Durables and Size-Dependence in the Marginal Propensity to Spend

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

December 2023

- **Stimulus checks** have become an important policy tool in recent US recessions

Recession	2001	2008	2020	2020-2021
Amount	\$300	\$600	\$1,200	\$2,000

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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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- **Models** of non-durables predict that the MPX falls sharply with the size of checks
- Relevant quantity for policy, however, is **total** household spending
- Empirically, **durable** spending accounts for a large share of the MPX

  Conjecture: durable purchases could respond more as checks become larger (Parker et al., Fuster et al.)

This Paper

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3. Embed the model in **HANK**. Evaluate effect of checks on output in recessions

   A large check of $2,000 increases output by 25 c/$, compared to 37 c/$ for a small $300 check

   Large checks remain effective, but extrapolating out of small checks overestimates their impact

Outline

A Model with a Smooth Hazard

Bringing the Model to the Data

Size-Dependence in the MPX

Stimulus Checks in General Equilibrium

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where

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

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Down payment
Recursive formulation

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

$$V_t(\mathbf{x}) = \max\left\{V_t^{\text{not}}(\mathbf{x}), V_t^{\text{adjust}}(\mathbf{x}) - \kappa\right\},$$

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

Adjustment Hazard

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$$\mathcal{S}_t(\mathbf{x}) = \begin{cases} 1 & \text{if } V_t^{\text{adjust}}(\mathsf{x}) - \kappa > V_t^{\text{not}}(\mathsf{x}) \\ 0 & \text{otherwise} \end{cases},$$

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

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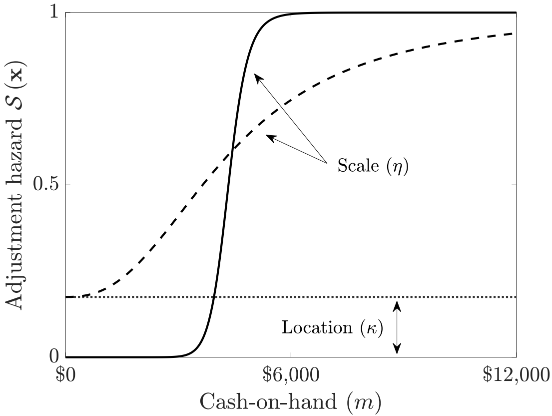
- Nest two polar cases: fully **state-dependent** ($\eta \to 0$) and **time-dependent** ($\eta \to +\infty$)

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



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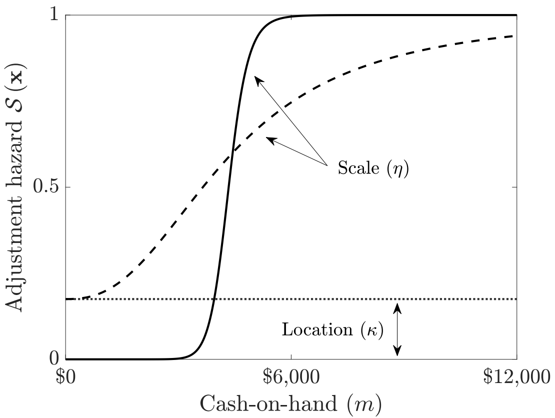

- The shape of the **adjustment hazard** is key for the **size-dependence** in the MPX

Marginal propensity to spend on durables:

$$\mathrm{MPX}^d(T) \equiv \frac{1}{T} \int\int \underbrace{\mathcal{S}(m,d)}_{\text{extensive}} \underbrace{x(m+d)}_{\text{intensive}} \{d\mu(m-T,d) - d\mu(m,d)\}$$

Adjustment Hazard and Size-Dependence

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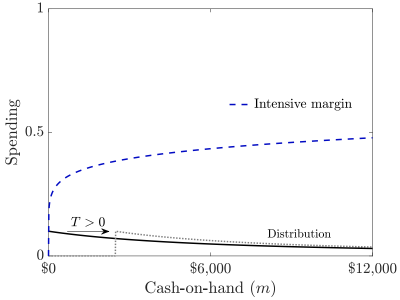
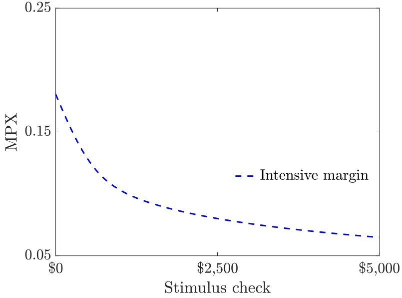
Spending functions



MPX



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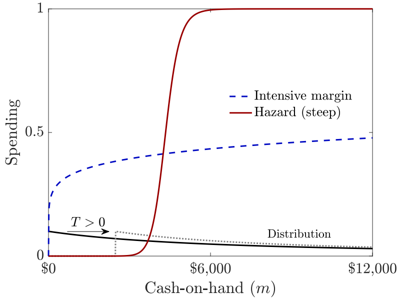
Hazard and intensive margin (fixing d, y)



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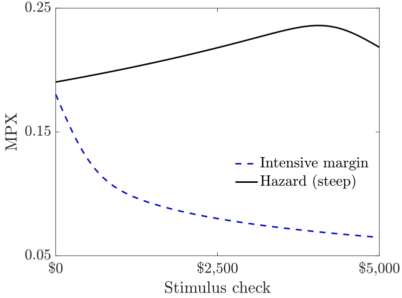

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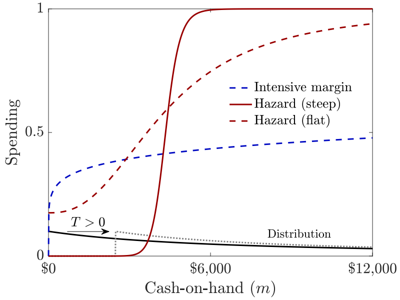

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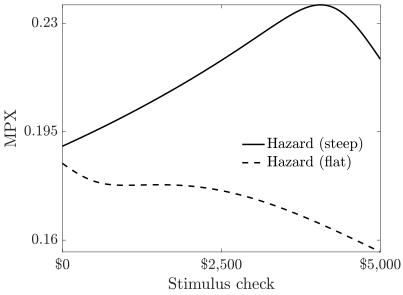

