Liquidity and Asset Prices: A New Monetarist Approach

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Motivation

- A monetary economy in which lenders cannot force borrowers to repay their debts, and financial assets are used as collateral to secure loans.
- Explicitly derive loan-to-value ratios, from the condition that lenders offer to loan only as much as borrowers are willing to repay.
- Endogenizing loan-to-value ratios can help relax the assumption of the exogenously given, constant loan-to-value ratios that have been made in the previous literature.
- Evidence: typical loan-to-value ratios vary significantly across countries, and this may partly reflect differences in the technology and institutions to deter default.

Observation

Table: Loan-to-value ratios and foreclosure cost

Country	BE	DE	GR	ES	FR	IT	NL	AT	PT	FI	UK	
LTV	80	70	70	72.5	91	65	101	84	71	81	85	
Duration	18	9	24	8	20	56	5	9	24	2.5	<12	<
cost	18.7	7.5	16	10	9.5	n/a	4	7.5	8	1.5	n/a	

Objectives

- Model main features: Borrowers lose their collateral once they renege on debts, and exclusion of defaulters occurs probabilistically, with a higher probability implying better enforcement.
- Determine simultaneously the asset prices, credit limits, and loan-to-value ratios.
- Key findings: Increased efficiency of the enforcement technology induces higher loan-to-value ratios, while inflation raises loan-to-value ratios only when enforcement is efficient enough.

Related literature

- credit market imperfections:
    - exogenous liquidity constraints: Holmstrom and Tirole (1998), Kiyotaki and Moore (2001, 2005)
    - exogenous loan-to-value ratios: Kiyotaki and Moore (1997), Chen (2001), Iacoviello (2005).
- recognizability of assets and endogenous liquidity constraints:
    - Lester, Postlewaite and Wright (2012)
    - Rocheteau (2011)
    - Li and Rocheteau (2012)
- endogenous credit constraints:
    - Berentsen, Camera and Waller (2007)
    - Ferraris and Watanabe (2008)

Model

- Two assets
  - fiat money, grows at the rate γ
  - real asset that yields a dividend of ρ units of general good each period, constant supply A
- The first subperiod
  - preference shock:
    Prob(an agent is a seller) $= n$: c(q)
    Prob(an agent is a buyer) $= 1 - n$: u(q).
- The second subperiod
  - All agents can produce and consume a good.
  - Agents adjust portfolio (m, a).
  - competitive banks: loan rate = deposit interest rate

Model: mechanisms to deter default

- Collateral mechanism: requires borrowers to pledge some assets to secure their loans, and banks are entitled to the collateral once borrowers renege on debts.
- Reputation mechanism: punishes defaulters by permanent exclusion.
- Our model combines the collateral mechanism and the reputation mechanism, in which exclusion occurs with probability $\zeta \in [0, 1]$; a higher probability implies better enforcement.

Subperiod 2: Maximization Problem

$$
\begin{aligned}
W(m, a, \ell, d) &= \max_{x, h, m_{+1}, a_{+1}} U(x) - h + \beta V_{+1}(m_{+1}, a_{+1}) \\
\text{s.t.} \quad x + \phi m_{+1} + \psi a_{+1} &= h + \phi(m + T) + (\psi + \rho)a \\
&+ \phi(1 + i_d)d - \phi(1 + i)\ell.
\end{aligned}
$$

F.O.C.

$$
\begin{aligned}
&U'(x) = 1 \\
&\phi \geq \beta V_{m_{+1}}(m_{+1}, a_{+1}), \text{ “=” if } m_{+1} > 0 \\
&\psi \geq \beta V_{a_{+1}}(m_{+1}, a_{+1}), \text{ “=” if } a_{+1} > 0
\end{aligned}
$$

Envelope conditions

$$\begin{aligned} W_m &= \phi \\ W_a &= \psi + \rho \\ W_\ell &= -\phi(1+i) \\ W_d &= \phi(1+i_d) \end{aligned}$$

Subperiod 1: Maximization Problem

$$\begin{aligned} V(m,a) &= (1-n)[u(q_b) + W(m+\ell - pq_b, a, \ell)] \\ &\quad + n[-c(q_s) + W(m - d + pq_s, a, d)]. \end{aligned}$$

