conjecture: HH might **tilt spending towards durables** for large checks (Parker et al.)
  This could dampen / reverse decline in MPX predicted by models of non-durables

This Paper

Build a rich and flexible model $\rightarrow$ micro data $\rightarrow$ size-dependence? checks?

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Lumpy durables

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1. Smooth hazard is key to explain a rich set of micro facts that existing models miss.

   Discipline the shape of this hazard by matching: (i) relative MPX on durables; (ii) short-run price elasticity of durables; (iii) distribution of adjustments sizes; (iv) conditional probability of adjustment, etc.

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   A large check of \$2,000 increases output by 27 c/\$, compared to 41 c/\$ for a small check of \$300

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   Larger checks remain effective, but extrapolating from small checks overestimates their impact

Outline

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where

$$u\left(c, d\right) = \frac{1}{1-\sigma} U\left(c, d\right)^{1-\sigma} \qquad \text{with} \qquad U\left(c, d\right) = \left[\vartheta_c^{\frac{1}{\nu}} c^{\frac{\nu-1}{\nu}} + \vartheta_d^{\frac{1}{\nu}} d^{\frac{\nu-1}{\nu}}\right]^{\frac{\nu}{\nu-1}}$$

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Down payment Recursive formulation

Adjustment Hazard

- **Canonical model of durables**: Discontinuous hazard,

$$V_t(\mathbf{x}) = \max\left\{V_t^{\text{non}}(\mathbf{x}), V_t^{\text{adjust}}(\mathbf{x}) - \kappa\right\},$$

where $\kappa > 0$ is the (utility) cost of adjustment.

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$$\mathcal{S}_t\left(\mathbf{x}\right) = \begin{cases} 1 & \text{if } V_t^{\text{adjust}}\left(\mathbf{x}\right) - \kappa > V_t^{\text{non}}\left(\mathbf{x}\right) \\ 0 & \text{otherwise} \end{cases},$$

  i.e., (s, S) adjustment bands.

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$$\mathcal{S}_t(\mathbf{x}) = \frac{\exp\left(\frac{V_t^{\text{adjust}}(\mathbf{x}) - \kappa}{\eta}\right)}{\exp\left(\frac{V_t^{\text{adjust}}(\mathbf{x}) - \kappa}{\eta}\right) + \exp\left(\frac{V_t^{\text{non}}(\mathbf{x})}{\eta}\right)},$$

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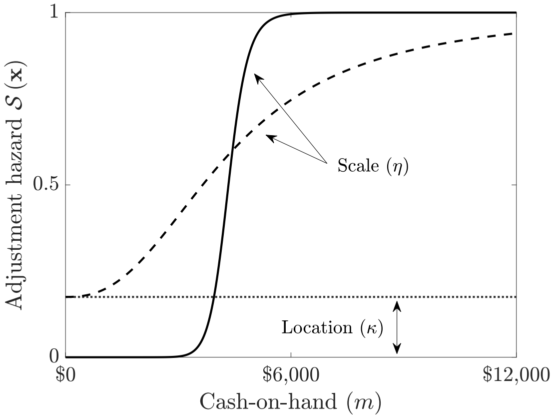
- Nest two polar cases: fully **state-dependent** $(\eta \to 0)$ and **time-dependent** $(\eta \to +\infty)$

Figure 1: Adjustment hazard (fixing *d* and *y*)



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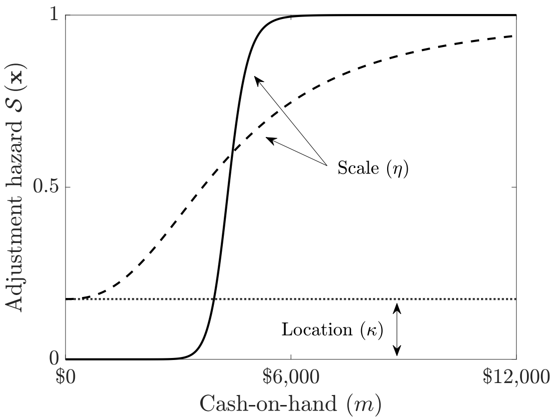

- The shape of the **adjustment hazard** is key for the **size-dependence** in MPX

Adjustment Hazard and Size-Dependence

- Marginal propensity to spend on durables:

$$\text{MPX}^d(T) \equiv \qquad d\mu(m,d)$$

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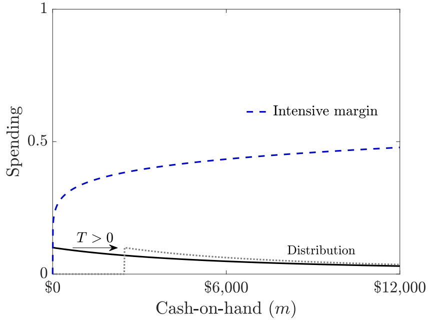
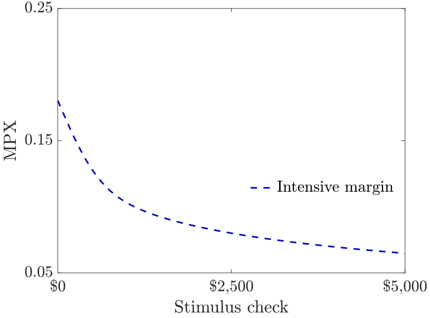
Spending functions (fixing d)



MPX



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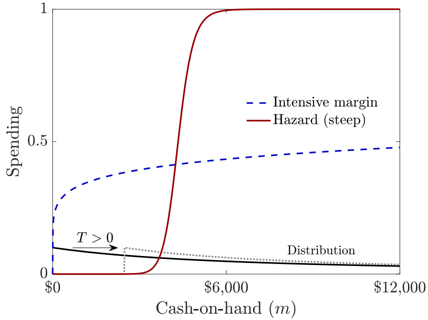

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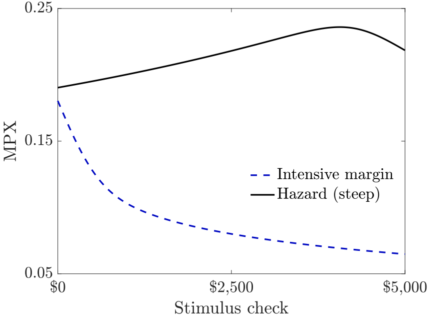

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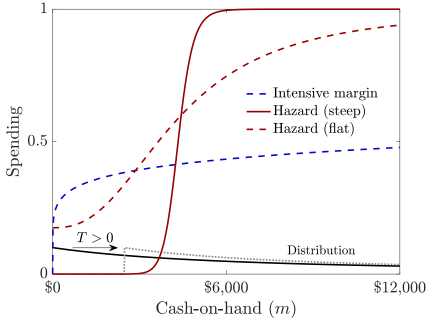

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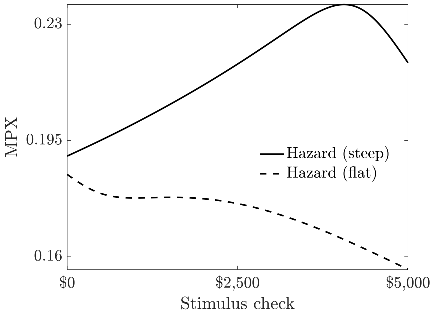

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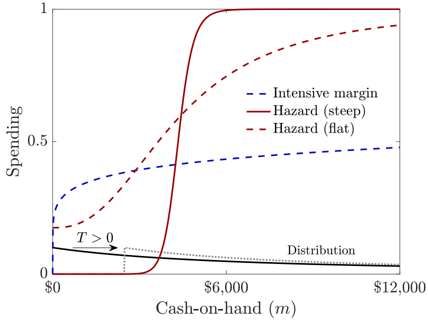

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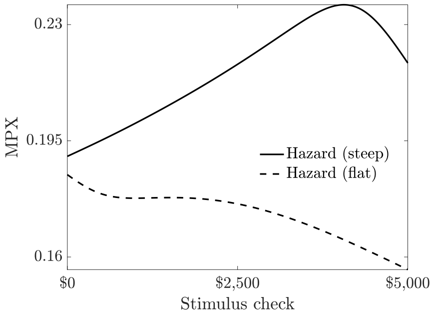