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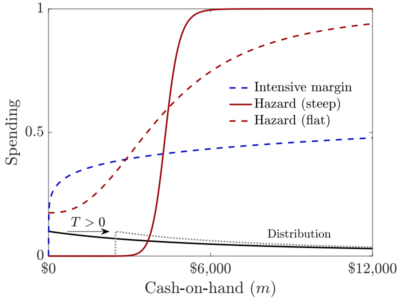

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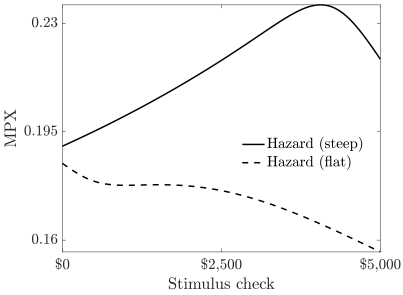

- Getting the **shape of hazard** right is crucial for **size-dependence** + **match evidence**

Calibration

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Parameter	Description	Calibr.	Target	Value	Source
β	Discount factor	0.944	Liquid assets / A Inc	26%	Kaplan et al.
ϑ	Non-durable parameter	0.687	Durables / non-durables	26%	CEX
ι	Maintenance	0.257	Maintenance / new investment	32.6%	CEX
κ	Location parameter	0.803	Frequency of adjustment	23.8%	PSID
η	Scale parameter	0.20	Next slide		

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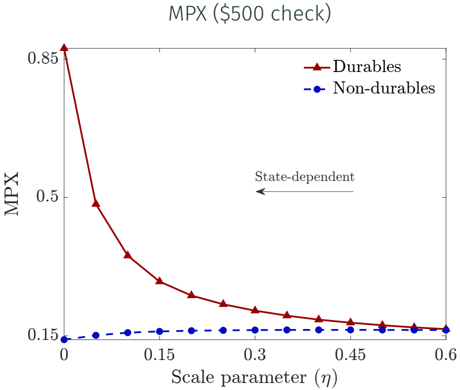

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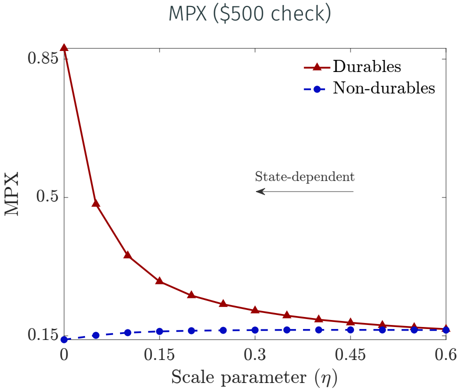

- **Evidence**: $\text{MPX}^d > \text{MPX}^c$ (Havranek-Sokolova) $\rightarrow$ not too time-dependent

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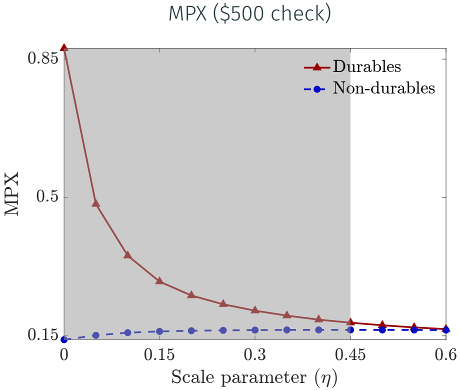

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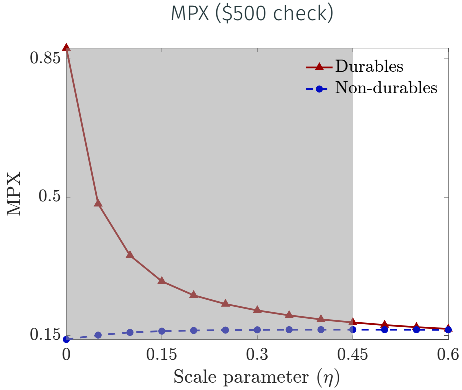

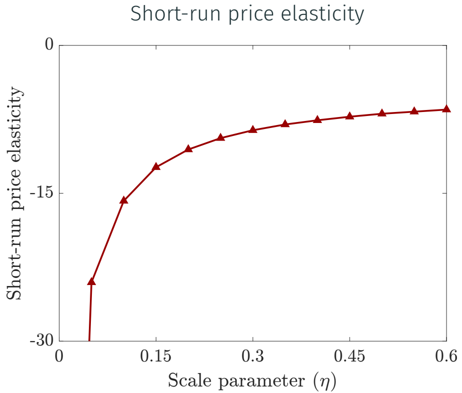

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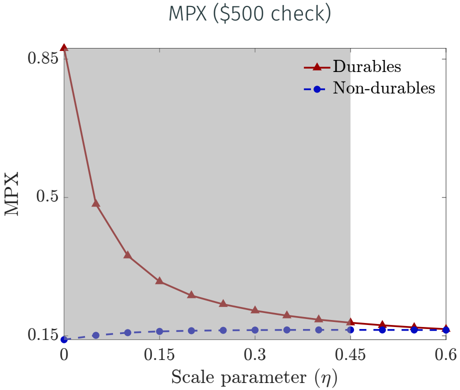

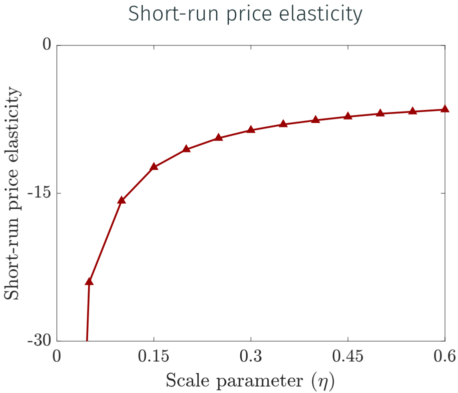

- **Evidence**: Elasticity ≥ -15 (Bachmann et al.) $\rightarrow$ not too state-dependent (McKay-Wieland)

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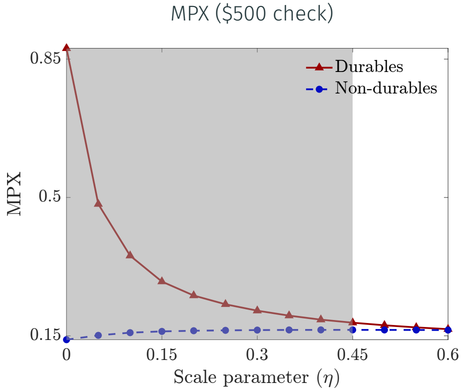