Sellers' maximization problem:

$$\begin{aligned} \max_{q_s, d} \quad & -c(q_s) + W(m - d + pq_s, a, d) \\ \text{s.t.} \quad & d \leq m. \end{aligned}$$

Buyers' maximization problem:

$$\begin{aligned} \max_{q_b, \ell} \quad & u(q_b) + W(m + \ell - pq_b, a, \ell) \\ \text{s.t.} \quad & pq_b \leq m + \ell, \\ \lambda_\ell : \quad & \ell \leq \bar{\ell} \end{aligned}$$

Subperiod 1: First order conditions

$$\frac{u'(q_b)}{c'(q_s)} = 1 + i + \frac{\lambda_\ell}{\phi}.$$

- Credit constraint does not bind, $\lambda_\ell = 0$:

$$\frac{u'(q_b)}{c'(q_s)} = 1 + i.$$

- $\lambda_\ell > 0$ and credit constraint binds:

$$\frac{u'(q_b)}{c'(q_s)} > (1 + i).$$

The optimal portfolio choices

- The marginal values of holding money and assets:

$$
\begin{aligned}
V_m(m,a) &= (1-n)\frac{u'(q_b)}{p} + n\phi(1+i_d) \\
V_a(m,a) &= (1-n)\phi[\frac{u'(q_b)}{c'(q_s)} - (1+i)]\frac{\partial \ell}{\partial a} + (\psi+\rho).
\end{aligned}
$$

- optimal portfolio choices:

$$
\begin{aligned}
\frac{\gamma-\beta}{\beta} &= (1-n)[\frac{u'(q_b)}{c'(q_s)} - 1] + ni_d, \\
\frac{1-\beta}{\beta}\psi &= \rho + (1-n)\phi[\frac{u'(q_b)}{c'(q_s)} - (1+i)]\frac{\partial \ell}{\partial a}.
\end{aligned}
$$

Equilibrium with full enforcement

- $\bar{\ell} = \infty$.
- $i = \frac{\gamma - \beta}{\beta}$

With full enforcement, the equilibrium value of real asset is the present value of dividends; that is, $\psi = \psi^u$ where

$$\psi^u = \frac{\beta\rho}{1-\beta}.$$

Collateral mechanism

- $\widehat{W}(m, a)$: a deviating buyer's expected discounted utility
- Existence of eqm with credit requires that borrowers voluntarily repay loans:

$$W(m, a) \geq \widehat{W}(m, a).$$

- The real borrowing constraint $\phi\bar{\ell}$ satisfies

$$(1 + i)\phi\bar{\ell} = (\psi + \rho)a.$$

Loan-to-value ratio under the collateral mechanism

- The loan-to-value ratio is

$$\theta_1 = \frac{1 + r_p}{1 + i},$$

  where $r_p = \frac{\rho}{\psi}$ is the dividend-price ratio.
- The loan-to-value ratio is the rate at which the assets can generate liquidity to the economy.

Asset price under the collateral mechanism

$$\psi_1 = \frac{\beta B \rho}{1 - \beta B}$$

where

$$B = 1 + (1-n)[\frac{u'(q_b)}{c'(q_s)} \frac{1}{1+i} - 1]$$

- βB is the 'effective' discount factor by taking into account the credit market imperfections.
- credit constraint binds:
  $\frac{u'(q_b)}{c'(q_s)} > 1 + i \Rightarrow B > 1 \Rightarrow \psi_1 > \psi^u$.
- The 'liquidity premium' is higher when credit rationing is more severe.

Effects of monetary policy

- Monetary policy has similar effects on the loan rate, allocations, and prices in a constrained and unconstrained equilibrium : $\frac{\partial i}{\partial \gamma} > 0$, $\frac{\partial q_b}{\partial \gamma} < 0$, $\frac{\partial \phi \ell}{\partial \gamma} < 0$, $\frac{\partial p}{\partial \gamma} > 0$.
- In a constrained equilibrium, $\frac{\partial \theta_1}{\partial \gamma} < 0$ and $\frac{\partial \psi}{\partial \gamma} \lesseqqgtr 0$ iff $\frac{-u'' q_b}{u'} \lesseqqgtr 1$.

