On the Welfare Effect of Credit Arrangements

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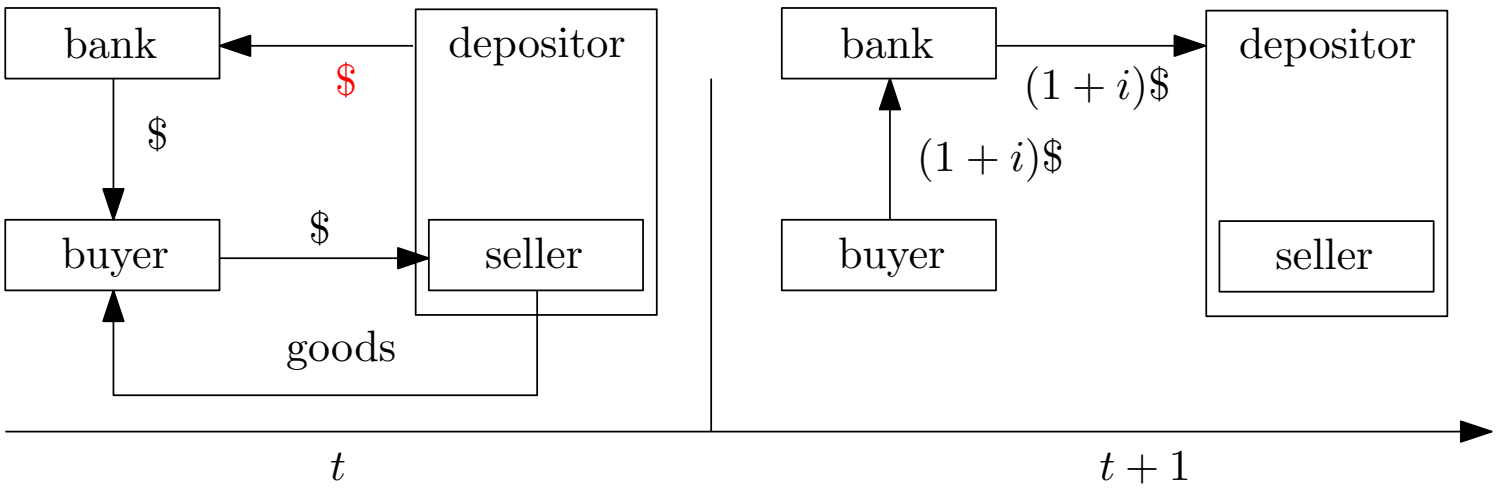
Motivation

- Allocation in a monetary economy is typically inefficient:
  - inflation distortion,
  - liquidity shock.
- Some forms of credit arrangement can help improve efficiency.
- However, the effect of credit arrangement and its interaction with money are less well understood.

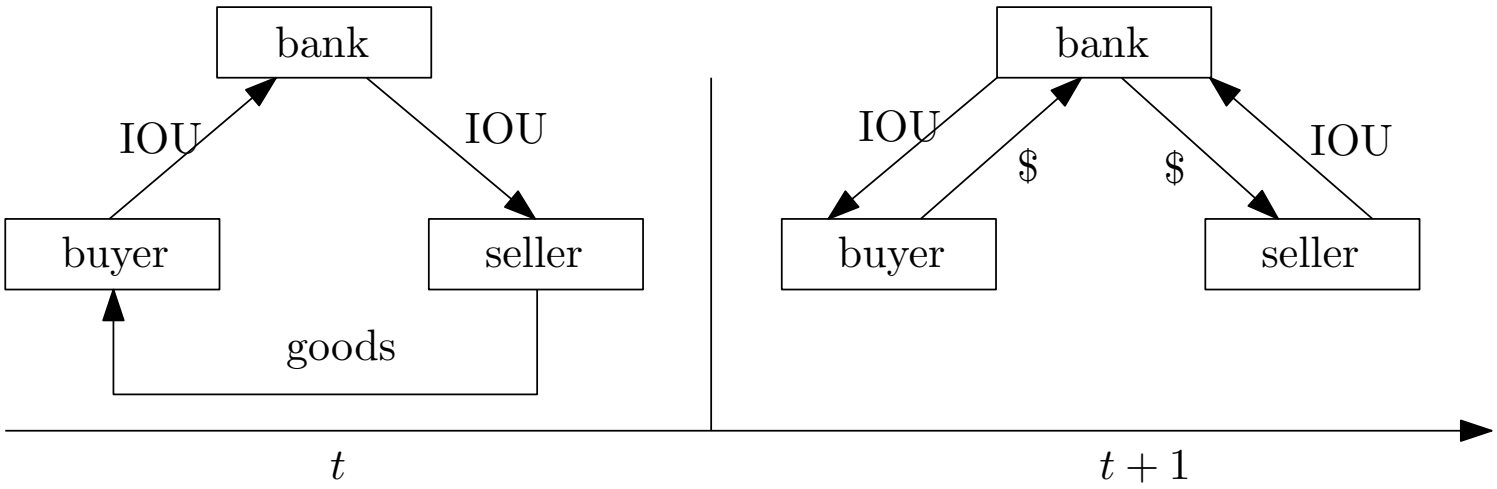
Credit Arrangement: Nominal

- Facilitate inter-temporal trade of money balances,
  - required record-keeping technology: record financial history,
  - function of credit: a means of borrowing,
    $\Rightarrow$credit creation subject to liquidity constraints,
  - relationship with money: complement the use of money.



Credit Arrangement: Real

- Facilitate inter-temporal trade of goods
  - required record-keeping technology: record goods transaction history,
  - function of credit: [1] a means of borrowing and [2] a means of payment,
    $\Rightarrow$credit creation is not subject to liquidity constraints,
  - relationship with money: substitute the use of money.



Research Questions

- Does increasing access to credit always improve welfare, given inefficient monetary allocations?
  - Economize on the usage of cash and reduce the impact of inflation.
  - Distort allocation through redistribution.
- Does the structure of credit arrangement matter?
  - Functions of credit.
  - Relationship with money.

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What have we done?

- Construct two economies that differ by their record-keeping technology.
  1. Arrangement 1: record financial history $\rightarrow$ "nominal loan" economy, e.g., Berentsen et al. (2007) or Chiu and Meh (forthcoming).
  2. Arrangement 2: record goods transaction history $\rightarrow$ "real loan" economy, e.g., Monnet and Roberds (2007) or Sanches and Williamson (2010).
- Compare welfare among real loan, nominal loan and monetary economy.
  - Identify different channels that affect welfare.
- Examine the robustness of the results.

Results

- Increase credit usage *may not* necessarily increase welfare.
- Two effects
  - quantity effect (intensive margin effect)
  - price effect (redistribution effect)
- The structure of credit arrangement *matters*.
- Robustness:
  - linear v.s. convex cost,
  - competitive pricing v.s. mechanism design,
  - perfect v.s. limited enforcement.

Environment I

- Time is discrete and continues forever. In each period: Market 1 (Day) + Market 2 (Night). Discount factor: β
- Buyers: a fraction of α have access to credit (permanent); a fraction π wants to consume during the day (i.i.d. shock realized at the beginning of the day)
- Sellers: all have access to credit; all can produce but do not want to consume during the day
- Monetary authority: $M_+ = \gamma M$. New money as lump-sum transfer (or tax) to buyers.