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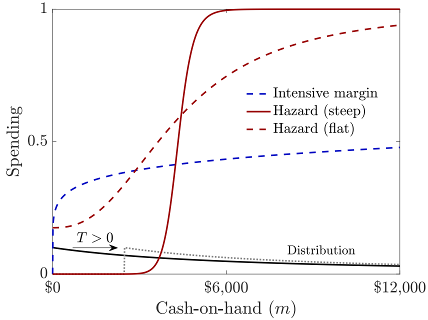

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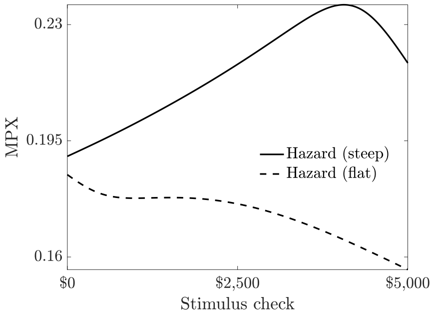

- Getting the **shape of hazard** right is crucial for **size-dependence** + **match data**

Outline

- **Consumer durables** (cars, furniture, appliances), i.e., exclude housing.

Calibration

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- External: $\sigma = 2$ (Berger-Vavra), $\nu \to 1$ (Orchard et al.), $\theta = 0.20$ (Adams et al.), $\delta = 0.05$ (CEX)

Calibration

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Parameter	Description	Calibr.	Target	Value	Source
β	Discount factor	0.944	Liquid assets / A GDP	26%	Kaplan et al.
ϑ	Non-durable parameter	0.637	Durables / non-durables	26%	CEX
ι	Maintenance	0.257	Maintenance / new investment	32.6%	CEX
κ	Location parameter	0.803	Frequency of adjustment (A)	23.8%	PSID
η	Scale parameter	0.20	Next slide		

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Scale Parameter (η)

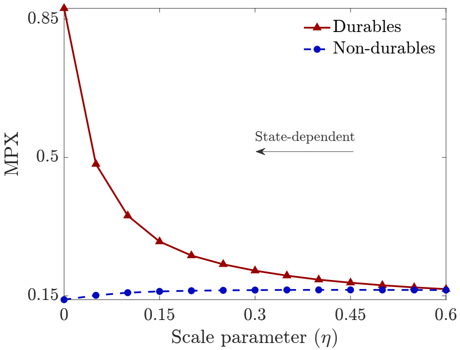
- Two moments are informative: MPX out of $500 (PE) and user cost elasticity (GE)

Scale Parameter (η)

- Capture: (i) relative importance of durables; and (ii) strength of extensive margin.

Scale Parameter (η)

MPX ($500 check)



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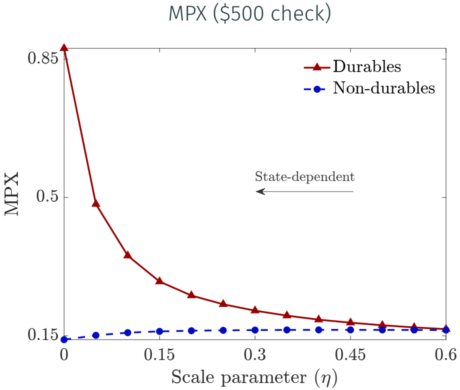

- **Evidence**: $\text{MPX}^d > \text{MPX}^c$ (Havranek-Sokolova) $\rightarrow$ not too time-dependent

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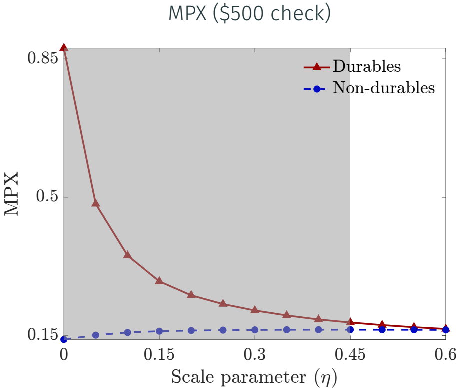

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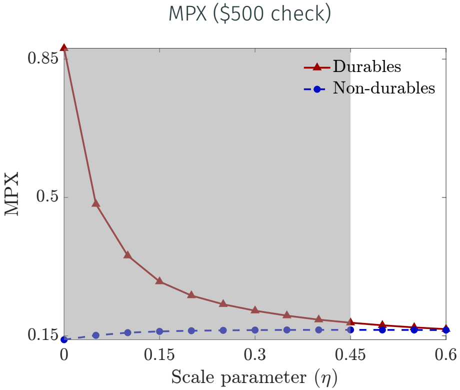

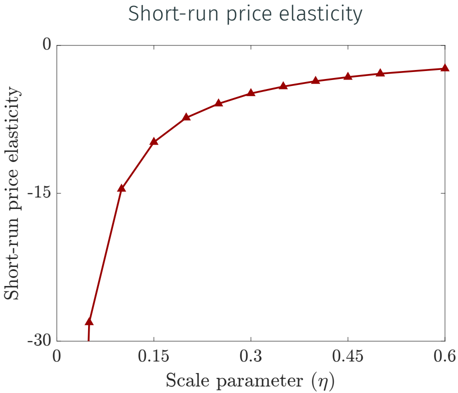

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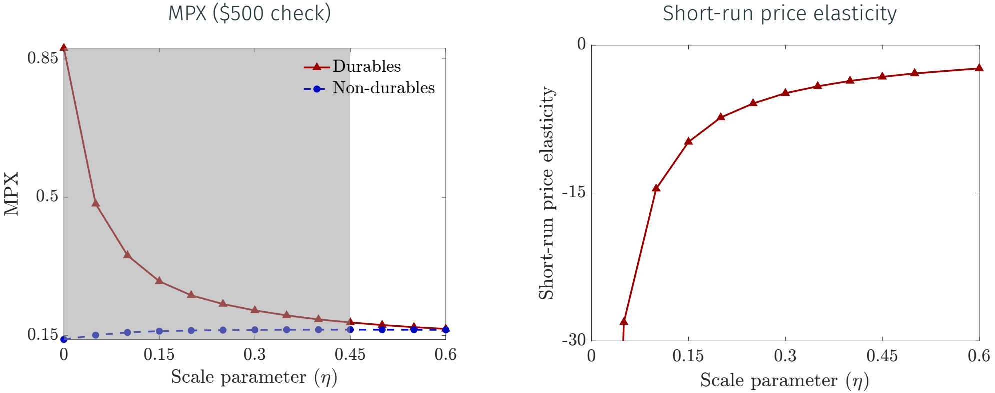

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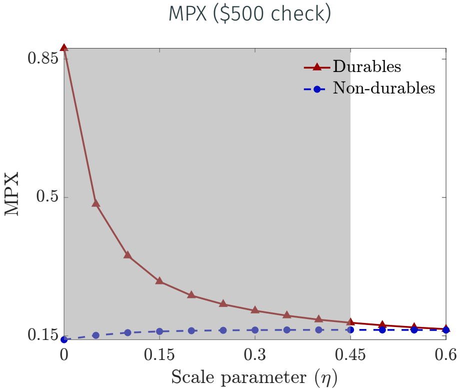
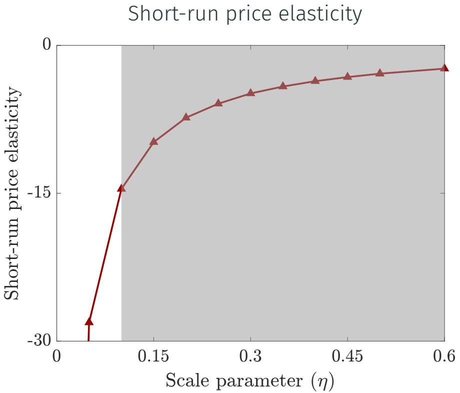
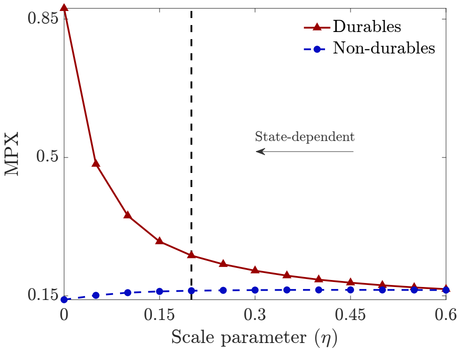