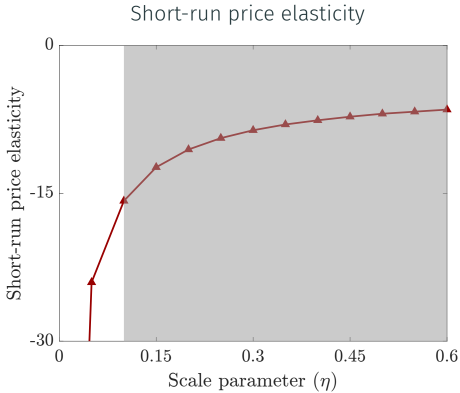

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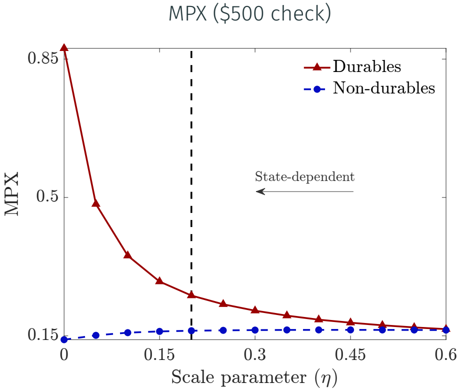
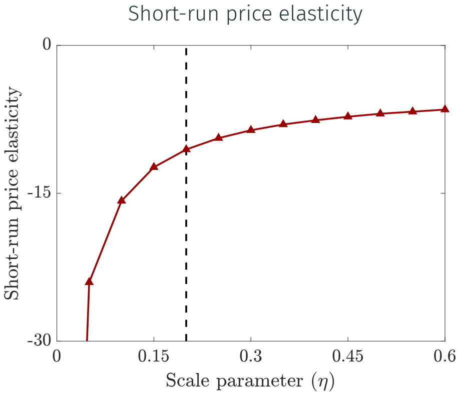
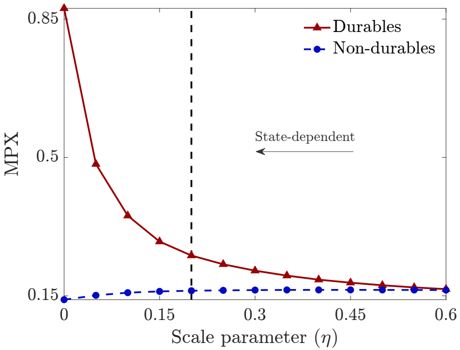


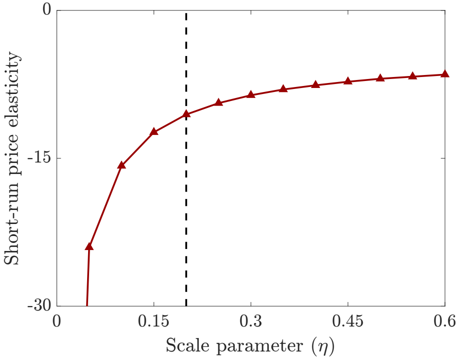


- Benchmark calibration: $\eta = 0.2$ (+ robustness checks)

MPX ($500 check)

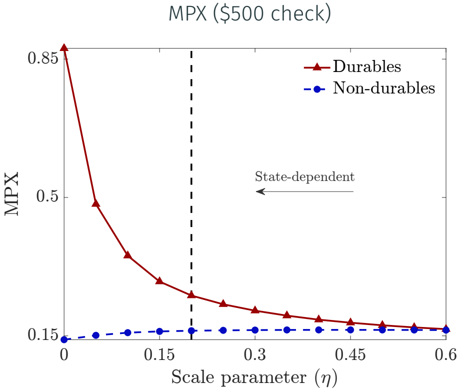


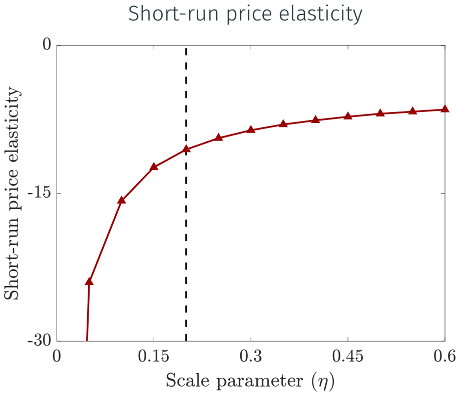
Short-run price elasticity



- Benchmark calibration: $\text{MPX}^d \sim 1.5 \times \text{MPX}^c$ (Havranek-Sokolova) and elasticity ~ -10

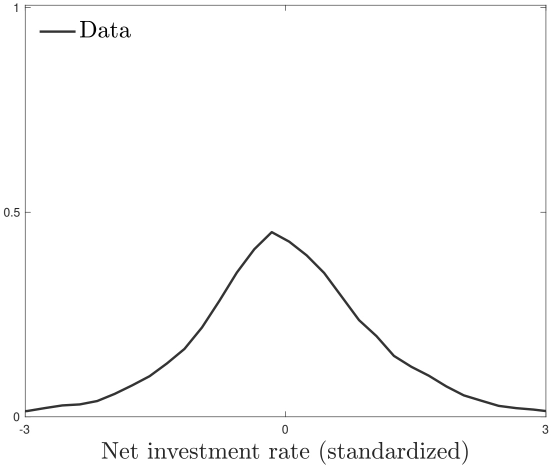
Scale Parameter (η)





