Credit Market Imperfections, the New Keynesian Model, and Monetary Policy

Tommaso Monacelli

Università Bocconi, IGIER and CEPR

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- **New Keynesian** framework modern tool for monetary policy and business cycle analysis

- Basic ingredients: dynamic general equilibrium + imperfect competition + (some form of) nominal stickiness

- Culmination: Woodford, *Interest &Prices*, 2003

- Main feature**: perfect credit markets**

1. Free borrowing/lending at a given interest rate

2. Transmission of monetary policy is via **intertemporal** allocation of consumption

A NK Model with **Collateralized Borrowing**

1. Two **final-good** sectors: Durables + Non Durables

2. **Heterogeneity** in preferences (patience rates) (Becker 1980, Krusell-Smith 1998, Kiyotaki-Moore 1997, Iacoviello, 2005, Campbell and Hercowitz, 2006)

3. **Impatient** agent (*Borrower*) has preferences tilted towards current consumption (**MU consumption** $>$ **MU saving)**

4. Borrower is subject to **collateral constraint** (avoids impatient accumulates debt indefinitely)

Notice: in equilibrium, borrower is **opposite** to a standard **permanent-income consumer**

- **Borrowers (**measure ω)

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^t U(X_t, N_t) \right\} \qquad \underbrace{\beta}_{\text{bor row er}} < \underbrace{\gamma}_{\text{saver}}$$

(i) Consumes index of durable and non-durable **final** goods

$$X_t \equiv \left[(1-\alpha)^{\frac{1}{\eta}} \left(C_t\right)^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} \left(D_t\right)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}$$

(ii) Sequence of budget constraints (in units of ND)

$$C_t + q_t(D_t - (1-\delta)D_{t-1}) + \frac{R_{t-1}\, b_{t-1}}{\pi_{c,t}} = b_t + \frac{W_t}{P_{c,t}} N_t + T_t$$

$q_t \equiv$ relative price of durables

Notice: **inflation** affects borrower's **net worth**

(iii) **Collateral constraint** (in nominal terms)

$$R_t B_t \leq (1-\chi)(1-\delta) E_t \left\{ D_t P_{d,t+1} \right\}$$

$\chi \equiv$ down-payment rate (1 - LTV ratio)

- Intutition: **limited commitment** (Kyiotaki and Moore 1997, Kocherlakota 2000)

- Amount $R_t B_t$ agreed today (t) to be repayed tomorrow (t+1) is proportional to the (expected) value of the asset pledged as a collateral

- Idea: if borrower defaults in t+1, lender can expect to seize a value $E_t \left\{ D_t P_{d,t+1} \right\}$

Borrower's Lagrangian: choose$\{C_t,\ D_t,\ N_t,\ B_t\}$

$$
\begin{aligned}
&E_0 \sum_{t=0}^{\infty} \beta^t U(X_t, N_t) \\
&-\beta^t \lambda_t \left[P_{c,t} C_t + P_{d,t}(D_t - (1-\delta) D_{t-1}) + R_{t-1}\ B_{t-1} - B_t - W_t N_t - T_t \right] \\
&-\beta^t \lambda_t \psi_t \left[R_t B_t - (1-\chi)(1-\delta) E_t \left\{ D_t P_{d,t+1} \right\} \right]
\end{aligned}
$$

Borrower's Efficiency Conditions

(i) **D/ND margin**

$$\underbrace{U_{c,t}\ q_t = U_{d,t} + \beta(1-\delta)E_t\left\{U_{c,t+1}q_{t+1}\right\}}_{\text{under free borrowing}} + \underbrace{(1-\chi)\,(1-\delta)U_{c,t}q_t\psi_t E_t\left\{\pi_{d,t+1}\right\}}_{\text{MU of using D as collateral}}$$

$\uparrow \psi_t \equiv \uparrow$ shadow value of borrowing $\rightarrow$ **tightening** of collateral constraint

(ii) **Pseudo-Euler condition**

$$R_t \psi_t = 1 - \beta E_t \left\{ \frac{U_{c,t+1}}{U_{c,t}} \frac{R_t}{\pi_{c,t+1}} \right\}$$

$$\psi_t > 0 \quad \rightarrow \quad \underbrace{U_{c,t}}_{MU \text{ consumption}} \quad > \quad \underbrace{\beta E_t \left\{ U_{c,t+1} \frac{R_t}{\pi_{c,t+1}} \right\}}_{MU \text{ shifting consumption intertemporally}}$$