Effects of changes in A and ρ

- A change in the asset supply does not affect the loan rate and allocations in an unconstrained equilibrium, but it has real effects in a constrained equilibrium: $\frac{\partial q_b}{\partial A} > 0$, $\frac{\partial i}{\partial A} > 0$, $\frac{\partial \psi}{\partial A} < 0$, $\frac{\partial \phi}{\partial A} > 0$, $\frac{\partial p}{\partial A} < 0$, $\frac{\partial \theta_1}{\partial A} = 0$.
- A change in the asset's dividend flows affects only the asset price in an unconstrained equilibrium: $\frac{\partial \psi}{\partial \rho} > 0$; however, it also affects the loan rate and allocations in a constrained equilibrium: $\frac{\partial i}{\partial \rho} > 0$, $\frac{\partial q_b}{\partial \rho} > 0$, $\frac{\partial \phi}{\partial \rho} > 0$, $\frac{\partial p}{\partial \rho} < 0$, $\frac{\partial \psi}{\partial \rho} > 0$ if $\left| \frac{\partial B / B}{\partial \rho / \rho} \right| < 1 - \beta B$, $\frac{\partial \theta_1}{\partial \rho} = 0$.

Combined collateral mechanism and reputation mechanism

At the end of each period after banks have seized defaulters' collateral, an agent's default record is updated with probability ζ, and the updating does not occur with probability $1 - \zeta$.

- With probability $1 - \zeta$ a defaulter faces only the punishment of losing collateral, and his expected utility is $\widehat{W}(m, a)$.
- With probability ζ a defaulter will be excluded, and has the expected discounted utility is $\widetilde{W}(m, a)$.
- The expected discounted utility of a deviator entering the second subperiod is

$$\overline{W}(m, a) = \zeta \widetilde{W}(m, a) + (1 - \zeta) \widehat{W}(m, a).$$

Asset price and loan-to-value ratio

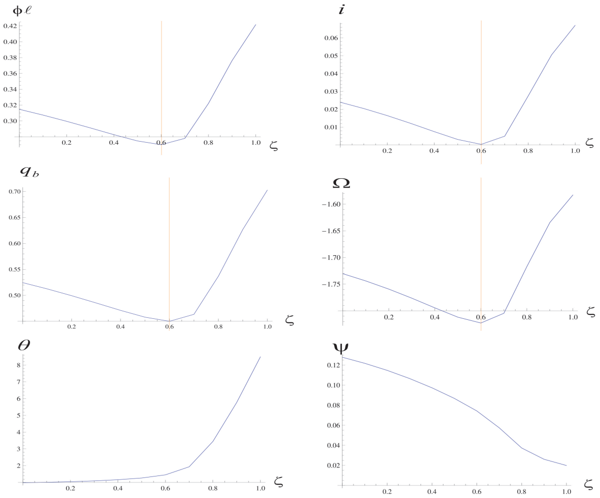
$$\psi_2 = \frac{\beta B_2 \rho}{1 - \beta B_3},$$

where

$$\begin{aligned} B_2 &= 1 + (1-n)(1 + \frac{\beta\zeta}{1-\beta})[\frac{u'(q_b)}{c'(q_s)}\frac{1}{1+i} - 1] \\ B_3 &= 1 + (1-n)(1-\zeta)[\frac{u'(q_b)}{c'(q_s)}\frac{1}{1+i} - 1], \end{aligned}$$

$$\begin{aligned} \theta_2 &= \frac{(1-\beta+\beta\zeta)r_p + (1-\beta)(1-\zeta)}{(1-\beta)(1+i)} + \frac{\zeta\beta}{(1-\beta)(1+i)\psi a} \\ &\quad \{(1-n)\Psi(q_b, \widetilde{q}_b) + \frac{\gamma(1-\beta)}{\beta}c'(q_s)[\widetilde{q}_b - (1-n)q_b]\}. \end{aligned}$$

Effects of efficiency of enforcement



Key insights: enforcement

- Increased efficiency of the enforcement technology raise loan-to-value ratios, while reducing the asset price, because collateral becomes a less important commitment device for borrowing.
- Result: when the technology's efficiency is above some threshold, the punishment of exclusion is substantial enough to make the rise in the loan-to-value ratio a dominant effect. As a result, aggregate liquidity, output, and welfare increase with advances in the technology.