Environment II

- Night:
  - all agents can consume and produce good x
  - quasilinear preferences: $v(x) - y$
  - production: $f(y) = y$
- Day:
  - anonymity + lack of double coincidence of wants $\rightarrow$ money is essential
  - fraction of α can access credit
  - buyers (fraction of π): $u(q)$
  - sellers: $-c(q)$

Environment III

- Credit: banks
  - record only financial history $\rightarrow$ make loans (credit) or take deposits in the form of money $\rightarrow$ money is the only means of payment during the day
  - open at night and the beginning of the day

Model – Nominal Loan with Perfect Enforcement

Buyers

- Night

$$W^b(m,\ell,k) = \max_{x,y,\hat{m}_+} \left\{ v(x) - y + \beta V^b(\hat{m}_+) \right\}$$

$$\text{s.t. } \underbrace{y + \phi(m+\tau) + (1+i^k)k}_{\text{total income}} = \underbrace{x + \phi\hat{m}_+ + (1+i^\ell)\ell}_{\text{total expenditure}}$$

- Day

$$V^b(\hat{m}) = \max_{q,\ell,k} \{ \pi \left[u(q) + W^b(\hat{m} + \ell - pq, -\ell, 0) \right] + (1-\pi) W^b(\hat{m} - k, 0, k) \}$$

$$\text{s.t. } pq \leq \hat{m} + \ell \text{ and } k \leq \hat{m}$$

Model – Nominal Loan with Perfect Enforcement

Sellers

- Night

$$W^s(m) = \max_{x,y,\hat{m}_+} \{v(x) - y + \beta V^s(\hat{m}_+)\}$$

$$\text{s.t. } y + \phi m = x + \phi \hat{m}_+$$

- Day

$$V^s(\hat{m}) = \max_q [-c(q) + W^s(\hat{m} + pq)]$$

Model – Nominal Loan with Perfect Enforcement

Banks

- Free entry to the banking sector: $i^k = i^\ell$
- Loan market clearing: $(1-\pi)k = \pi\ell$ in a symmetric equilibrium

- In equilibrium, $i^k = i^\ell = i = \frac{\gamma}{\beta} - 1$ and (q^1, q^0, q^s) solve

$$\frac{u'(q^1)}{c'(q^s)} = 1 + i,$$
$$\frac{u'(q^0)}{c'(q^s)} = 1 + \frac{i}{\pi},$$
$$q^s = \pi \left[\alpha q^1 + (1-\alpha) q^0\right].$$

- Note
  1. credit as a means of borrowing $q^1 > q^0$, quantity effect
  2. competitive market, q^1 and q^0 are related through $c'(q^s)$, price effect

Model – Real Loan with Perfect Enforcement

Credit

- Credit:
  - record goods transaction history $\rightarrow$ credit can be used as a means of payment directly $\rightarrow$ no demand for loans and no deposit

Model – Real Loan with Perfect Enforcement

Buyers and Sellers during the Day

- A buyer

$$V^b(\hat{m}) = \max_{q,d,\ell} \pi \left[u(q) + W^b(\hat{m} - d, -\ell) \right] + (1 - \pi) W^b(\hat{m})$$

$$\text{s.t. } pq = d + \ell \text{ and } d \leq \hat{m}$$

- A seller

$$V^s(\hat{m}) = \max_{q^s} \left[-c(q) + W^s(\hat{m} + d, \ell) \right]$$

$$\text{s.t. } pq = d + \ell$$

Assume that sellers receive the same portfolio (d, ℓ)

- In equilibrium, $i = \frac{\gamma}{\beta} - 1$ and (q^2, q^0, q^s) solve

$$\frac{u'(q^2)}{c'(q^s)} = 1,$$
$$\frac{u'(q^0)}{c'(q^s)} = 1 + \frac{i}{\pi},$$
$$q^s = \pi \left[\alpha q^2 + (1-\alpha) q^0\right].$$

- Note
  1. credit as a means of borrowing $q^2 > q^0$, quantity effect
  2. competitive market, q^2 and q^0 are related through $c'(q^s)$, price effect

Aggregate Welfare

- Aggregate welfare

$$\mathcal{W} = \frac{1}{1-\beta}\left\{2v(x^*) - 2x^* + \left[\alpha\pi u(q^1) + (1-\alpha)\pi u(q^0) - c(q^s)\right]\right\}$$

where $\pi\alpha q^1 + \pi(1-\alpha)q^0 = q^s$

Linear Cost

- Linear production function $c''(q) = 0$,
  $\mathcal{W}(real) > \mathcal{W}(nominal) > \mathcal{W}(money)$.
  Intuition: no price effect; when $i > 0$, $q^1 < q^2$ and $q^{01} = q^{02} \rightarrow$ quantity effect

Convex Cost

- Convex production function $c''(q) > 0$, results depend on (i, π, α)

Proposition

If $c'(0) > 0$, then $\mathcal{W}'(\alpha) < 0$ when $0 < \alpha < 1$, $i > 0$ and π is small.