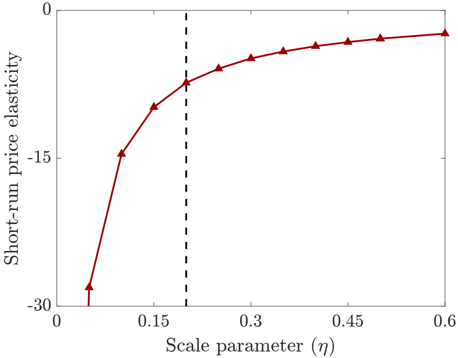


- **Evidence**: Elasticity ≥ -15 (Bachmann et al.) $\rightarrow$ not too state-dependent (McKay-Wieland)

MPX ($500 check)



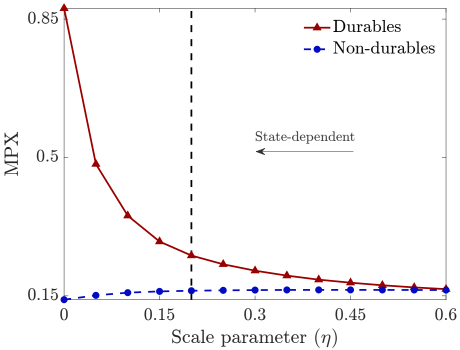
Short-run price elasticity



- Benchmark calibration: $\eta = 0.2$ (+ robustness checks)

Scale Parameter (η)

MPX ($500 check)



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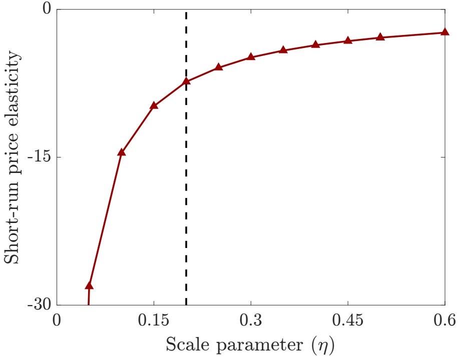
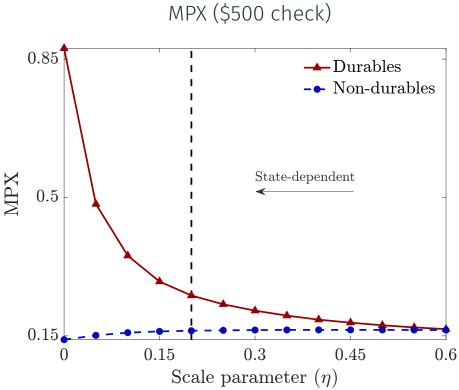
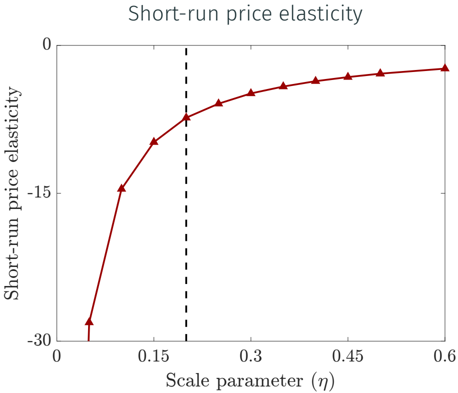


- Benchmark calibration: MPX^d $\sim 1.5 \times$ MPX^c (Havranek-Sokolova) and elasticity ~ -7

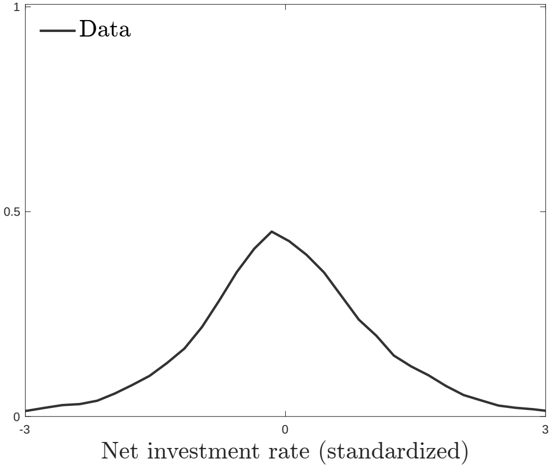
Scale Parameter (η)

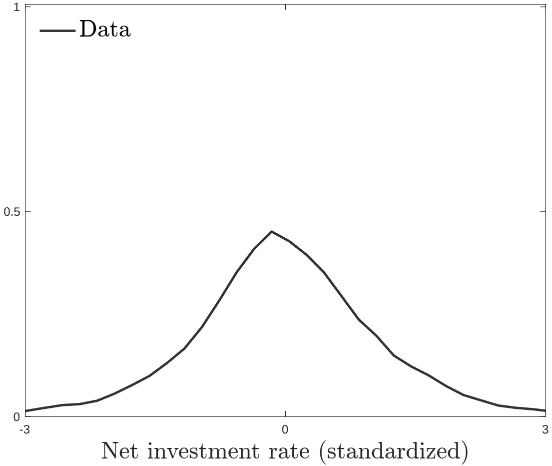




- Benchmark calibration: matches well **untargeted** moments

1. Distribution of Adjustments (PSID)





- Reflects the **shape of hazard**: $\int_{-\infty}^{z} f(s)\, ds = \int \mathbf{1}_{\{\log(d'(\mathbf{x})/d) \in (-\infty, z)\}} \mathcal{S}(\mathbf{x}) \mu(d\mathbf{x})$

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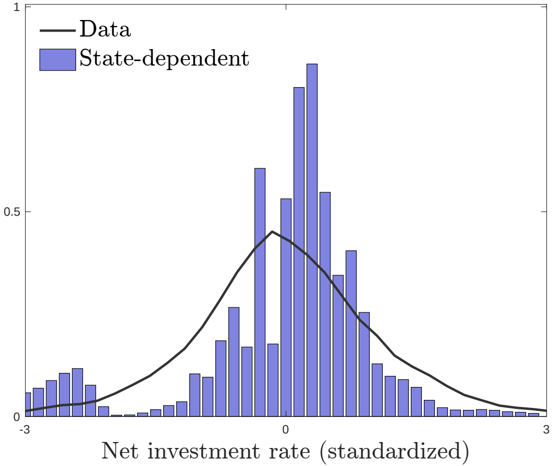

- State-dependent model: misses the overall shape, the tails, etc.

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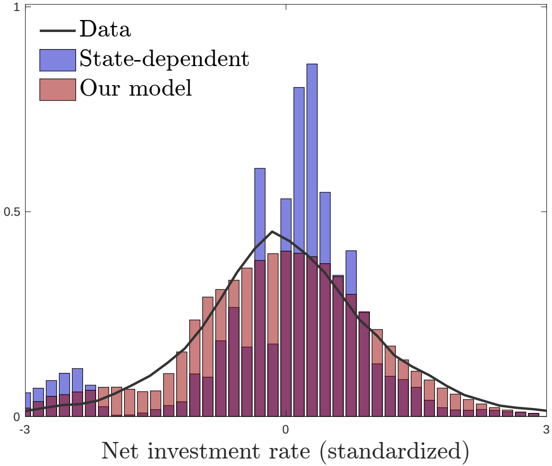
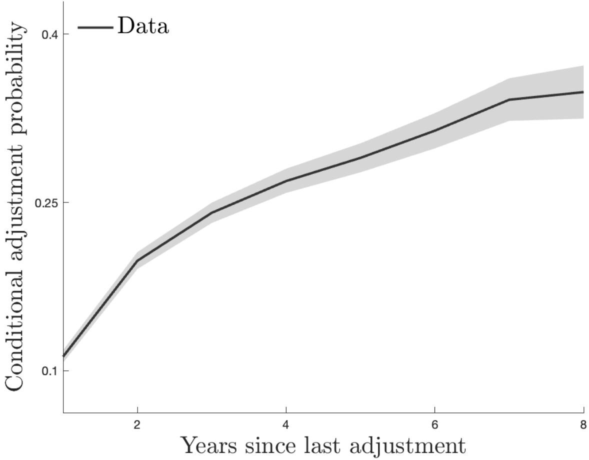


- Our model: fits the distribution closely, i.e., the data supports our smooth hazard.