Key insight: inflation

- Higher inflation exerts adverse effects on output by reducing the incentive to produce.
- An additional transmission channel: binding credit constraints.
    - Inflation raises the loan rate and, thus, the repayment cost.
    - If exclusion is feasible, inflation relaxes the credit constraint by increasing the cost of default, because defaulters need to bring enough money to self-insure against consumption shocks.
- Result: when enforcement is strong enough for inflation to impose a sufficient penalty, loan-to-value ratios, liquidity, and output rise.

Conclusion

- This paper combines the collateral mechanism and the reputation mechanism with probabilistic exclusion to illustrate how loan-to-value ratios and monetary policy implications depend on enforcement.
- Key findings: high loan-to-value ratios are driven by sufficient efficiency in enforcement, while inflation may raise loan-to-value ratios only if the enforcement ability is high enough.
- Imposing restrictions on the access to future credit may improve liquidity and allocations only when they constitute a substantial punishment on defaulters.

A Unified Framework for Monetary Theory and Policy Analysis

Lagos and Wright (2005 *JPE*)

November 2016

Introduction

- Reduced-form monetary macro models: not explicit about the role of money in overcoming spatial, temporal or informational frictions.
- Search models have explicit micro-foundations.
- Previous search models: ill-suited for the analysis of monetary policy due to the extreme restrictions on money holding.
- This model: no extreme restrictions on money holding.

Main feature of the model

- Previous models without restrictions on money holding are complicated by the endogenous distribution of money holding, $F(m)$.
- Assumption of quasi-linear preference makes $F(m)$ degenerate: No wealth effects in the demand for money.
- This framework is as easy to use as standard reduced-form models (e.g. study the cost of inflation)

Model: market structure and preferences

$$\text{Market structure} \begin{cases} \text{Day – DM (search): special goods} \\ \text{Night – CM (Walrasian): general goods} \end{cases}$$

- Preferences: $U(\underbrace{x, h}_{\text{day}}, \underbrace{X, H}_{\text{night}}) = u(x) - c(h) + U(X) - H.$
- x, X: consumption. h, H: labor supply.
- $\exists q^* \in (0, \infty)$ $s.t.$ $u'(q^*) = c'(q^*)$.
  $\exists X^* \in (0, \infty)$ $s.t.$ $U'(X^*) = 1$ with $U(X^*) > X^*$

Model: DM

- DM: decentralized and anonymous $\rightarrow$ no credit.
  α: prob of meeting.
- special goods:
  prob(double coincidence of wants) $= \delta$.

  prob(single coincidence of wants) $= \sigma$.

  prob(neither wants the other produces) $= 1 - 2\sigma - \delta$.

Model: CM

- CM: All agents produce and consume a general good.
- Special goods and general goods are divisible and non-storable
  $\rightarrow$ no commodity money.

Model: distribution of money holdings

- money: perfectly divisible and storable in any non-negative quantity. M: total money stock
- $F_t(\tilde{m})$ $(G_t(\tilde{m}))$: measure of agents starting the DM (CM) holding $m \leq \tilde{m}$, F_0, G_0 exogenously given.
- $\int m \, dF_t(m) = \int m \, dG_t(m) = M, \forall t.$
- ϕ_t: value of money in terms of general goods in CM.
- No uncertainty in the basic model except for random matching.
- Aggregate variables such as F_t, G_t and prices are taken as given, an agent's decisions depend only on his money holdings, m.

Value function: DM

An agent with m entering DM:

$$
\begin{aligned}
V_t(m) &= \alpha\sigma \int \{u[q_t(m,\tilde{m})] + W_t[m - d_t(m,\tilde{m})]\} dF_t(\tilde{m}) \\
&+ \alpha\sigma \int \{-c[q_t(\tilde{m},m)] + W_t[m + d_t(\tilde{m},m)]\} dF_t(\tilde{m}) \\
&+ \alpha\delta \int B_t(m,\tilde{m}) \; dF_t(\tilde{m}) \\
&+ (1 - 2\alpha\sigma - \alpha\delta) W_t(m). \qquad (1)
\end{aligned}
$$

Value function: CM

An agent with m entering CM:

$$W_t(m) = \max_{X,H,m'} \{U(X) - H + \beta V_{t+1}(m')\} \tag{2}$$

$$\text{s.t.} X = H + \phi_t m - \phi_t m'$$

$$X \geq 0, 0 \leq H \leq \bar{H}, m' \geq 0.$$

m': money taken out of the market.