Price Effect

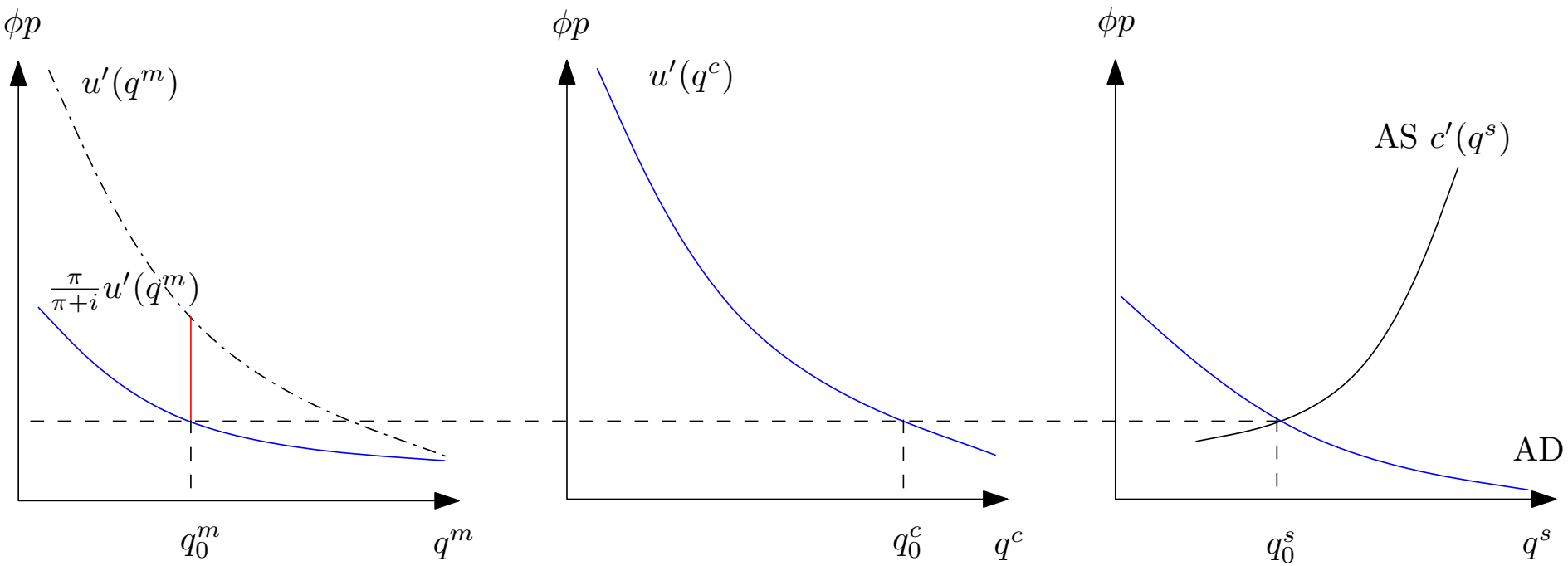


Figure: Intial α

Price Effect

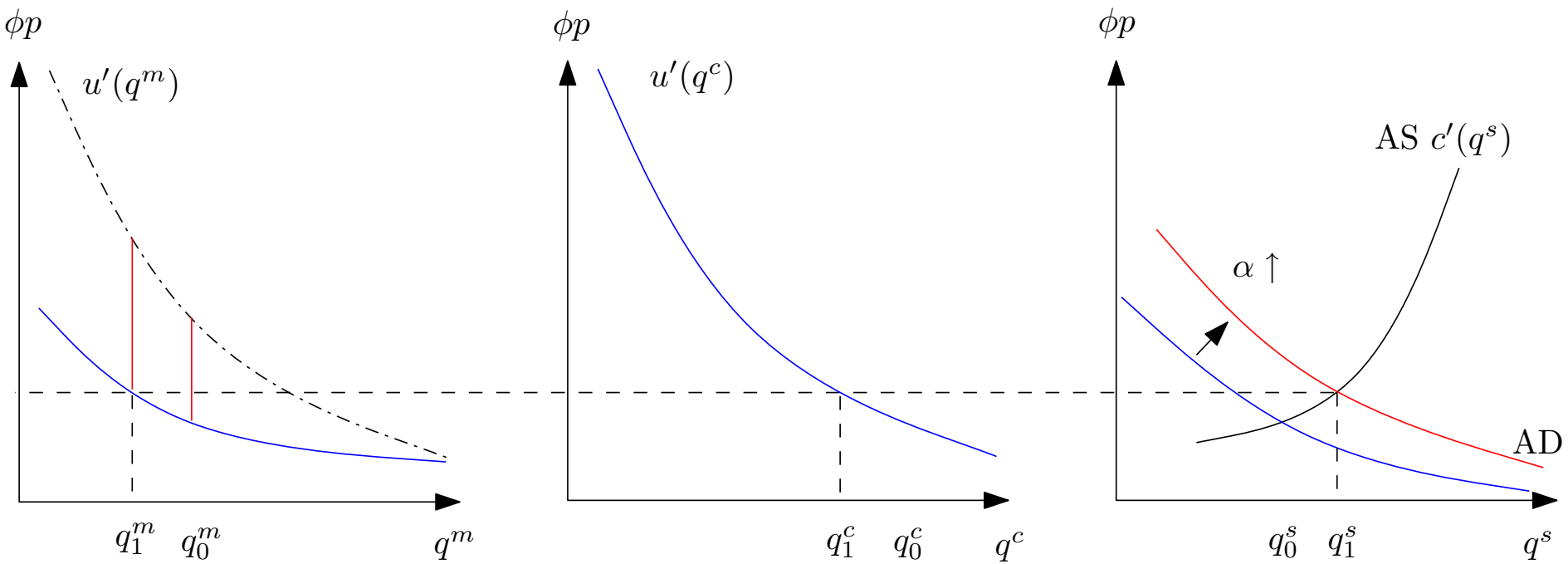


Figure: Increase α by $\Delta\alpha$

Price Effect

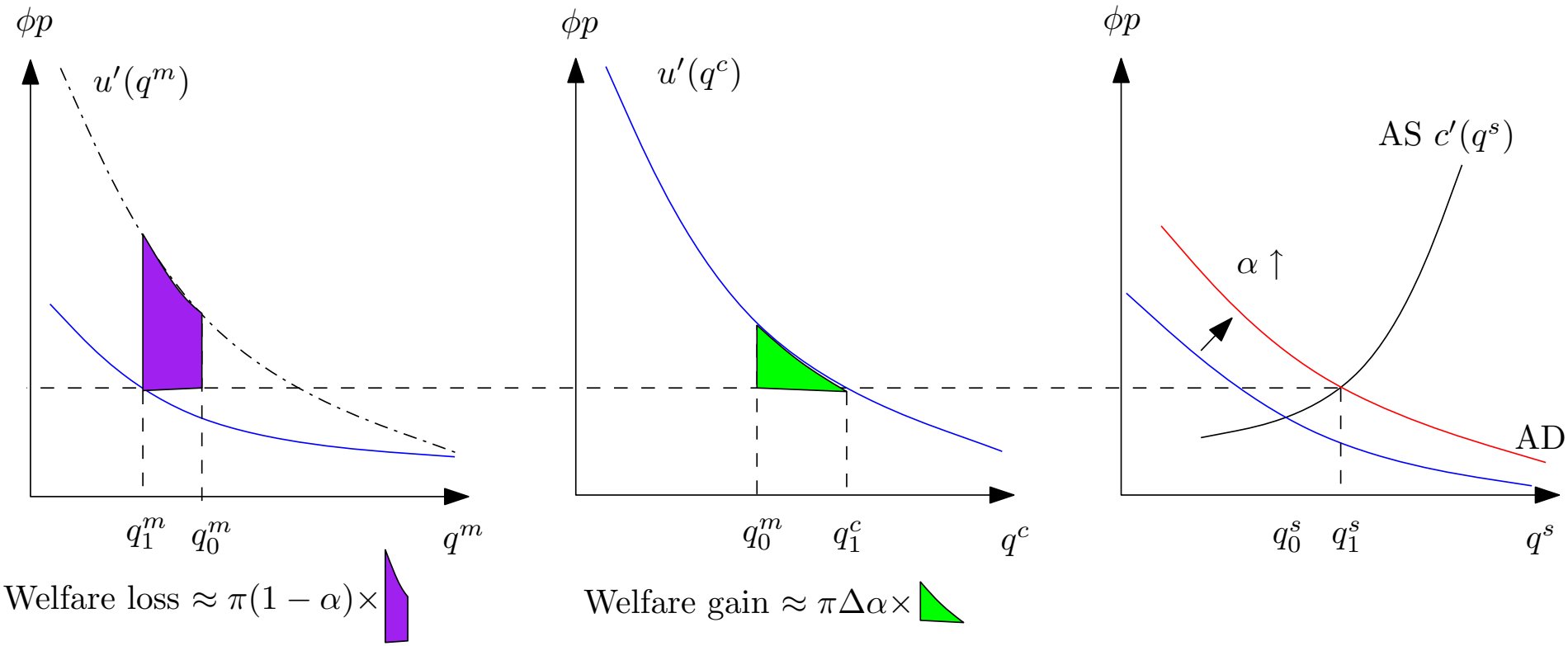


Figure: Welfare Change

Nominal Loan Dominates

Proposition

If $c'(0) > 0$, then $\mathcal{W}(real) < \mathcal{W}(nominal) < \mathcal{W}(money)$ when $0 < \alpha < 1$, $i > 0$ and π is sufficiently small.