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

1. Distribution of Adjustments (PSID)



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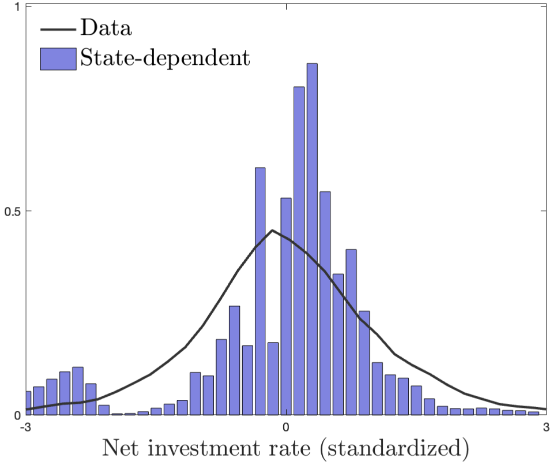
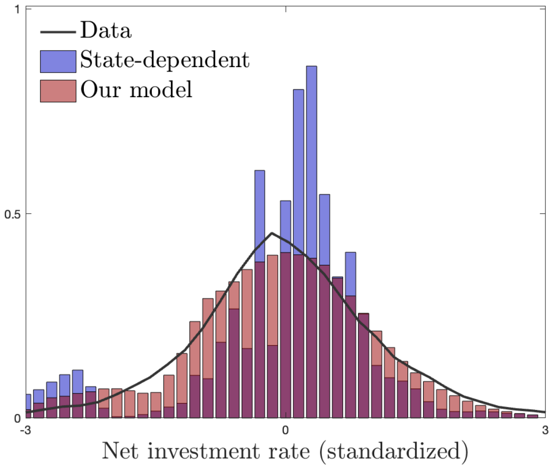


- Matching the **tails** reasonably well is important (Alvarez et al.)



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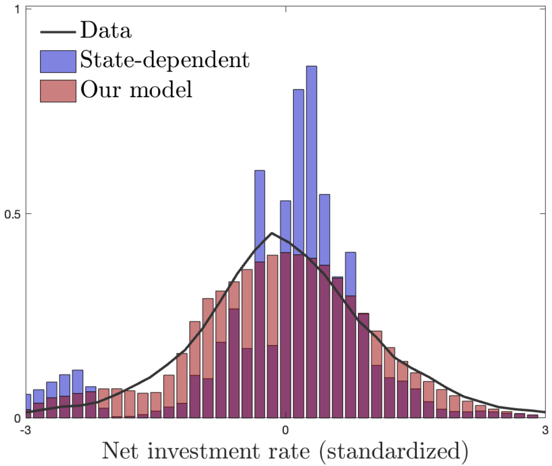

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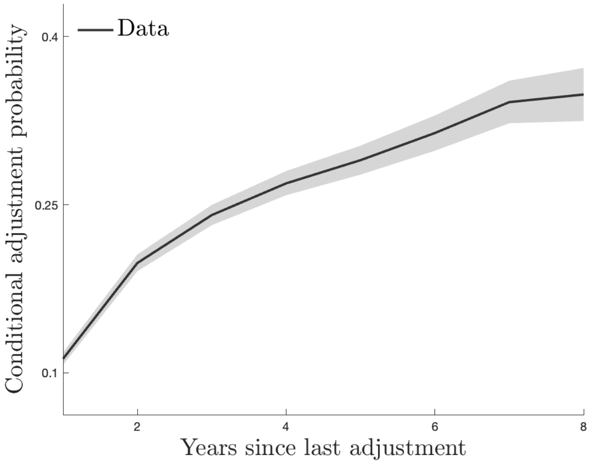
▸ CalvoPlus

2. Probability of Adjustment Since Last Purchase (PSID)



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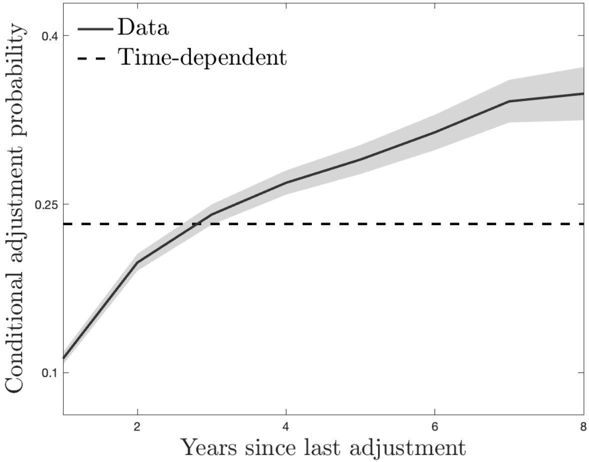
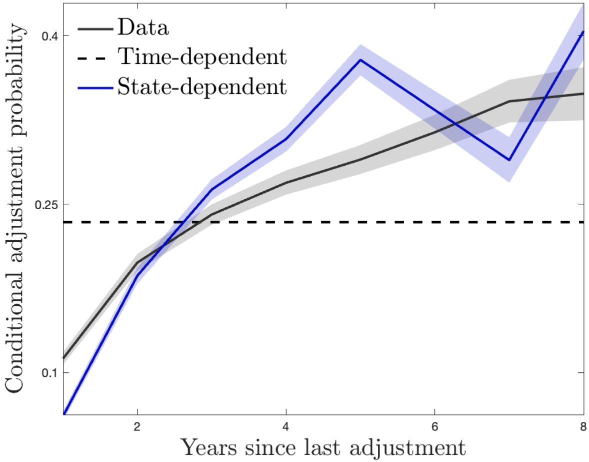
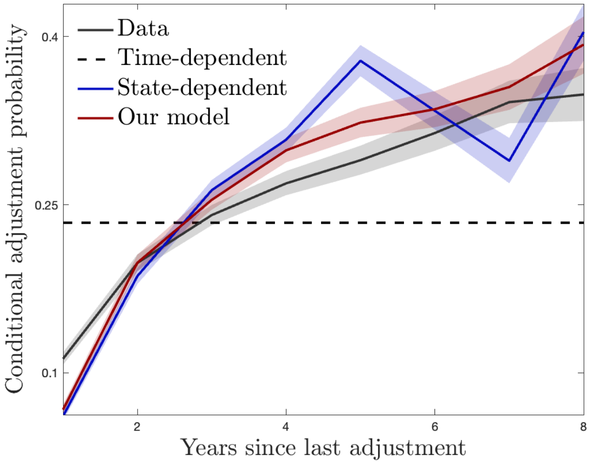


- Adjustment probability conditional on not having adjusted so far (Kaplan-Meier)

2. Probability of Adjustment Since Last Purchase (PSID)



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



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

3. Other Untargeted Moments

1. **Annual MPX ($500).** 42% on durables and 50% on non-durables ▸ Dynamics

   Total MPX of 92% similar to the value reported in Fagereng-Holm-Natvik for small lottery gains

2. **Hand-to-mouth.** 42% of households with $m \leq 1/2 \times$ M inc (Kaplan-Violante-Weidner)