2. Probability of Adjustment Since Last Purchase (PSID)



- Adjustment probability conditional on not having adjusted so far (Kaplan-Meier)

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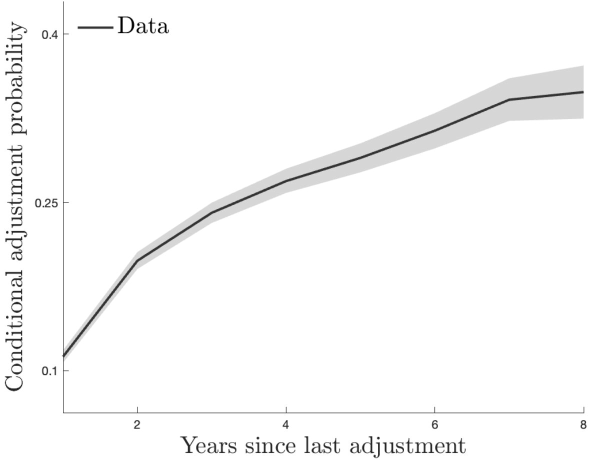

- Also informative about the overall **shape of hazard** (probability flat or steep)

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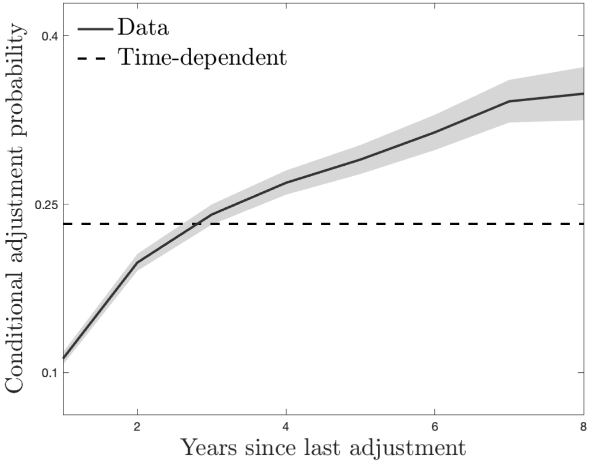

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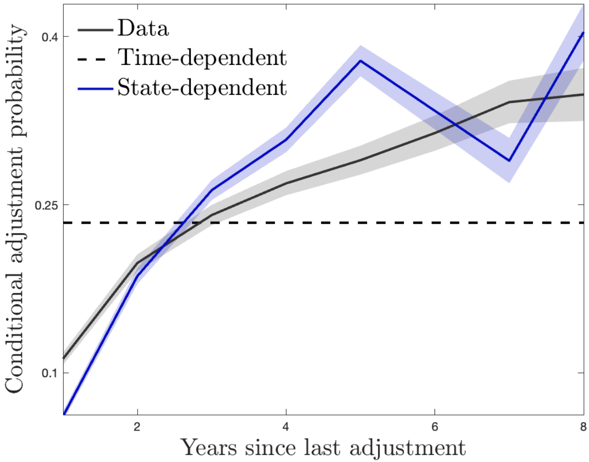
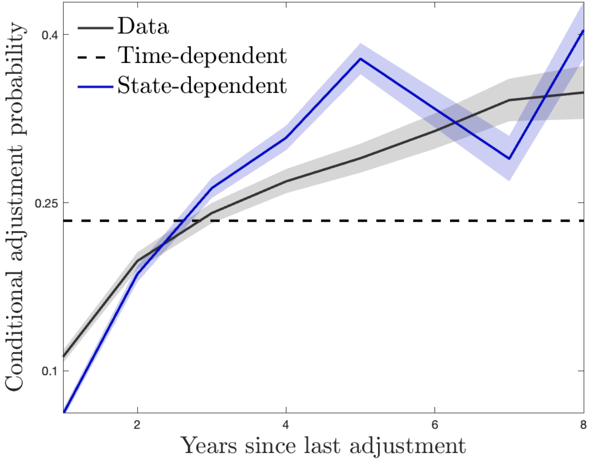


- Model-generated data discretized in PSID waves, CI are bootstrapped at 90%



- Again, the evidence rejects the purely state- and time-dependent models.

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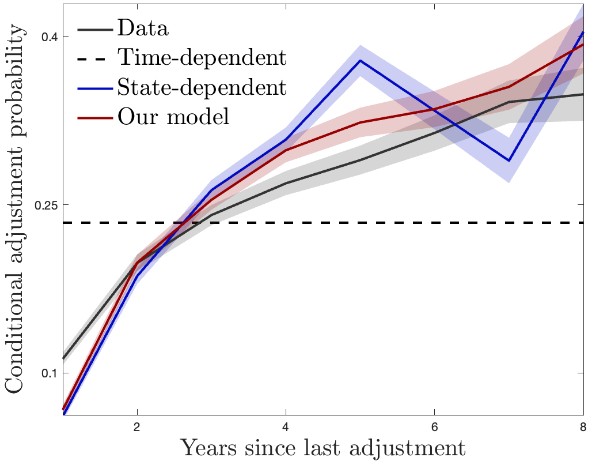

- Our model has both state-dependent and time-dependent features

3. Other Untargeted Moments

1. **Timing of response ($500).** MPX of 65% (6M), 75% (9M), 92% (12M) ▸ Dynamics

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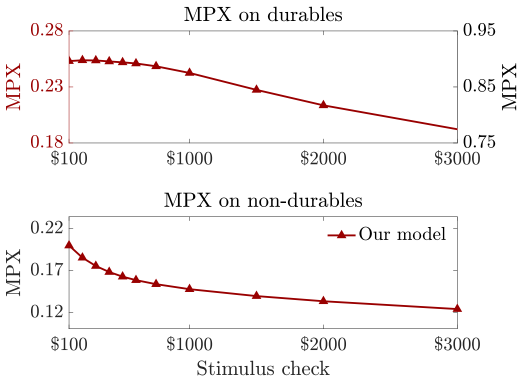
▸ State-dependence ▸ CalvoPlus

Outline

Size-Dependence in the MPX

MPX on durables and non-durables



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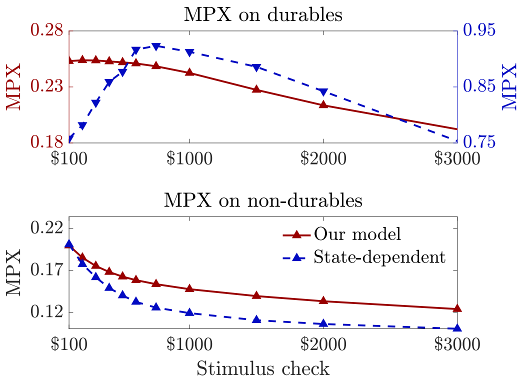

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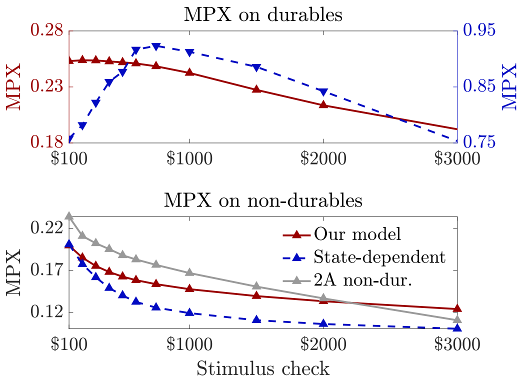

- Modelling **durables** is important for the **MPX on non-durables** (complementarity)