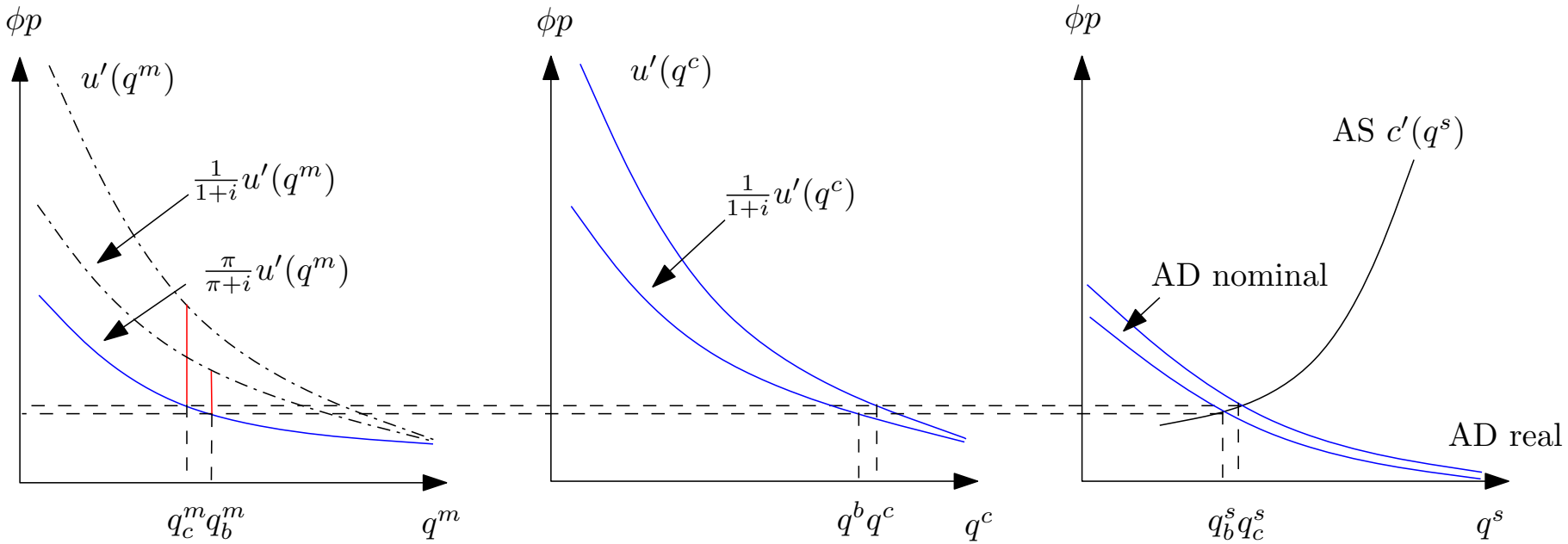


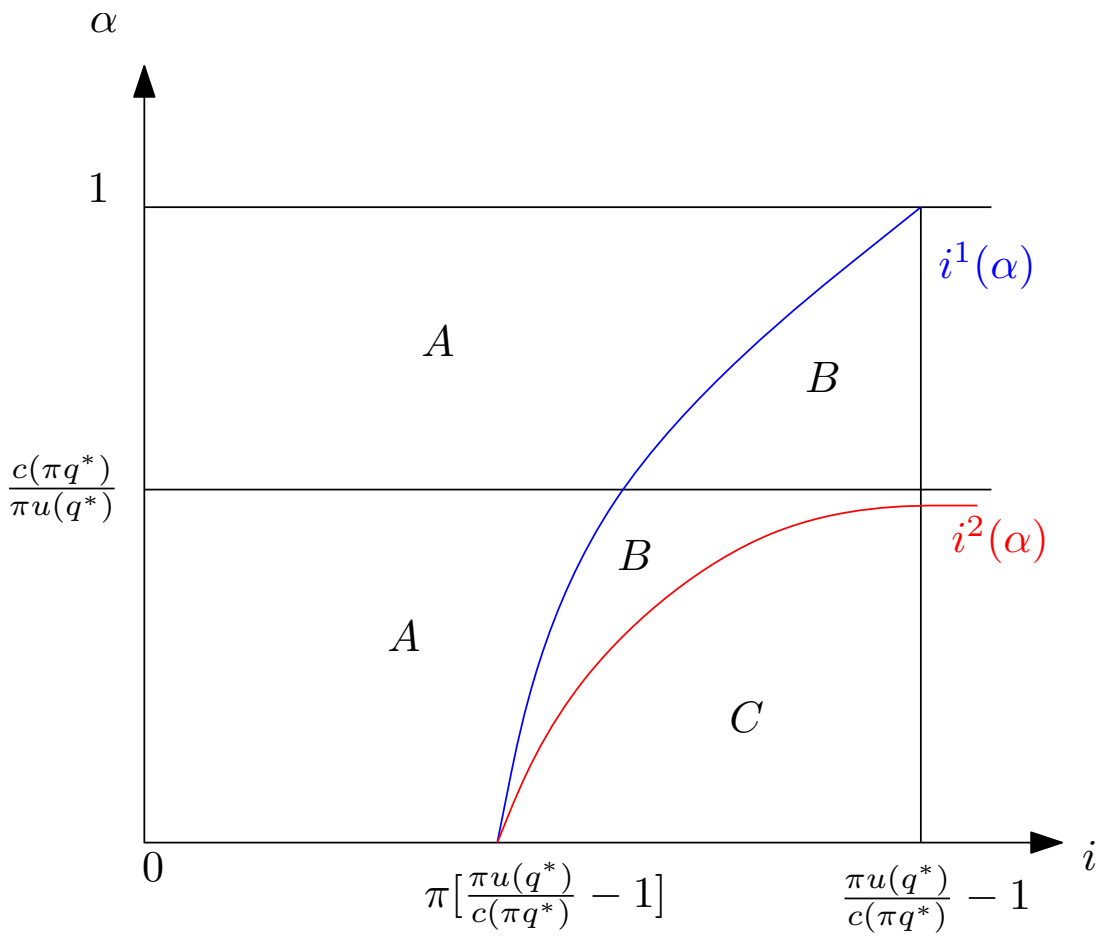
Figure: Nominal v.s. Real

Mechanism Design

- The above results depending on competitive pricing may not appear in a bilateral bargaining.
- Mechanism design approach à la Hu et al. (2009) and Rocheteau (2011).
  - Abstract from all pricing inefficiencies, and focus on monetary frictions.
- All types are publicly observable except money holdings.
- A mechanism is a mapping:
  $(\hat{m}, \chi_\alpha, \chi_\pi, \chi_s) \mapsto (q, d, \ell) \in \mathbb{R}^+ \times \mathbb{R}^+ \times \mathbb{R}$.
- Implementation concept: immune to individual deviation (Nash).
  - immune to cooperative deviation (can be the same as our competitive equilibrium, Jiang (2011)).