   Almost the exact value reported in Kaplan-Violante and Aguiar-Bils-Boar

3. **Secondary market.** 52% of purchases on secondary market

   Used cars represent roughly 55% of total spending on cars in the US

4. **Distribution of MPX.** Distribution is skewed (some have MPX > 1) ▸ Distribution

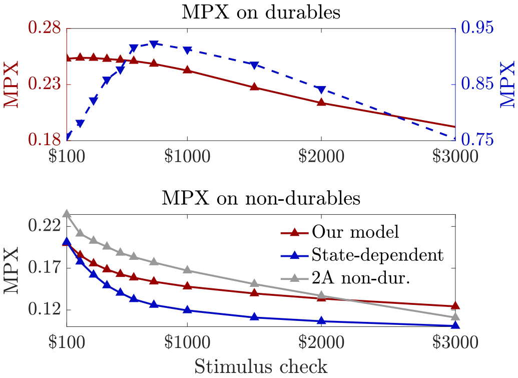
   Resembles the distribution in Lewis-Melcangi-Pilossoph, model of non-durables cannot match this

- Overall, our model provides a good description of households' spending behavior

▸ State-dependence

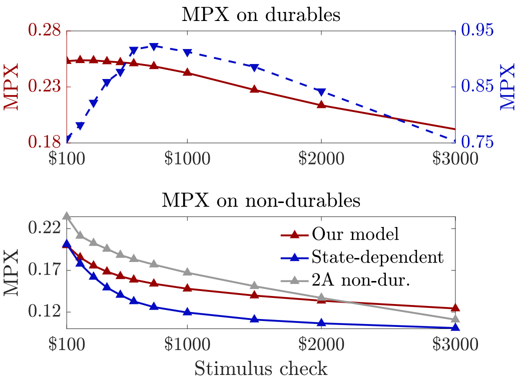
Outline

MPX on durables and non-durables



Size-Dependence in the MPX

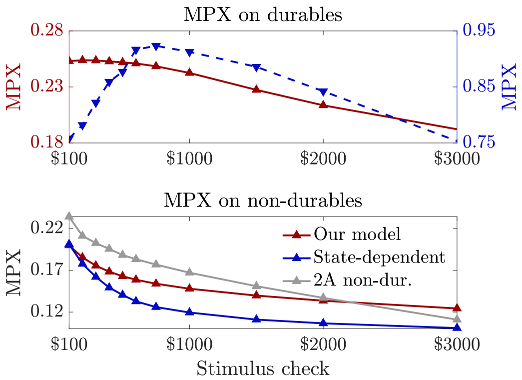
MPX on durables and non-durables



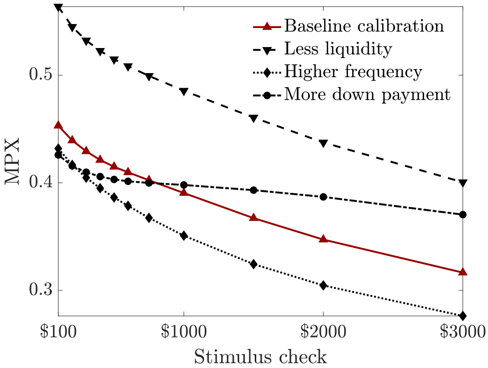
- Modeling **durables** are important for the **MPX on non-durables** (complementarity)

Size-Dependence in the MPX

MPX on durables and non-durables

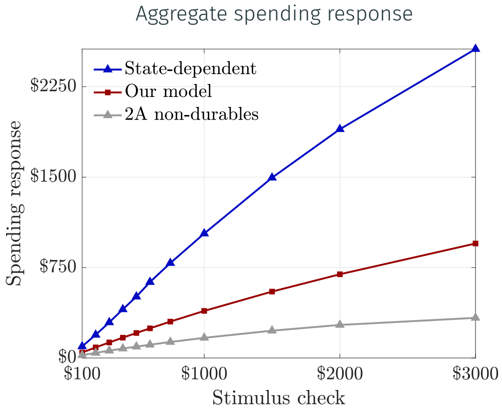


Total MPX



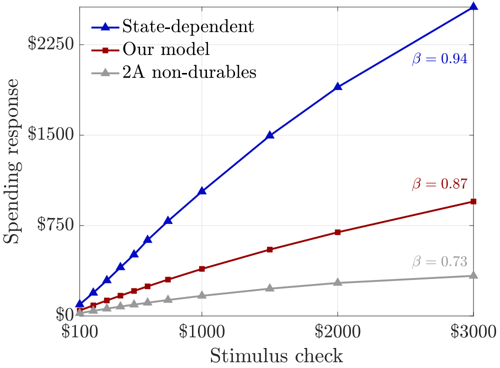
- Our model: **realistic total MPX** (level) that **decreases slowly** (size-dep.)

▸ Decompose

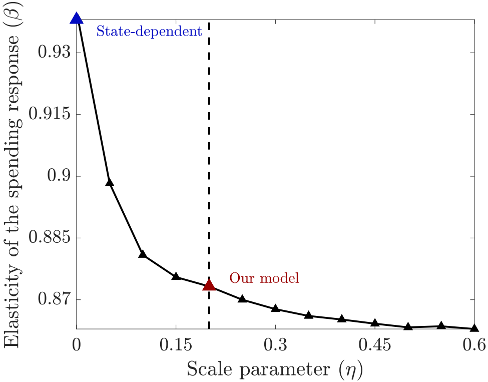

Aggregate spending response
State-dependent
Our model
2A non-durables
$2250
$1500
$750
$0
$100
$1000
$2000
$3000
Spending response
Stimulus check

Concavity in Aggregate Spending Response

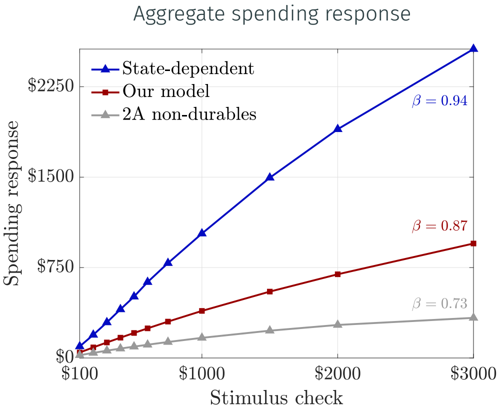
Aggregate spending response

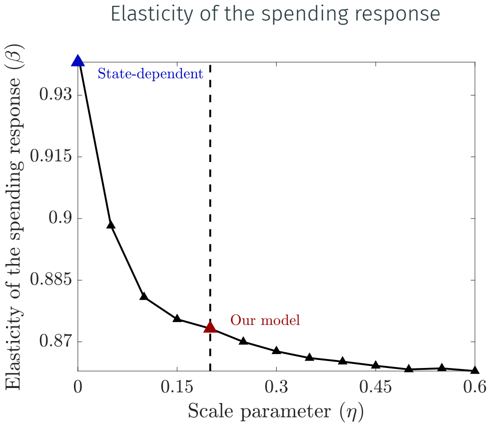


Elasticity of the spending response



Concavity in Aggregate Spending Response





- The size-dependence (concavity) is similar 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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- Extension: stronger **supply-side effects** (Orchard et al., Comin et al.)