- Assume interior solution for X, H, characterize equilibrium and then check $0 < H < \bar{H}$ is satisfied.

Bargaining: agents with m meets someone with $\tilde{m}$

- In a double-coincidence-of-wants meeting:
  symmetric Nash bargaining with the continuation value as the threat point:

$$B_t(m, \tilde{m}) = u(q^*) - c(q^*) + W_t(m).$$

- In a single-coincidence-of-wants meeting:
  Nash bargaining with the continuation value as the threat point, buyer's bargaining power θ:

$$\begin{aligned} \max_{q,d} \quad & [u(q_t) + W_t(m - d_t) - W_t(m)]^{\theta} \\ & [-c(q_t) + W_t(\tilde{m} + d_t) - W_t(\tilde{m})]^{1-\theta} \\ \text{s.t.} \quad & d \leq m, q \geq 0. \end{aligned}$$

- definition of equilibrium (p.468).

How to find an equilibrium?

1. Derive some properties of the solution to the CM problem.
2. Solve the bargaining problem.
3. Simplify V_t and solve for individual's problem of choosing $m'_t(m)$: $m'_t = M$ for all agents regardless of m_t, $\Rightarrow F_{t+1}$ degenerate
4. Combine the solutions to CM and DM problems to reduce the model to a single difference equation.

Steady state

CM: value function

The expected value of holding a unit of asset entering the CM market:

$$\begin{aligned} W(a) &= \max_{x,\ell,a_{+1}} \{U(x) - \ell + \beta V_{+1}(a_{+1})\}, \\ \text{s.t. } x &= \phi(a - a_{+1}) + \rho a + \ell + T \end{aligned}$$

- a and a_{+1} are asset holdings when trading opens and closes.
- ϕ is the price of a in terms of x.
- ρ is the dividend of asset.
- T is a transfer of new money.

DM: value function

$$
\begin{aligned}
V(a) &= (1-2\alpha\sigma)W(a+T) \\
&+\alpha\sigma\int\{u[q(a,a_S)]+W[a-d(a,a_S)+T]\}dF(a_S) \\
&+\alpha\sigma\int\{-c[q(a_B,a)]+W[a+d(a_B,a)+T]\}dF(a_B)
\end{aligned}
$$

- x is produced one-for-one using labor ℓ, so the CM real wage is 1.
- In the DM, agents can be buyers or sellers depending on who they meet:
  - as a buyer, his period utility is $\mathcal{U}(x,1-\ell)+u(q)$;
  - as a seller, his period utility is $\mathcal{U}(x,1-\ell)-c(q)$, where $\mathcal{U}(x,1-\ell)=U(x)-\ell$.

Properties of $W(a)$

$$
\begin{aligned}
W(a) &= (\phi+\rho)a + T + \max_{x}\{U(x) - x\} \\
&\quad + \max_{a_{+1}}\{-\phi a_{+1} + \beta V_{+1}(a_{+1})\}.
\end{aligned}
$$

Results:

- FOC: $-\phi + \beta V'_{+1}(a_{+1}) \geq 0$, "$=$" if $a_{+1} > 0$.
  a_{+1} is independent of initial wealth.
- Envelop condition: $W'(a) = \phi + \rho$.
  $W(a)$ is linear with slope $\phi + \rho$.
- $x = x^*$ is pinned down by $U'(x^*) = 1$.

Nash bargaining

For now, let $\rho = 0$, so that $d = a_B$.

The generalized Nash bargaining is

$$\max_q [u(q) - \phi a_B]^\theta [\phi a_B - c(q)]^{1-\theta},$$

and the solution is

$$z(q) = \frac{\theta c(q) u'(q) + (1-\theta) u(q) c'(q)}{\theta u'(q) + (1-\theta) c'(q)}.$$

Kalai bargaining

- Kalai's (1977) bargaining solution says that when a buyer gives an asset to a seller for q, the buyer gets a share θ of the total surplus, and the seller gets $1-\theta$.
- The solution is

$$z(q) = \theta c(q) + (1-\theta)u(q).$$

- Kalai bargaining makes buyers' surplus increasing in a;
- it does not give an incentive to hide assets;
- it makes $V(a)$ concave;
- it is easy.
- These results are not always true with Nash bargaining.