Optimal Mechanism

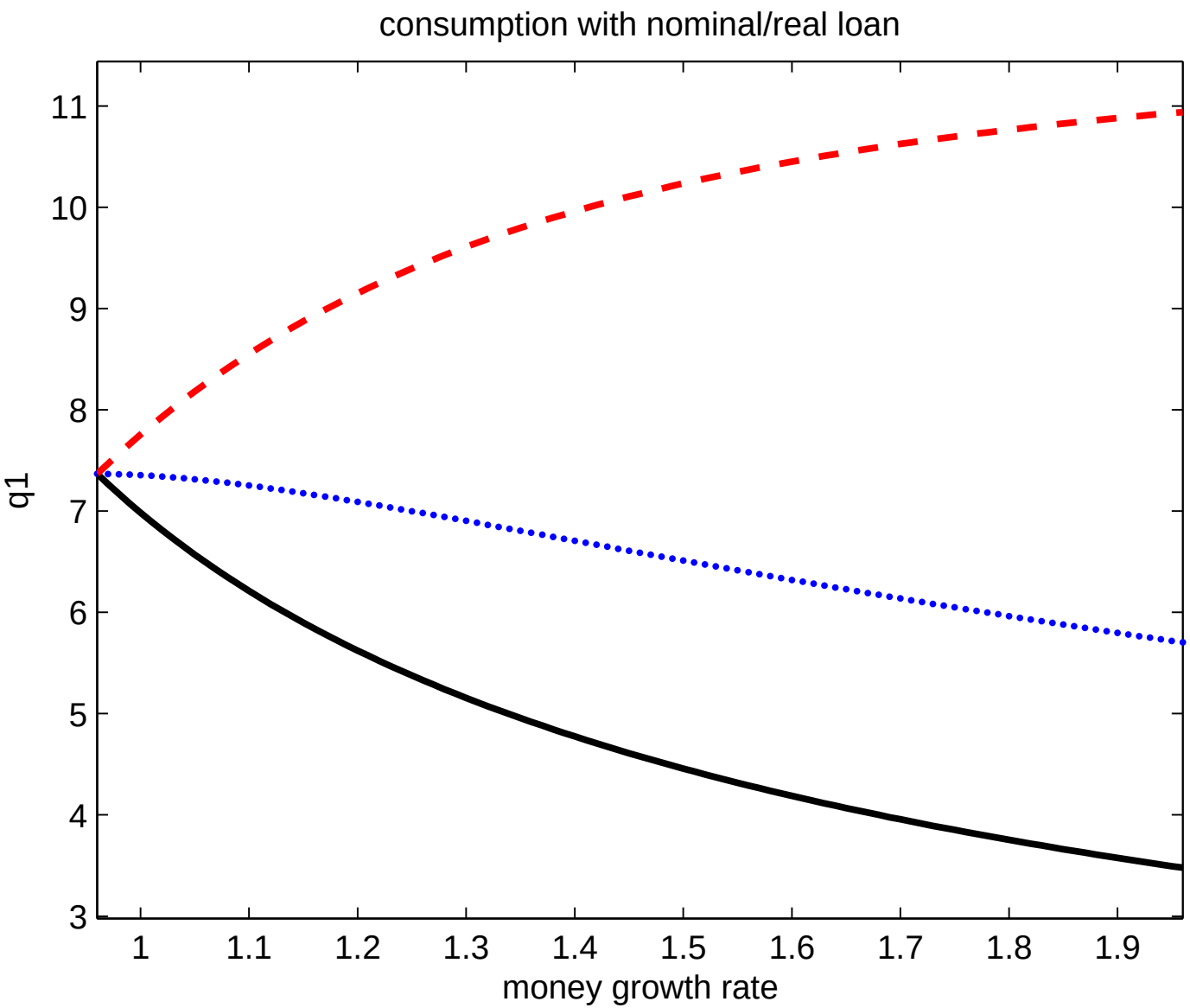
- Focus on the mechanism that maximize the social welfare subject to incentive constraints by different agents.
- Finding: real loan dominates.



Numerical Examples

- Numerical analysis: $u(q) = \frac{1}{\rho} q^{\rho}$ and $c(q) = \frac{A}{\eta} q^{\eta}$
  Let $\rho = 0.5$, $\eta = 2$, $A = 0.1$
  Benchmark: $\pi = 0.5$, $\alpha = 0.5$, $\gamma = 1.1$
- black – pure monetary economy; blue – nominal loan economy; red – real loan economy