- **Steady state**

1. Pin down real interest rate from saver's Euler: $1/\gamma = R$

2. From borrower's consumption Euler$\longrightarrow$

$$1 - \psi R = \frac{\beta R}{\pi_c}$$

Rewrite

$$1 - \frac{\psi}{\gamma} = \frac{\beta}{\gamma \pi_c}$$

$\longrightarrow$Obtain (with $\pi_c = 1$)

$$\psi = \gamma - \beta > 0$$

$\longrightarrow$Constraint **always binding** in the steady state

- Implications for **transmission mechanism** of monetary policy

1. Standard intertemporal **AD equation** becomes (log utility, all in % devs. from ss)

$$c_t = E_t\{c_{t+1}\} - \frac{\gamma}{\beta}\left[r_t + \underbrace{\left(1 - \frac{\beta}{\gamma}\right)\widehat{\psi}_t}_{\text{finance premium}} - \frac{\beta}{\gamma}E_t\left\{\pi_{c,t+1}\right\}\right]$$

- Movements in the shadow value of borrowing akin to **finance premium**

- $\uparrow R_t \;\rightarrow\; \uparrow \widehat{\psi}_t$ via collateral constraint equation

- Savers' standard consumption Euler equation

$$\widetilde{c}_t = E_t \{\widetilde{c}_{t+1}\} - r_t - E_t \left\{\pi_{c,t+1}\right\}$$

Recall: savers are in measure $1 - \omega$

- Combine to obtain **aggregate** consumption Euler equation:

$$c_t^A = E_t\left\{c_{t+1}^A\right\} - \sigma_r\left(r_t - E_t\left\{\pi_{c,t+1}\right\}\right) - \underbrace{\Theta\widehat{\psi}_t}_{\text{new channel}}$$

$$c_t^A \equiv \omega c_t + (1-\omega)\widetilde{c}_t$$

Notice: intertemporal elasticity of susbtitution in consumption **exceeds 1** even with log-utility

$$\sigma_r \equiv \frac{\omega\gamma}{\beta} + (1-\omega) \geq 1$$

$$\Theta \equiv \frac{\omega\gamma}{\beta}\left(1 - \frac{\beta}{\gamma}\right) \geq 0$$

Notice: $\Omega = 0$ if $\gamma = \beta$ and/or $\omega = 0$

2. Durable / non-durable margin

$\rightarrow$Consider **perfect** credit markets first ($\psi_t = 0$ for all t)

$$\underbrace{V_t \equiv q_t U_{c,t}}_{\text{shadow value of D}} = \underbrace{U_{d,t}}_{MU \text{ durables}} + \underbrace{\beta(1-\delta)E_t\left\{U_{c,t+1}q_{t+1}\right\}}_{MU \text{ from future resale}}$$

-Rearranging $\rightarrow$**user cost == intertemporal** relative price of durables

$$\underbrace{Z_t}_{\text{user cost}} \equiv q_t - \beta(1-\delta)E_t\left\{\frac{U_{c,t+1}}{U_{c,t}}q_{t+1}\right\} = \underbrace{\frac{U_{d,t}}{U_{c,t}}}_{MRS_{C,D}}$$

In compact form:

$$V_t = U_{d,t} + \beta(1-\delta)E_t\left\{V_{t+1}\right\}$$

$\longrightarrow$Integrating forward..

$$V_t = \underbrace{E_t\left\{\sum_{j=0}^{\infty}\left[\beta\left(1-\delta\right)\right]^j U_{d,t+j}\right\}}_{PDV \text{ of } \mathsf{U}_d} \approx const.$$

(i) Under perfect credit markets shadow value of durables is **quasi-constant**

(ii) Movements in user cost of durables dominated by "static" relative price q_t

- Under imperfect credit markets:

(i) **Shadow value** of durables becomes **time-varying**:

$$V_t = \frac{U_{d,t} + E_t\left\{V_{t+1}\right\}}{K_t}$$

$$K_t \equiv \left[1 - (1-\delta)(1-\chi)\psi_t E_t\left\{\pi_{d,t+1}\right\}\right]$$

Notice: $\psi_t = 0 \rightarrow K_t = 1 \rightarrow$ back to perfect credit markets

- Under imperfect credit markets:

(ii) User cost affected positively by shadow value of borrowing (in logs)

$$\widehat{Z}_t = \Phi^{-1}(1-\delta)\ \left[\Gamma \widehat{q}_t - \beta E_t\left\{\widehat{q}_{t+1}\right\} + \gamma \widehat{R}_{r,t} + (\gamma-\beta)\left(\chi\widehat{\psi}_t - \widehat{\zeta}_t\right)\right]$$

$$\Gamma \equiv \left[\frac{1-(1-\chi)(1-\delta)\,(\gamma-\beta)}{(1-\delta)}\right]$$

$$\Phi \equiv 1-(1-\delta)\left[\beta + (1-\chi)\,(\gamma-\beta)\right]$$

- $\widehat{R}_{r,t} \equiv \widehat{R}_t - E_t\left\{\widehat{\pi}_{c,t+1}\right\}$ is the (ex-ante) real interest rate in units of non-durables

- $\widehat{\zeta}_t \equiv E_t\left\{(1-\chi)\widehat{\pi}_{d,t+1} - \widehat{\pi}_{c,t+1}\right\}$ is a composite term in sectoral inflation

- Condition for user cost to rise

$$\Phi^{-1}(1-\delta)(\gamma-\beta)\chi > 0$$

(i) If $\delta = 0 \;\longrightarrow\; \Phi_{\delta=0} \equiv (1-\gamma) + \chi\,(\gamma-\beta) > 0$ $\longrightarrow$User cost always rises

(ii) If $0 < \delta < 1 \longrightarrow$ More easily satisfied:

- the higher the down-payment rate χ

- the higher the saver's patience rate γ

- Implications for consumption of **durables**: $\uparrow R_t \rightarrow \uparrow \psi_t \rightarrow \uparrow$ user cost of D $\rightarrow \downarrow$ demand of D

- Implications for consumption of **NON durables**

$$U_{c,t} q_t = V_t + \Omega_t$$

where

$$V_t \equiv E_t \left\{ \sum_{j=0}^{\infty} [\beta(1-\delta)]^j \, U_{d,t+j} \right\}$$

and

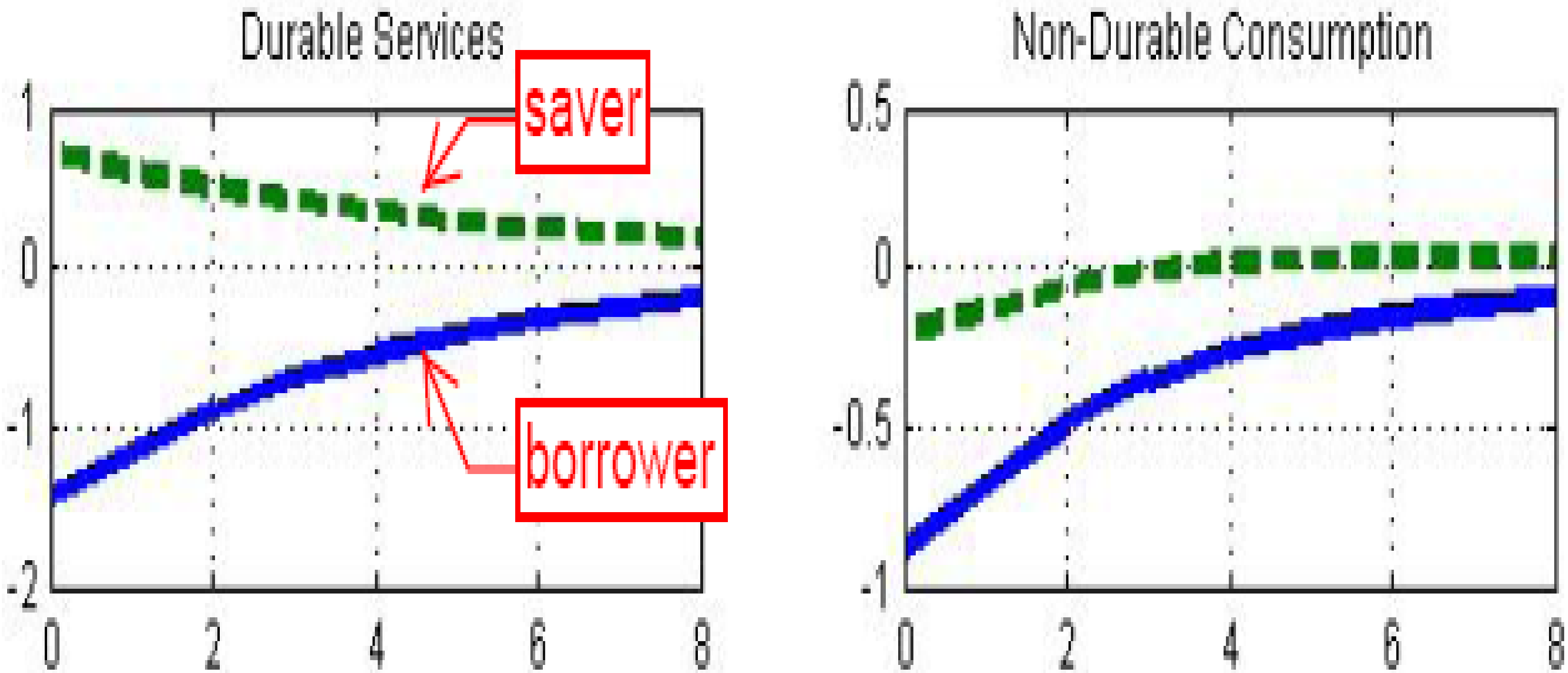
$$\Omega_t \equiv (1-\chi)(1-\delta)E_t\left\{\sum_{j=0}^{\infty}[\beta(1-\delta)]^j\, U_{c,t+j}q_{t+j}\psi_{t+j}E_t\left\{\pi_{d,t+j+1}\right\}\right\}$$