  Shocks to **potential output**, and **non-linear NKPC**

Aggregate demand

1. Eligible for checks if $e \leq \$75,000$

Aggregate supply

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2. Imports, e.g., for durables

$$x_t = \left[\sum_{j \in \{H,F\}} \left(\alpha_j^d\right)^{\frac{1}{\rho}} \left(x_t^j\right)^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}}$$

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$$K_t = \left\{1 - \delta^K + \Phi\left(I_t / K_{t-1}\right) + z_t\right\} K_{t-1} \longleftarrow$$

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

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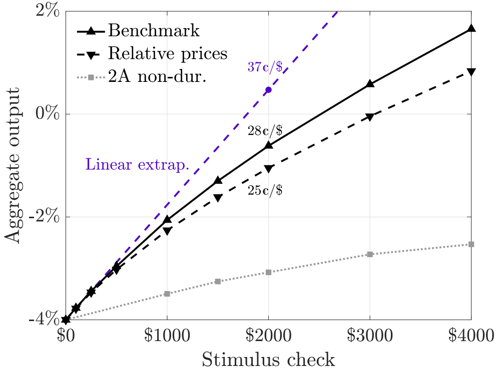
▸ Closing the model

Aggregate output ($t = 0$)



General Equilibrium Response to Stimulus Checks

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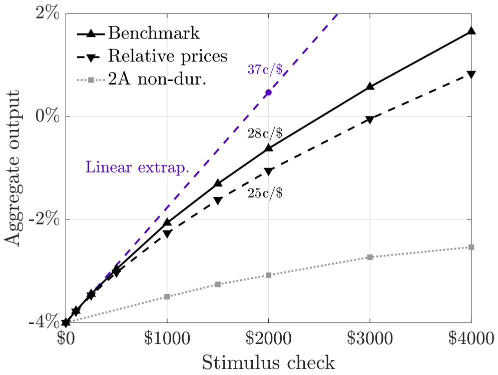

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Additional results

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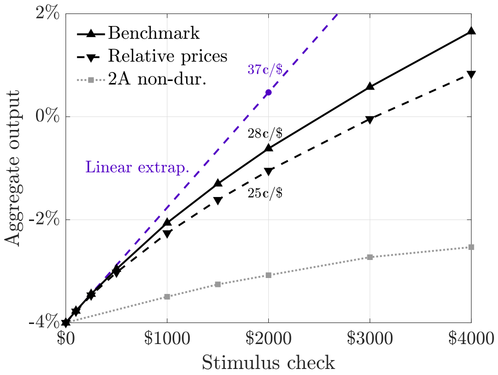
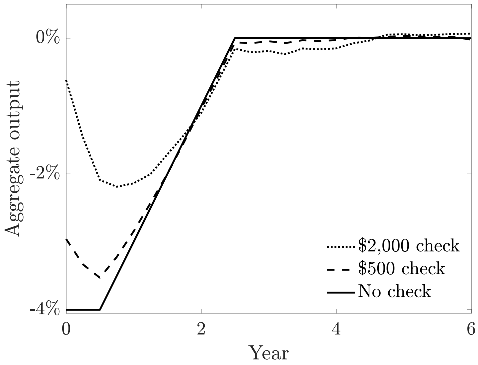


Aggregate output (dynamics)



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Supply Shocks and Inflation

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▸ Supply side

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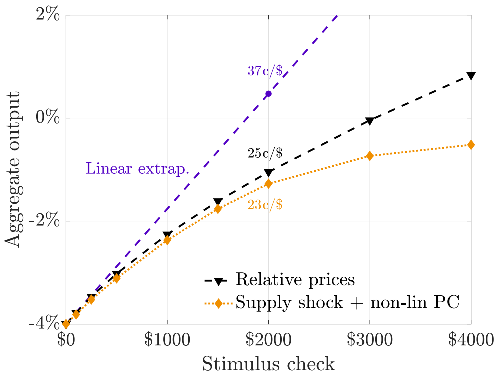

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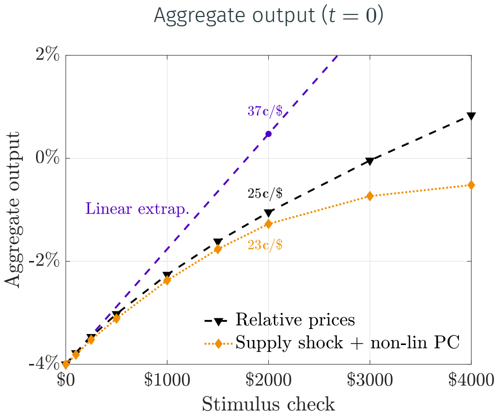

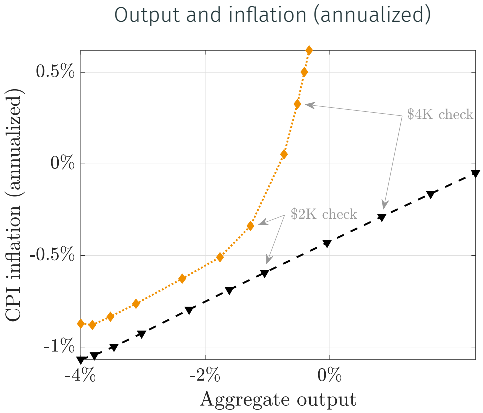

Supply side

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

Model Calibration

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- Credit b is proportional to durables d and is not an extra state variable.