Size-Dependence in the MPX

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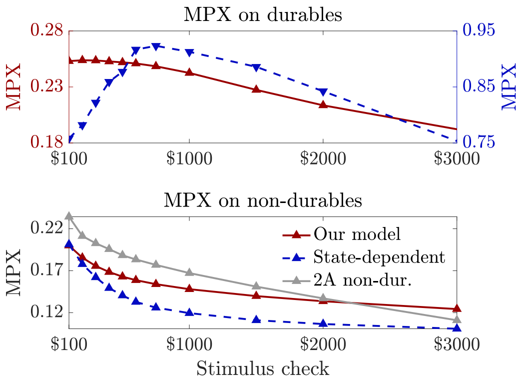
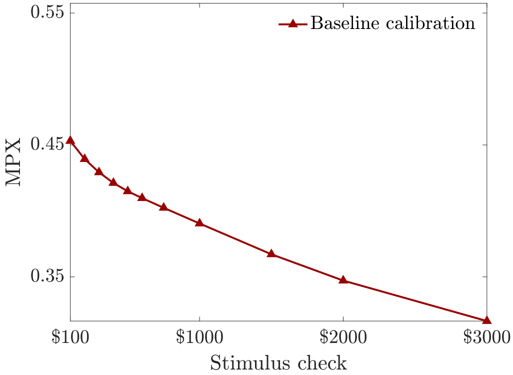
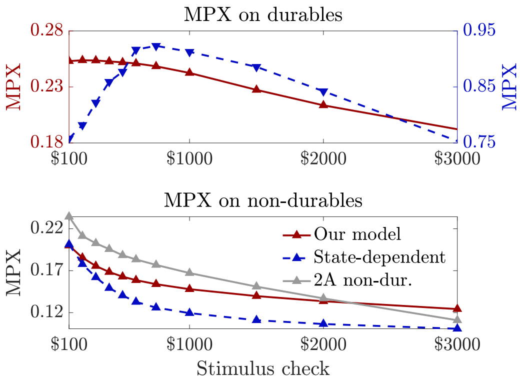


Total MPX



- Our model: **realistic total MPX** (level) that **decreases slowly** (size-dependence)

MPX on durables and non-durables



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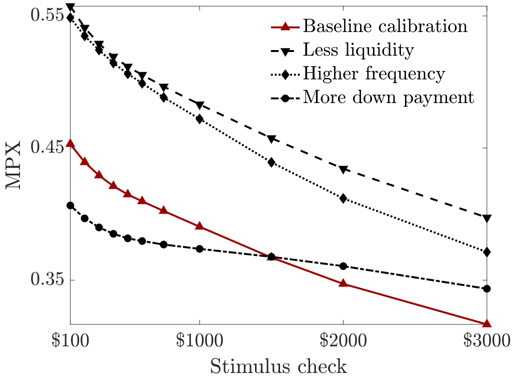
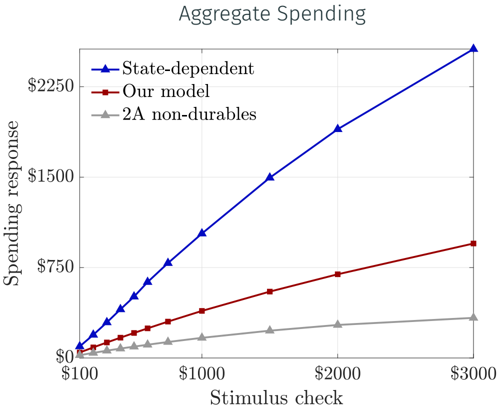


- More results: Decomposition Sensitivity

Aggregate Spending, Concavity, and the Role of η



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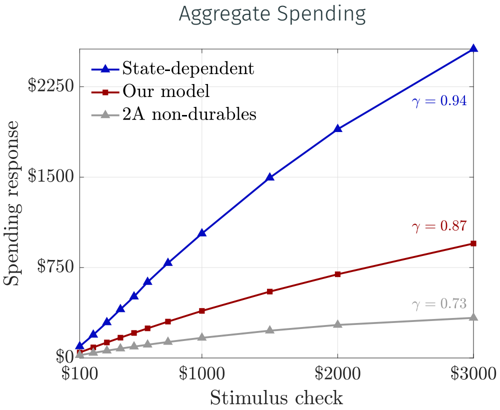

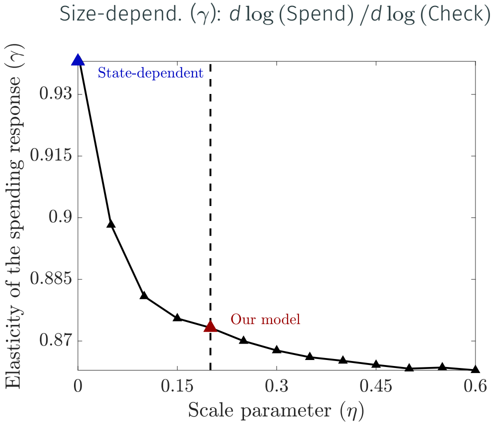

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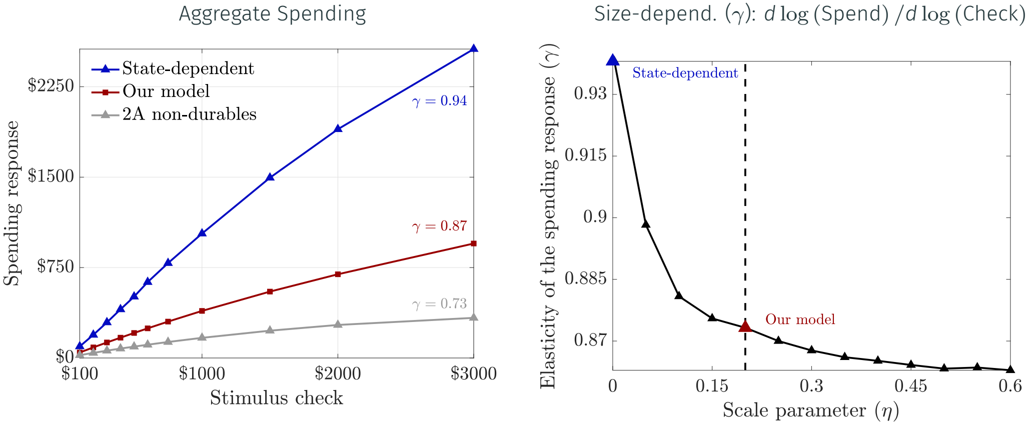

- The size-dependence (concavity) is very constant around $\eta = 0.2$

▸ State-contingency

Outline

A GE Application to Stimulus Checks

How effective are large checks at stimulating output in recessions?

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  Labor markets are slack

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- An extension with **supply-side constraints** (Orchard et al., Comin et al.)

  Shocks to **potential output**, **non-linear NKPC**, and **relative price** movements

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Aggregate supply

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← Solve for $\{z_t\}$ that generate recession

Aggregate Demand and Supply

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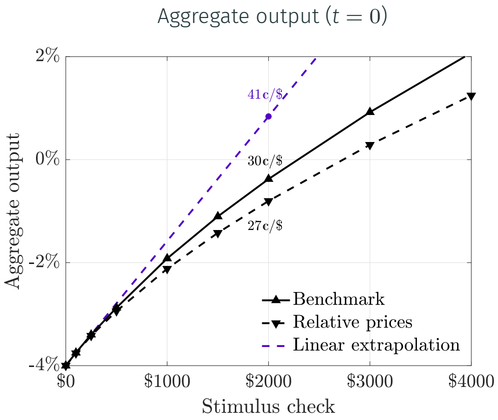
▸ Closing the model

General Equilibrium Response to Stimulus Checks



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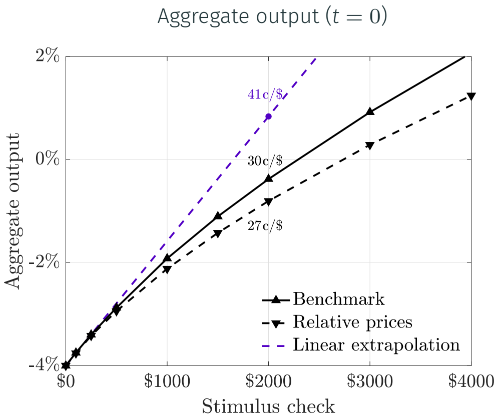