Consumption: agents who can access credit



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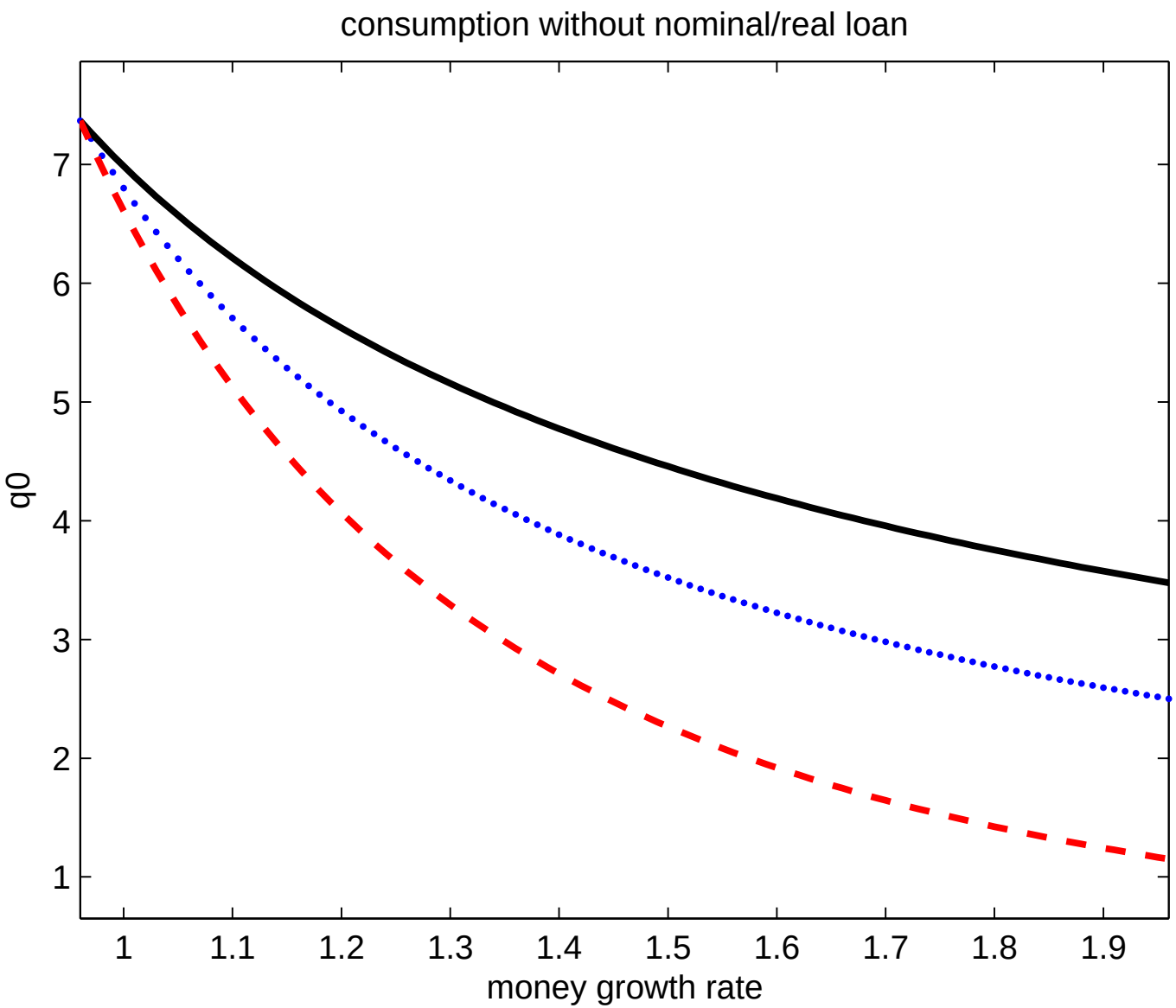
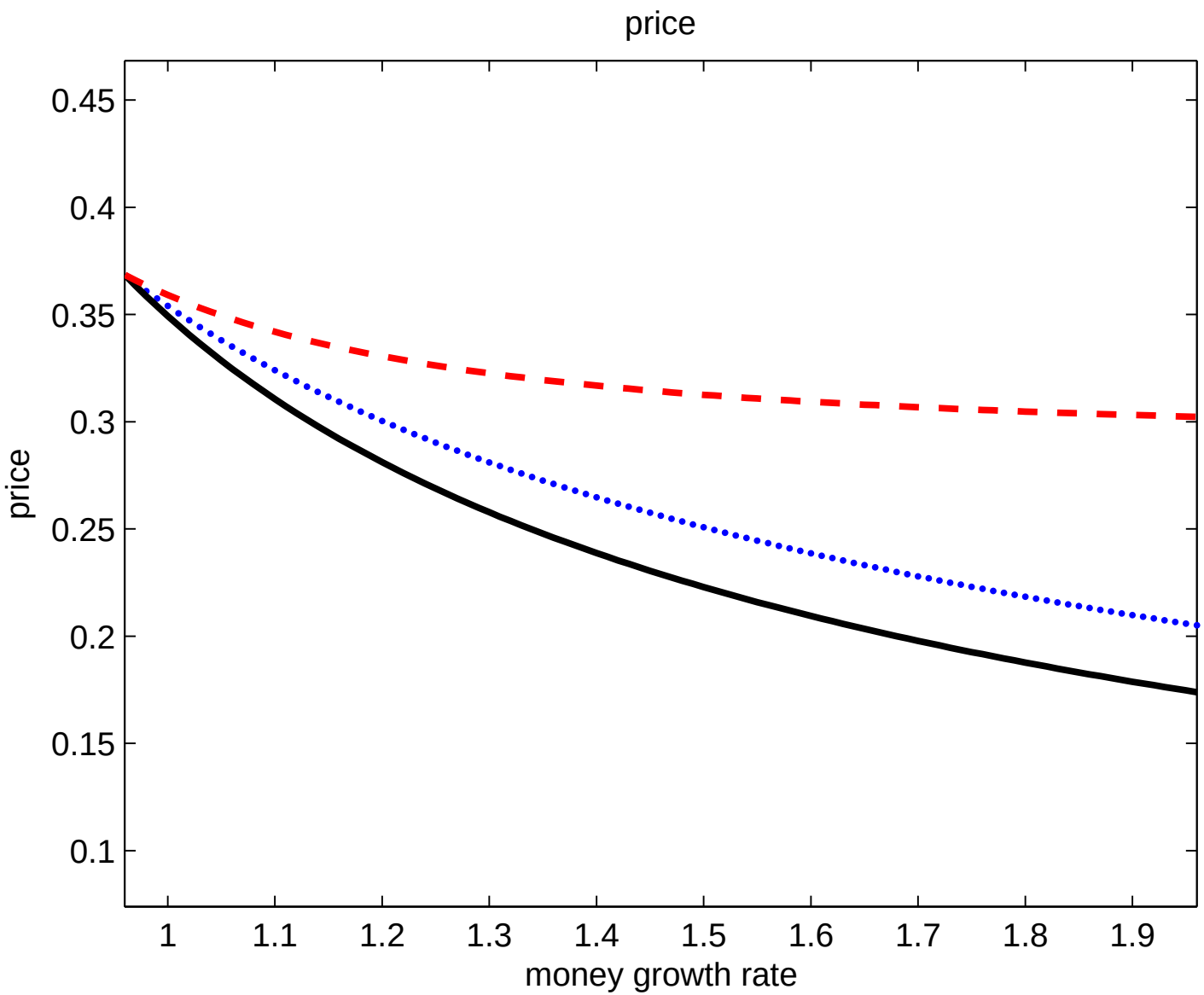
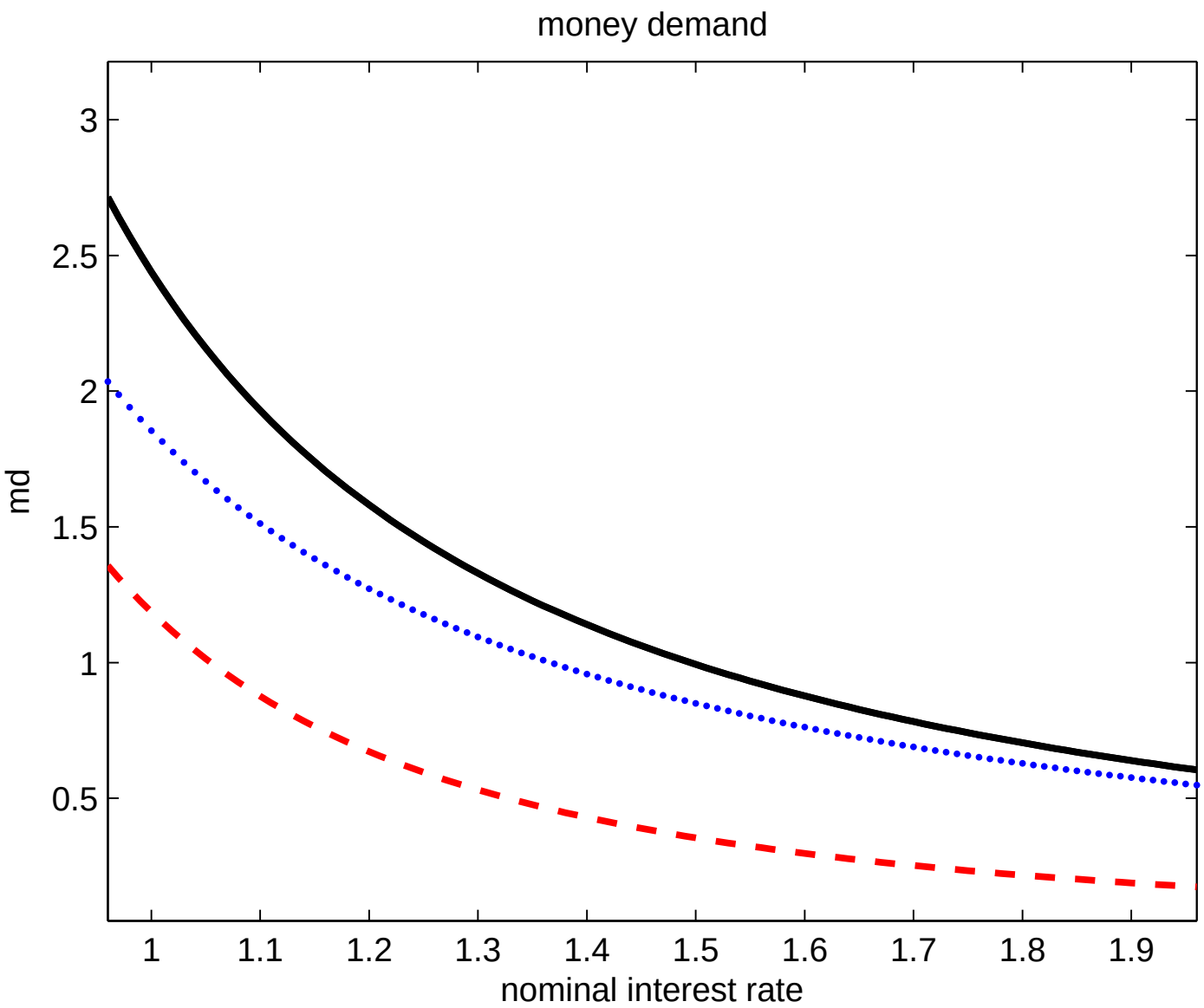