▸ 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

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

- When *not* adjusting

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

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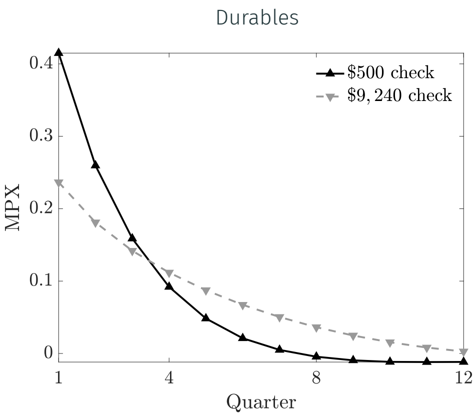
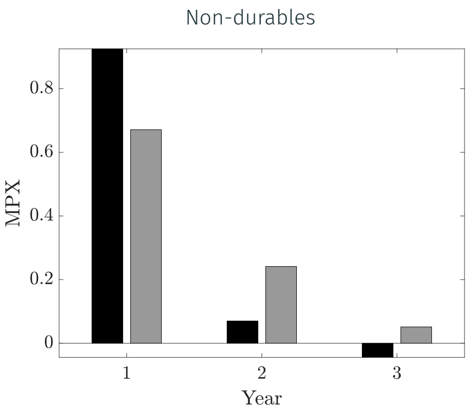
3. Annual MPX





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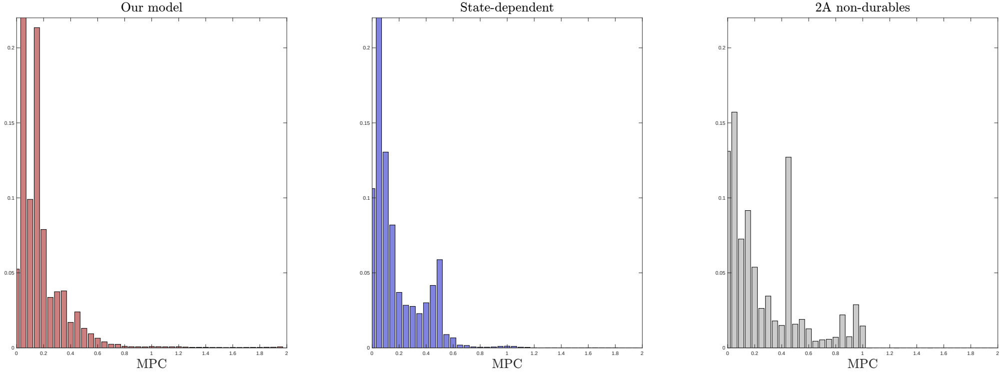
3. Distribution of MPXs (500$ Check)

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



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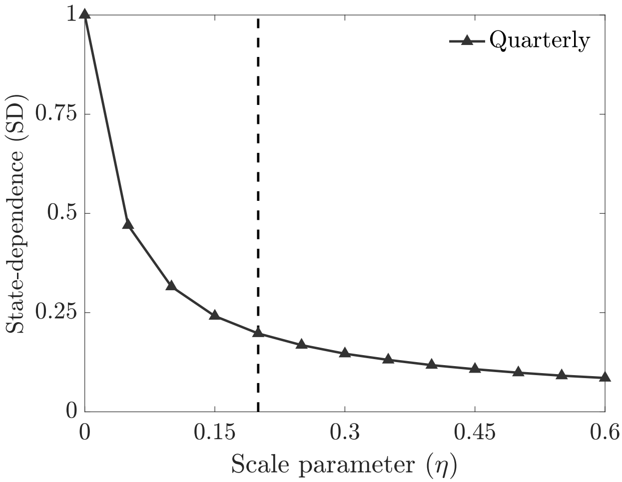
- By definition, $\text{SD} = 1$ in state-dependent model and $\text{SD} = 0$ in Calvo model.

State- and Time-Dependent Adjustments



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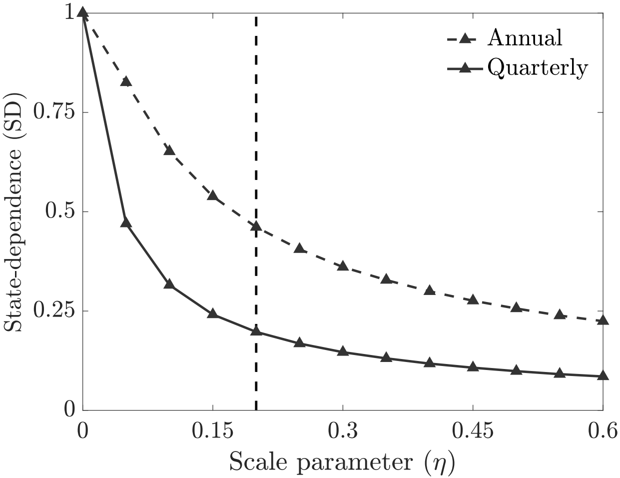
State- and Time-Dependent Adjustments



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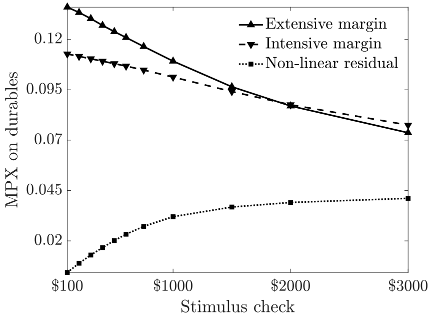
Extensive and Intensive Margins

- Why does the MPX $\downarrow$ 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 $\simeq$ Intensive margin
- **Selection** dominates (car $\rightsquigarrow$ fridge)
- Contrasts with purely state-dep. model

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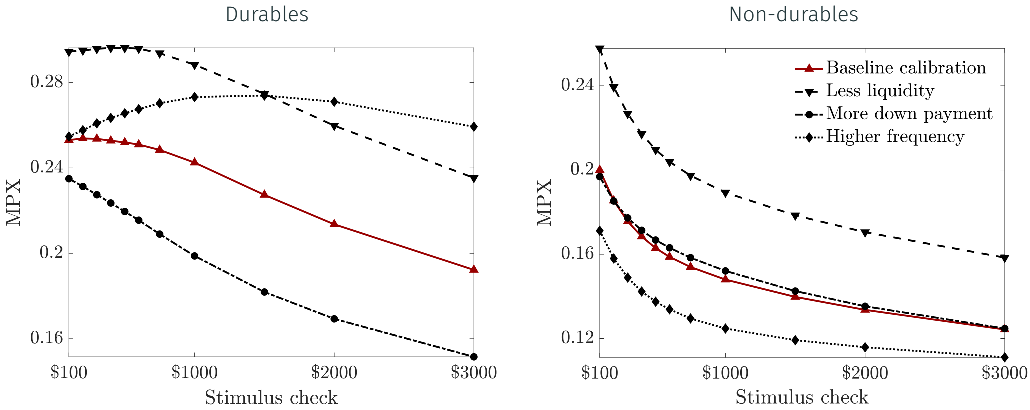
Sensitivity