- Large checks remain effective, but extrapol. from smaller ones overestimates impact

General Equilibrium Response to Stimulus Checks

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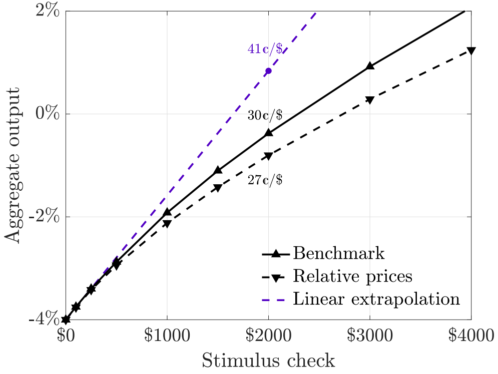

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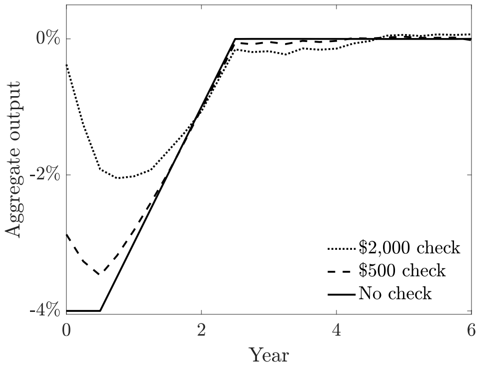

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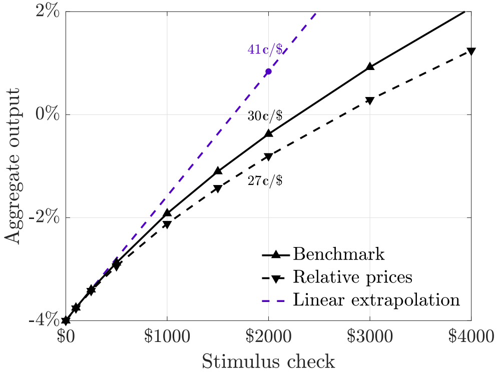

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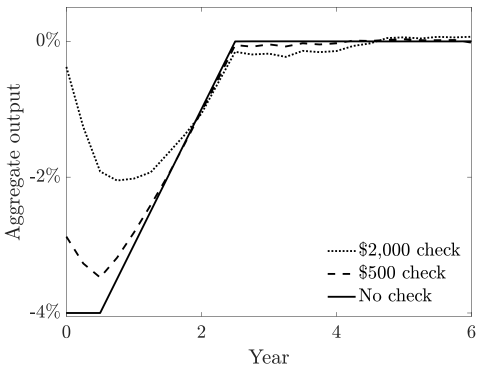

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Additional results

- Perfect storm: shocks to **potential output**, **non-linear NKPC**

Supply Side Effects

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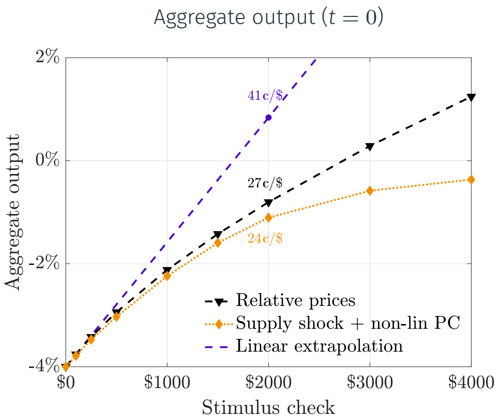

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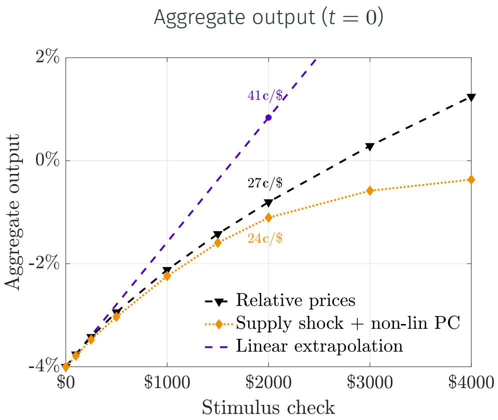
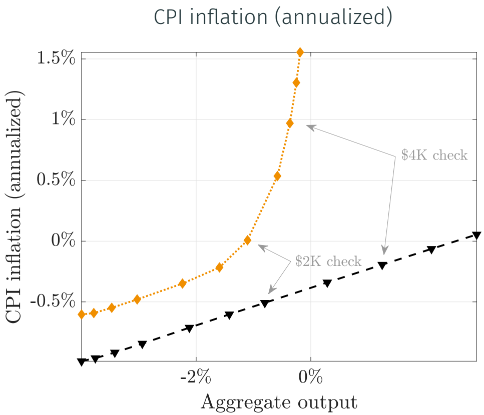
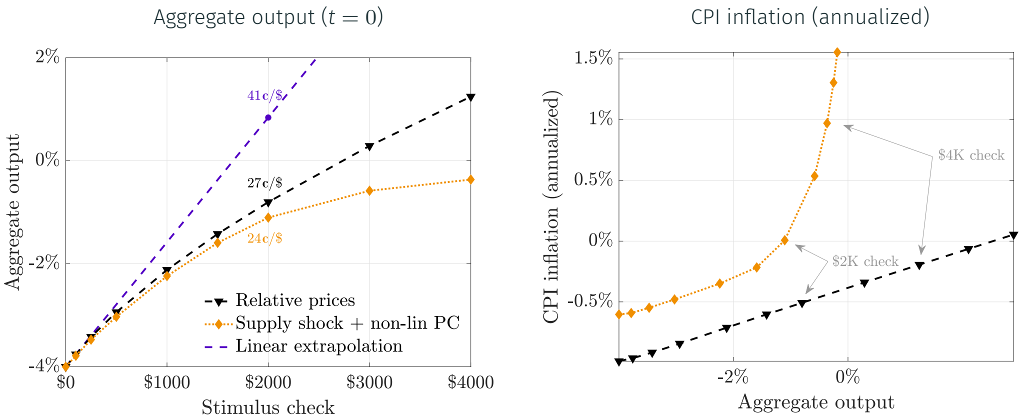




Supply Side Effects

- Perfect storm: shocks to **potential output, non-linear NKPC**



Supply side

Takeaways

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1. The **MPX declines slowly** with the size of stimulus checks
2. **Larger checks remain effective** at stimulating output in recessions, but **extrapolating from small checks overestimates** their impact

Down Payment

- Empirically, some households with large MPX (> 1) (Lewis et al., Fuster et al.)

Model Calibration

Down Payment

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- Standard LTV

$$m_t \geq -(1-\theta)\, d_t, \tag{LTV}$$

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- Empirically, typical car loan is 5-6 years while car depreciates at 20%, pre-determined payments (Argyle et al.), and prepayments are rare for consumer durables (Heitfield-Sabarwal), and households make minimum down payment (Green et al.).