Price


price
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
price
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
money growth rate

Real Demand for Money



Access to Credit

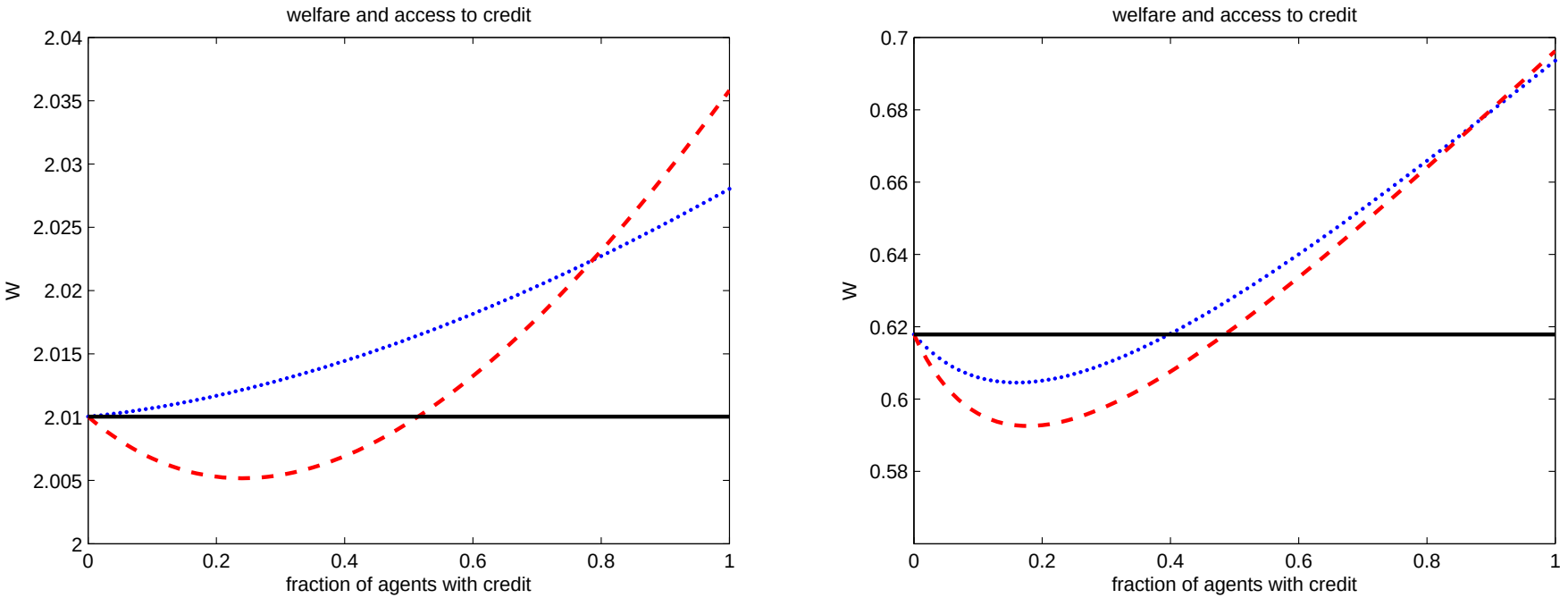
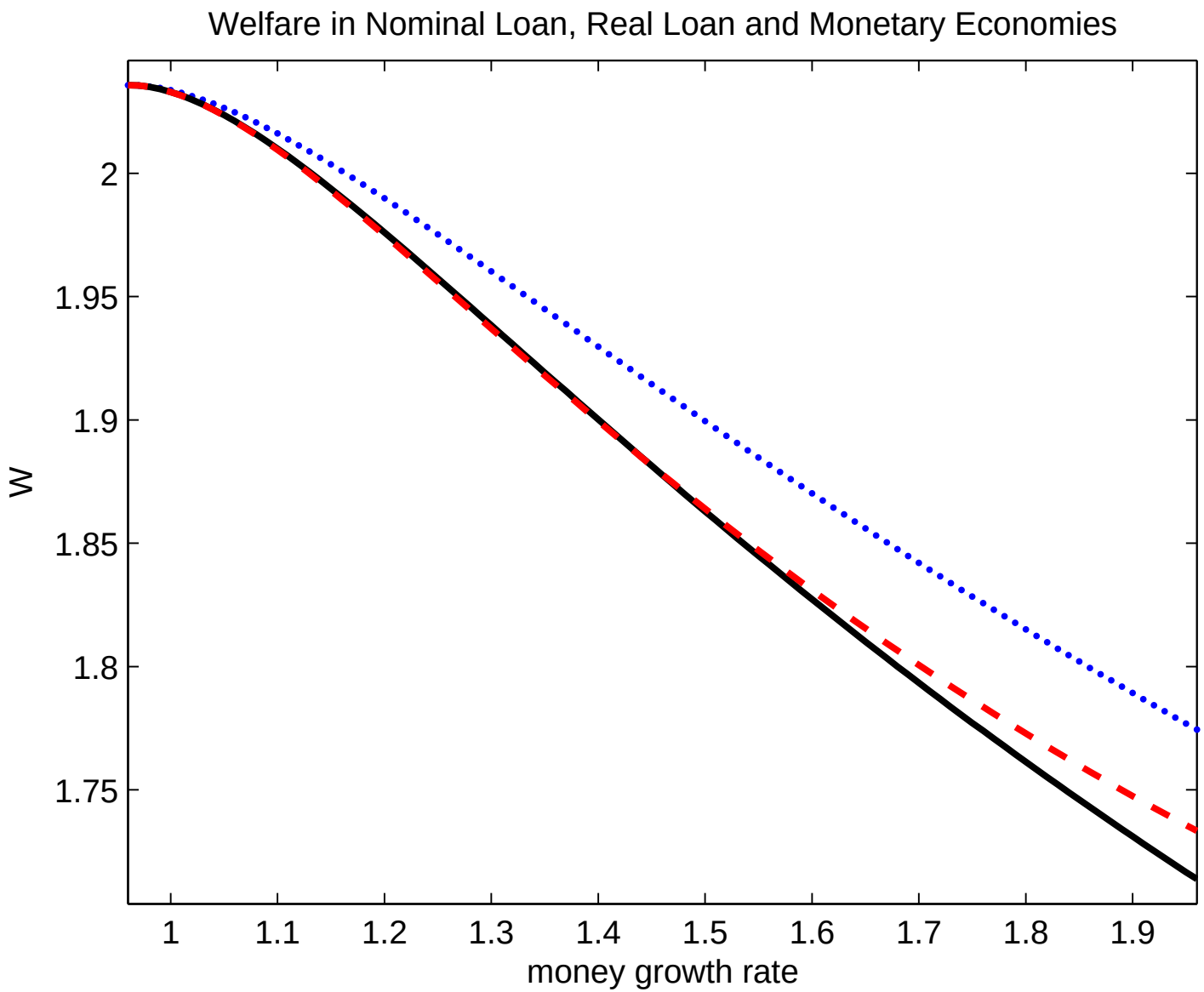
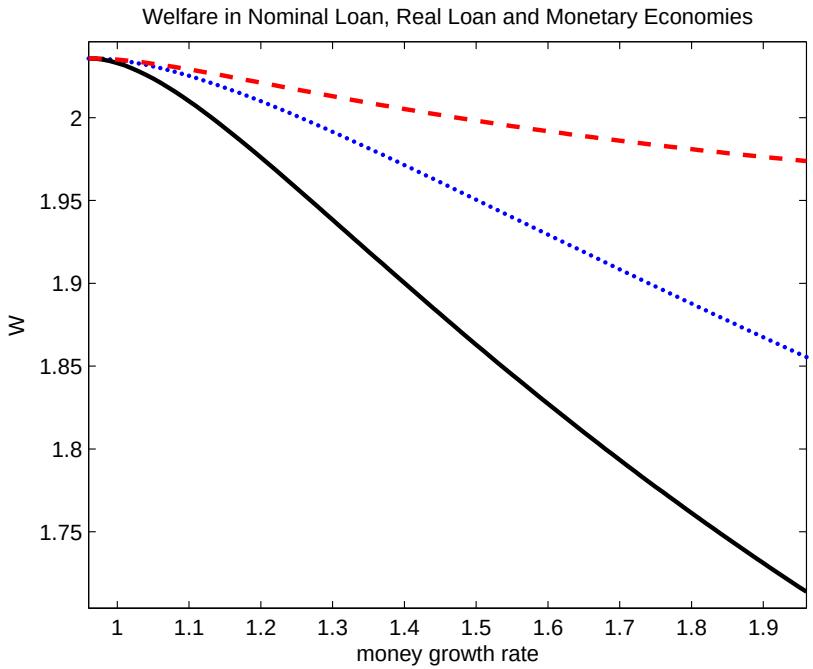