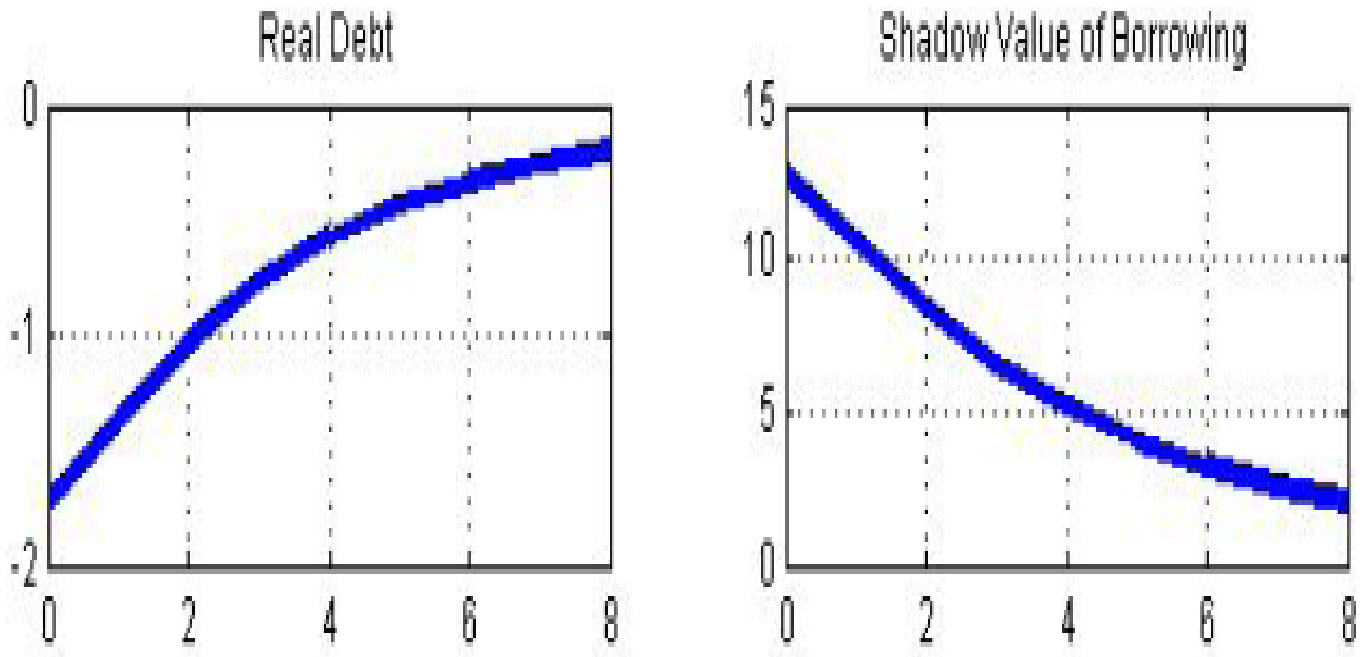
Note: monetary policy affects Ω_t via shadow value of borrowing