▸ Model ▸ Calibration

Recursive Formulation

- Discrete choice problem

$$\mathcal{V}_t(\mathbf{x};\epsilon) = \max\left\{V_t^{\text{adjust}}(\mathbf{x}) - \epsilon, V_t^{\text{non}}(\mathbf{x})\right\}$$

- When adjusting

$$\begin{aligned} V_t^{\text{adjust}}(\mathbf{x}) = \max_{c,d',m'} \; & u(c,d') + \beta \int \mathcal{V}_{t+1}(d',m',y';\epsilon')\, d\mathcal{E}(\epsilon')\, \Gamma(dy';y) \\ \text{s.t. } & [1-(1-\theta)(1-\delta)]\, d' + m' + c \leq \mathcal{Y}_t(\mathbf{x};T_t) + \theta(1-\delta)\, d \\ & m' \geq 0, \end{aligned}$$

- When *not* adjusting

$$\begin{aligned} V_t^{\text{non}}(\mathbf{x}) = \max_{c,m'} \; & u(c,d') + \beta \int \mathcal{V}_{t+1}(d',m',y';\epsilon')\, dG(\epsilon')\, \Gamma(dy';y) \\ \text{s.t. } & m' + c \leq \mathcal{Y}_t(\mathbf{x};T_t) - \iota\delta d - (1-\theta)\left[(1-\delta)\, d - d'\right] \\ & m' \geq 0 \end{aligned}$$

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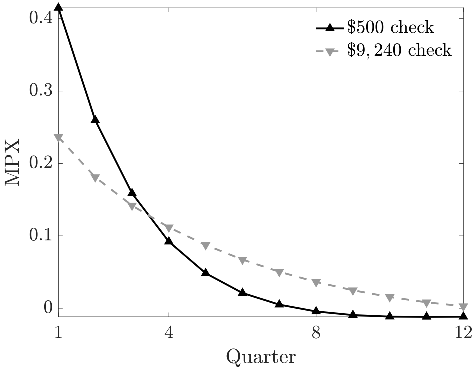
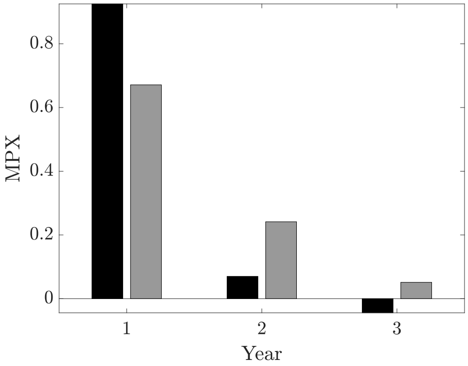
3. Annual MPX

Quarterly MPX



Annual MPX



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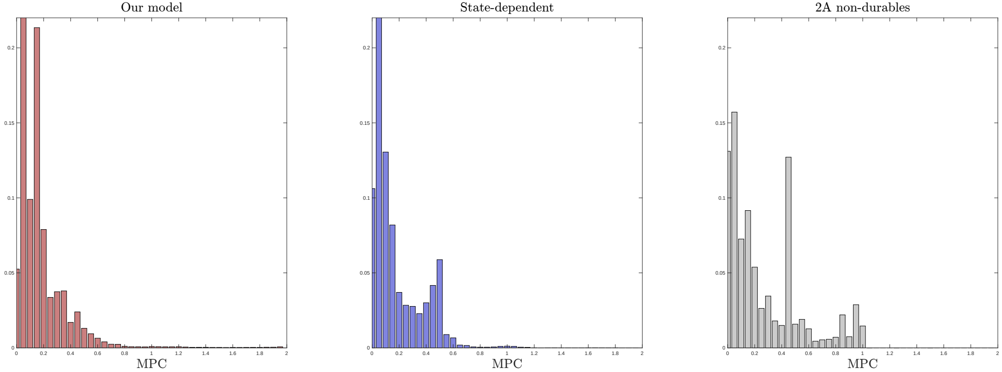
4. Distribution of MPXs (500$ Check)

- Empirically, distribution declines smoothly and large MPX (> 1) (Lewis et al., Fuster et al.)



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State- and Time-Dependent Adjustments

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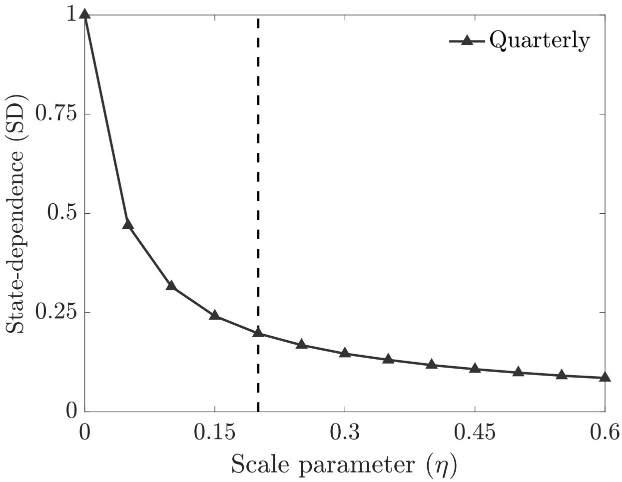
- By definition, $\text{SD} = 1$ in state-dependent model and $\text{SD} = 0$ in Calvo model.

State- and Time-Dependent Adjustments



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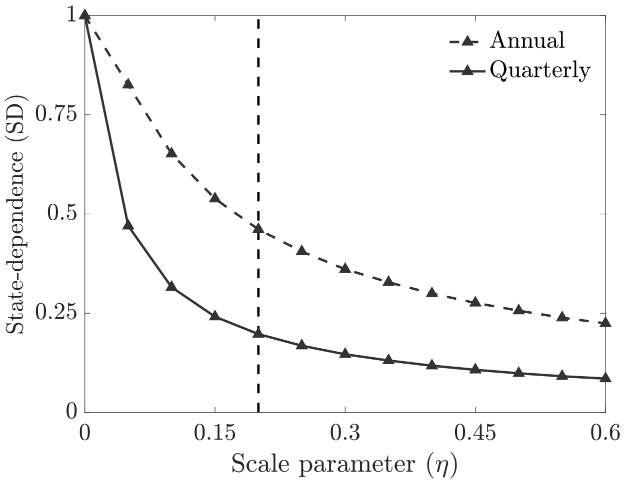

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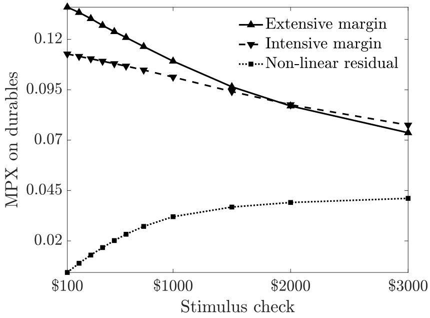
Extensive and Intensive Margins

- Why does the MPX ↓ in our model? **Smooth hazard** dampens the **extensive margin**.



Extensive margin

$$\frac{\int \overbrace{\{\mathcal{S}_0(d, m+T, y) - \mathcal{S}_0(d, m, y)\}}^{\text{\# of marginal adjusters}} \times \overbrace{x(d, m, y)}^{\text{selection}} \times d\pi(\mathbf{x})}{T}$$

- Extensive margin ≃ Intensive margin
- **Selection** dominates (car ⇝ fridge)
- Contrasts with purely state-dep. model

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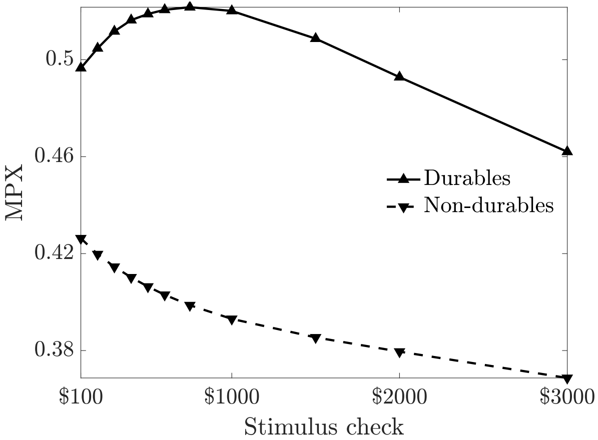
Size-Dependence (Annual MPX)

Figure 9: Annual MPX



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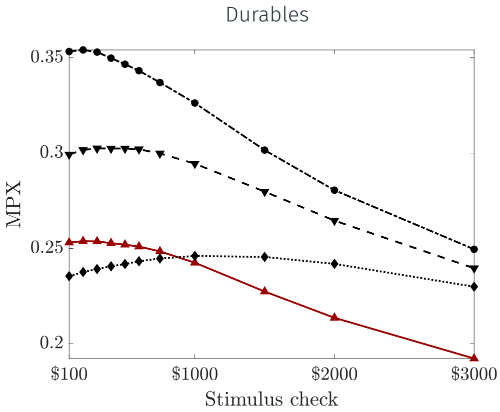
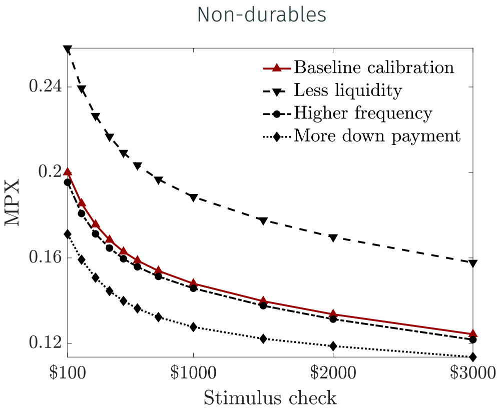
Sensitivity