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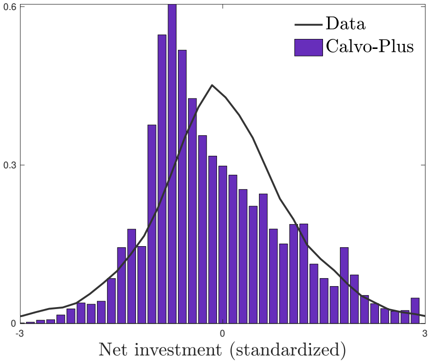
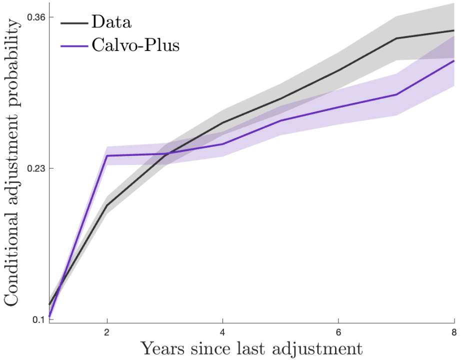
Calvo Plus: Data

Distribution of Investments



Conditional Adj. Probability



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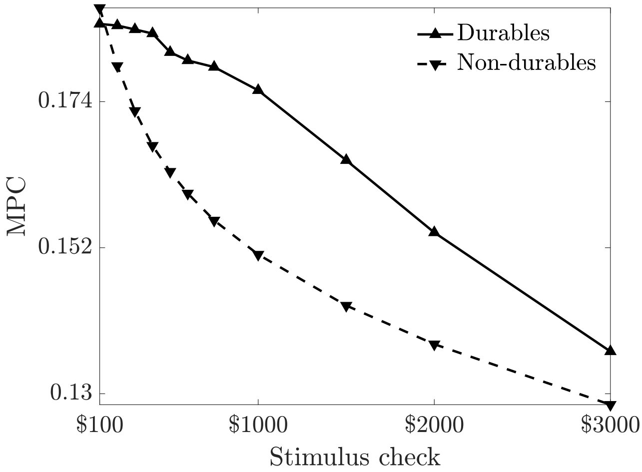
Calvo Plus: Size-Dependence



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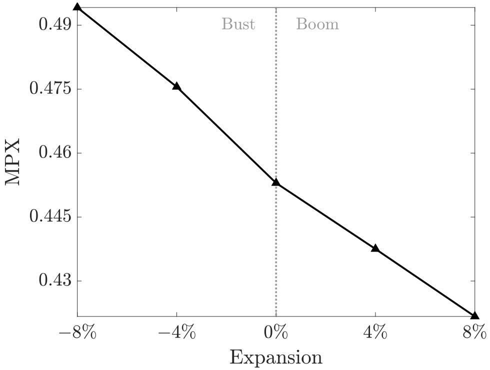
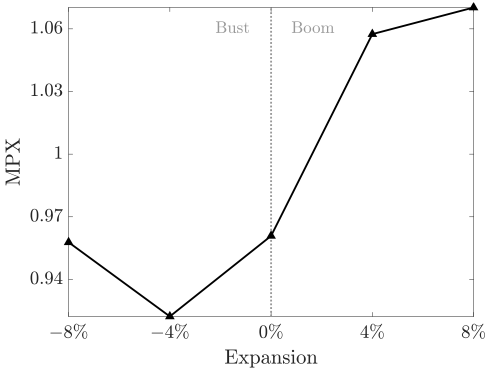
State-Contingency in the MPX

Our model



State-dependent model



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Monetary policy

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

Closing the Model

Monetary policy

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

Fiscal policy

$$B_t^g = \frac{1 + r_t}{1 + \pi_t} B_{t-1}^g + \mathcal{T}_t - t_t - G_t$$

(checks t_0 financed over 15 years)

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Market clearing

$$P_t^c \left(C_t + G_t\right) + F^{-1}\left(X_t^{\text{dom}}\right) + \text{NX}_t^{c,\text{real}} = Y_t^{\text{dom}}$$

$$P_t^d X_t + p_t^d I_t + \text{NX}_t^{d,\text{real}} = p_t^d \left(X_t^{\text{dom}} + A_1 K_{t-1}\right)$$

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Incomes

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

(with dividend smoothing)

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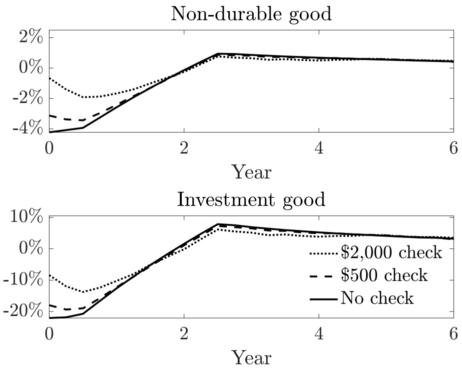
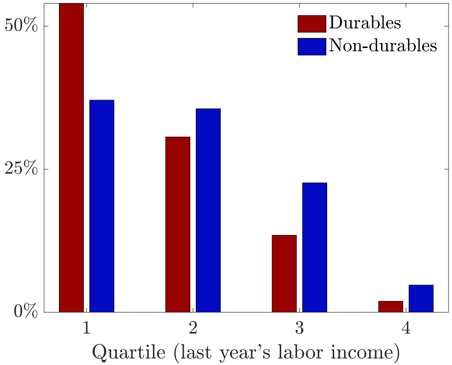
Sectoral and Distributional Outcomes

Sectoral output gaps



Spending multipliers



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Supple Side

1. Non-linear Phillips curve

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

   with $\kappa^\star = 0.1$ (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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