- If $V_t \simeq$ constant: $\uparrow R_t \rightarrow \uparrow \psi_t \rightarrow \uparrow \Omega_t \rightarrow \uparrow U_{c,t} \rightarrow \downarrow C_t$ (new channel on consumption)

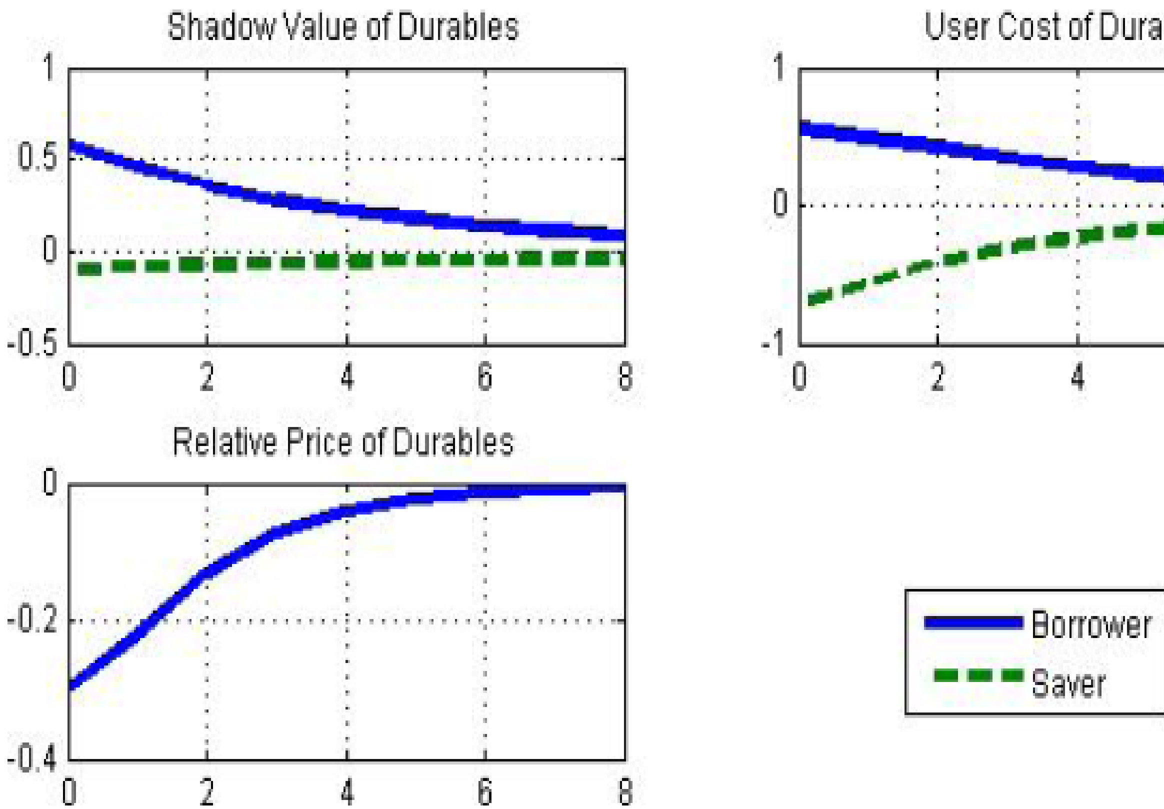
- Notice: this holds even if q_t constant (equal price stickiness or flexibility across sectors)

- Equilibrium dynamics: responses to a **monetary policy tightening**


Durable Services
saver
borrower
1
0
-1
-2
0
2
4
6
8
Non-Durable Consumption
0.5
0
-0.5
-1
0
2
4
6
8



Real Debt
0
-1
-2
0
2
4
6
8
Shadow Value of Borrowing
15
10
5
0
0
2
4
6
8



Shadow Value of Durables
1
0.5
0
-0.5
0
2
4
6
8
User Cost of Durables
1
0
-1
0
2
4
6
8
Relative Price of Durables
0
-0.2
-0.4
0
2
4
6
8
Borrower
Saver

Extensions

1. Collateral constraint both on households and firms $\longrightarrow$ Evidence that households are more affected by credit constraints when interest rates change

2. Alternative forms of borrowing constraint: "**willingness to pay**" vs. "**ability to pay**"

3. Optimal monetary/fiscal policy

- **Ability to pay** constraint

$$R_t B_t \leq (1 - \chi) E_t \{W_t N_{t+1}\}$$