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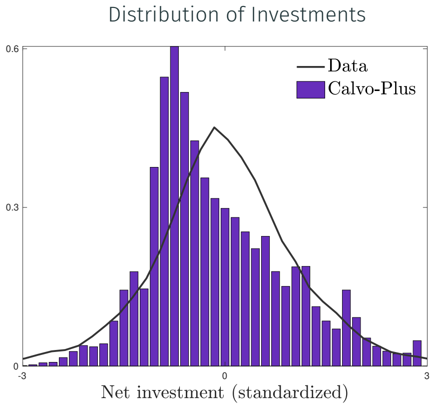
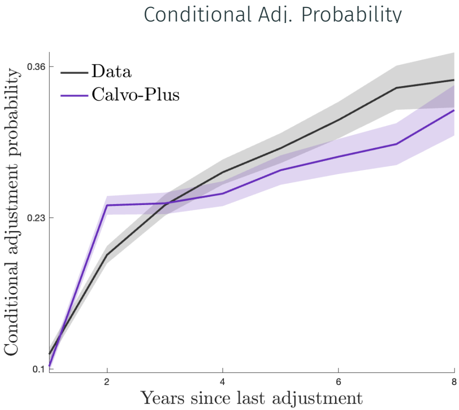
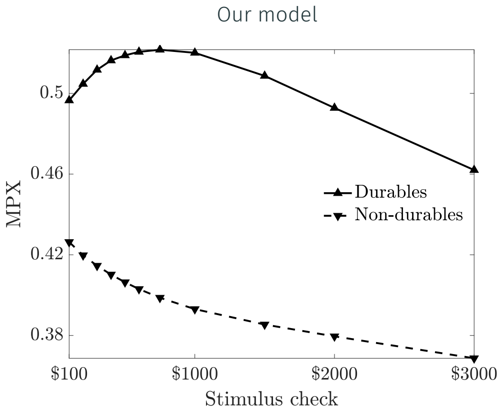
Calvo Plus: Data

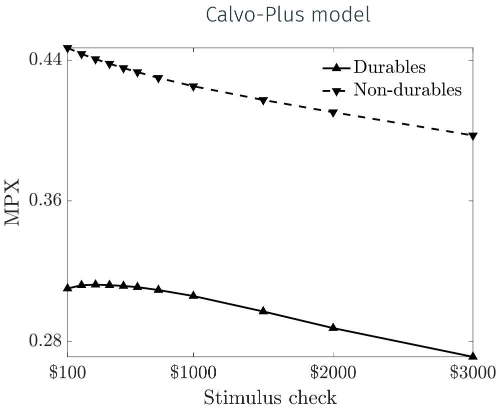




- MPX on durables (18%) is smaller than in our model (25%) and Orchard et al. (30%)
- MPX on durables and non-durables $\sim$ same *vs.* our model + data (ratio 150%)

CALVO PLUS: ANNUAL MPX





- The proportions are reversed compared to our model that matches the data!

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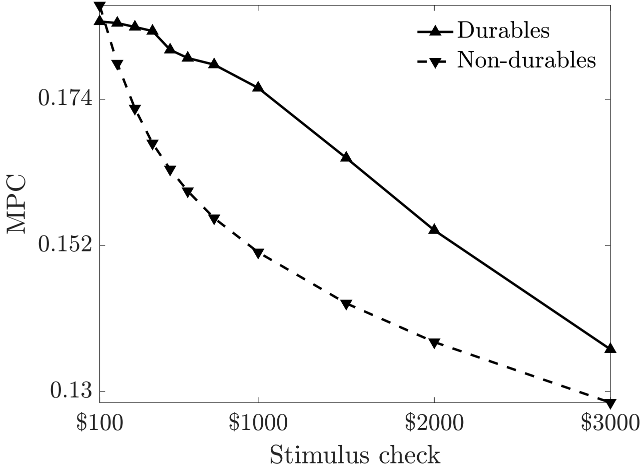
Calvo Plus: Size-Dependence



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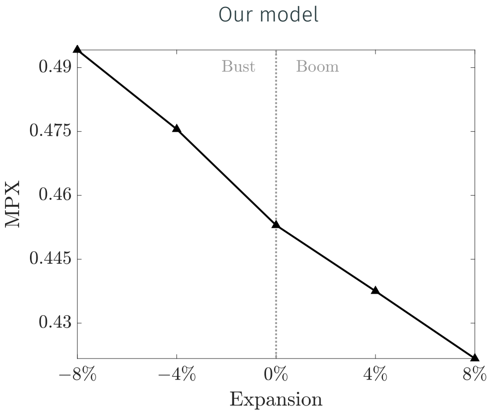
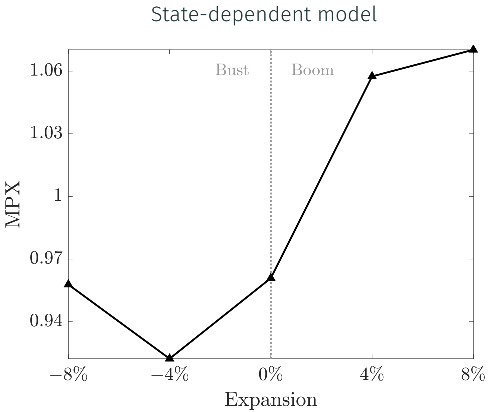
State-Contingency in the MPX





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Closing the Model

Monetary policy

$$r_t^m = \max\left\{r^m + \phi_\Pi \pi_t + \phi_y \hat{Y}_t, \underline{r}\right\}$$

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(checks t_0 financed over 15 years)

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$$E_t^{\text{net}}\left(\mathbf{x}\right) = \psi_{0,t}\left\{y\left(Y_t + \text{Div}_t\right)\right\}^{1-\psi_1}$$

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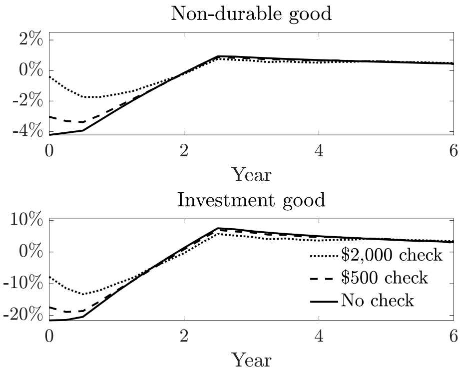
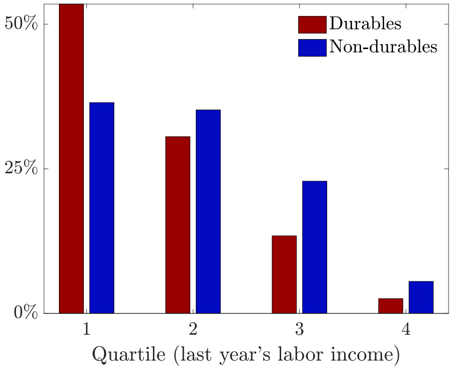
Sectoral output gaps



Decomposing households' responses ($500)



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Supple Side

1. Non-linear Phillips curve

$$\pi_t = \kappa \hat{y}_t + \kappa^\star \max\left\{\hat{y}_t, 0\right\}^2 + \beta \pi_{t+1}$$

   with $\kappa = 0.0031$ (Hazell et al.) and $\kappa^\star = 0.1$ (Mavroeidis et al., Cerrato-Gitti)

2. Reduction in Y_t^{potent} and X_t^{potent} by 50% of initial gap

3. Relative price movements

$$p_t^d \equiv \left(\frac{X_t^{\text{dom}}}{X_t^{\text{potent}}}\right)^{1/\zeta}$$

   with $\zeta = 1/0.049$ (McKay-Wieland)

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