Incorporating bargaining solution $z(q)$ into $V(a)$

$$\begin{aligned} V(a) &= W(a) + \alpha\sigma\{u[q(a)] + \phi a\} \\ &\quad + \alpha\sigma \int \{\phi\tilde{a} - c[q(\tilde{a})]\} dF(\tilde{a}), \end{aligned}$$

where a is money held by an individual while $\tilde{a}$ is held by others.
Using $q'(a) = \phi/z'(q)$, which follows from $\phi a = z(q)$, we have

$$\begin{aligned} V'(a) &= \phi + \alpha\sigma\{u'[q(a)]q'(a) - \phi\} \\ &= \phi\{1 + \alpha\sigma\frac{u'[q(a)]}{z'[q(a)]} - \alpha\sigma\}. \end{aligned}$$

Euler equation

$$V'(a) = \phi\{1 + \alpha\sigma \frac{u'[q(a)]}{z'[q(a)]} - \alpha\sigma\}$$

Inserting $V'(a)$ into the FOC from the previous CM, $\phi_{-1} = \beta V'(a)$ where the -1 subscript indicates last period, we get the Euler equation:

$$\phi_{-1} = \beta\phi[1 + \alpha\sigma\lambda(q)] \tag{3}$$

where $\lambda(q) \equiv \frac{u'(q)}{z'(q)} - 1$ is the liquidity premium.

Effects of Inflation

- Using $\phi a = z(q)$, $a = A$, and $A = (1+\pi)A_{-1}$, becomes

$$(1+\pi)z(q_{-1}) = \beta z(q)[1 + \alpha\sigma\lambda(q)]. \tag{4}$$

- In a stationary eqm ϕA is constant, so gross inflation $\frac{\phi}{\phi_{+1}} = 1+\pi$ is pinned down by the rate of monetary expansion.
- Using Fisher equation $1+\iota = (1+\pi)(1+r)$ to define ι. Then (2) becomes

$$\iota = \alpha\sigma\lambda(q). \tag{5}$$

- Given ι, (3) determines q, and $\frac{\partial_q}{\partial\iota} < 0$.

Results

- Let $\pi = \tau$.
- $\theta = 1 : z(q) = c(q)$, get q^* iff $\tau = \tau^F$ $(i = 0)$
- $\theta < 1 : q < q^*$ at τ^F since a necessary condition for monetary equilibrium is $\tau \geq \tau^F$ $(i \geq 0)$.
  The Friedman rule is optimal here but does not achieve the efficient outcomes q^*.
- Why?

Two types of inefficiencies

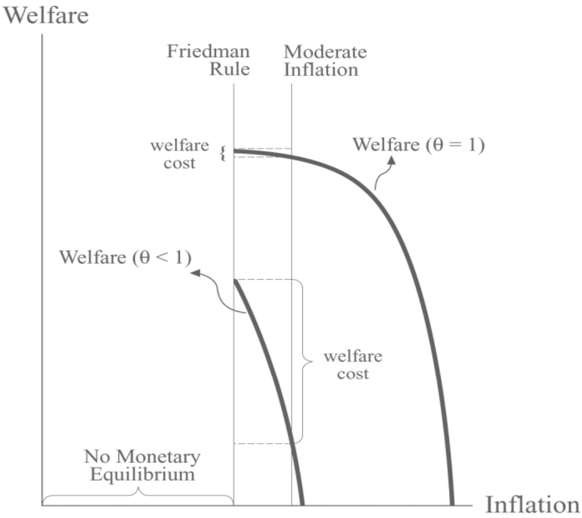
- due to $\beta < 1$: $q < q^*$
- due to $\theta < 1$: holdup problem.

- Hosios (1990) condition for efficiency:
  The bargaining solution should split the surplus so that each party is compensated for his contribution to the surplus in a match.

- The surplus in a single-match is all due to the buyer, since the outcome depends on m but not on $\tilde{m}$. Hence, efficiency requires $\theta = 1$ here.

- The wedge due to $\theta < 1$ is important for issues such as the welfare cost of inflation.

Welfare cost of moderate inflation



Welfare cost of inflation

- Calibrate the model to standard observations and use it to measure the cost of inflation.
- Going from 10 percent to 0 percent inflation is worth between 3 and 5 percent of consumption – much higher than previous estimates.
- The empirical relevance of the holdup problem is important to assessing the welfare cost of inflation.