Figure: Left: $\pi = 0.5$, Right: $\pi = 0.1$

Inflation: Benchmark



Inflation: Different α



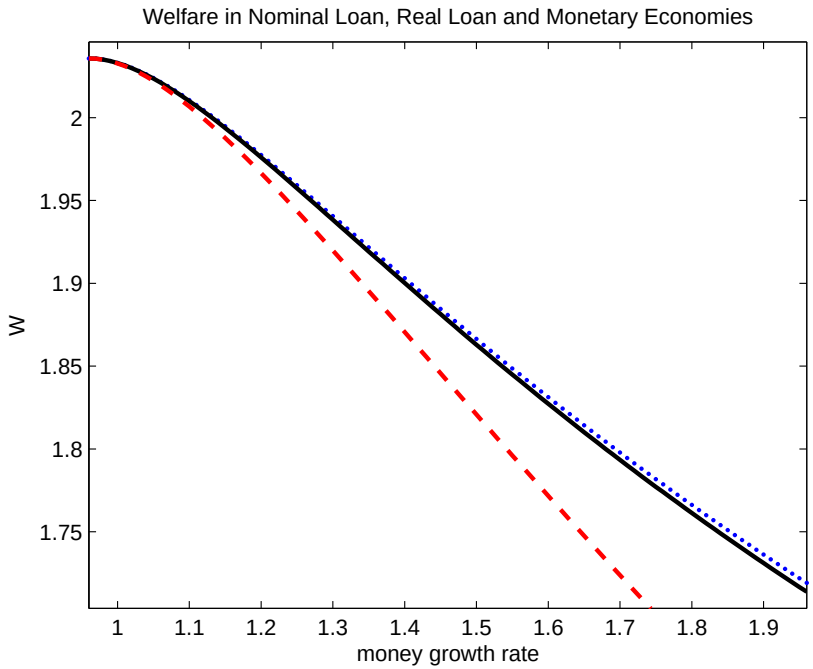


Figure: Left: $\alpha = 0.9$, Right: $\alpha = 0.1$

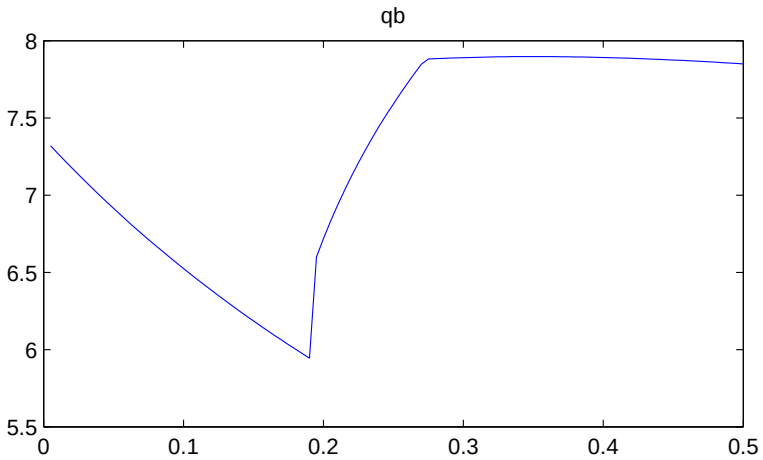
Imperfect Enforcement

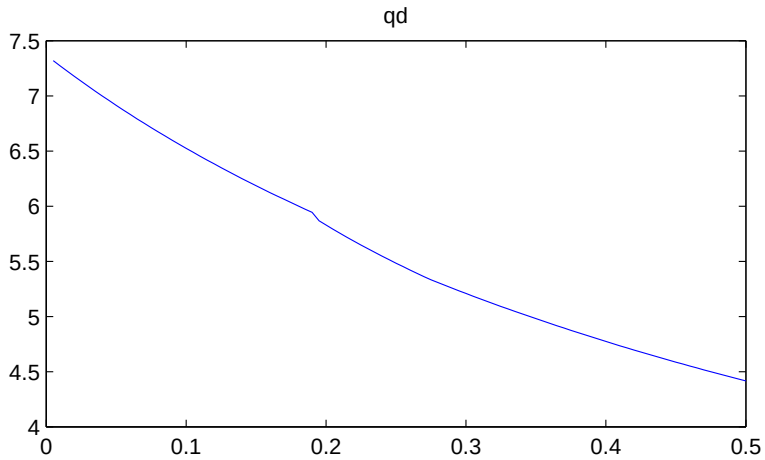
- Suppose that repayment of credit cannot be enforced. There exists an endogenous credit limit. Add $l \leq \bar{l}$ to the buyer's problem in CM1.
- In both credit arrangements, there exists three types of equilibrium:
  1. pure monetary equilibrium,
  2. equilibrium with money and constrained credit,
  3. equilibrium with money and unconstrained credit.
- Inflation relaxes the endogenous credit limit. Welfare implications are similar to before. Jump to Appendix

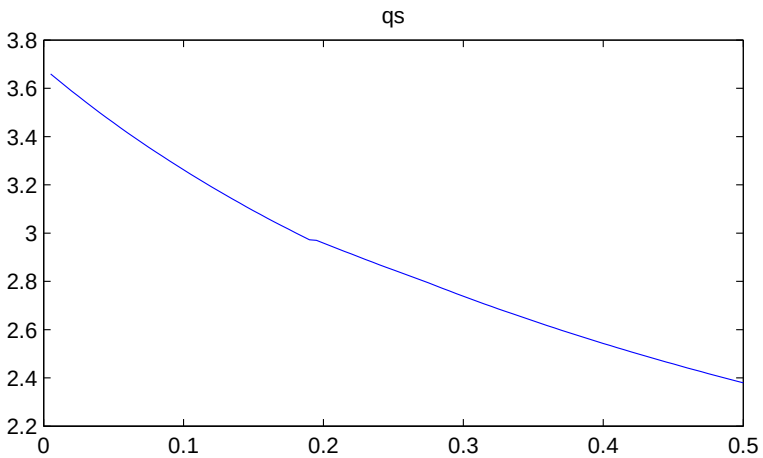
Conclusion

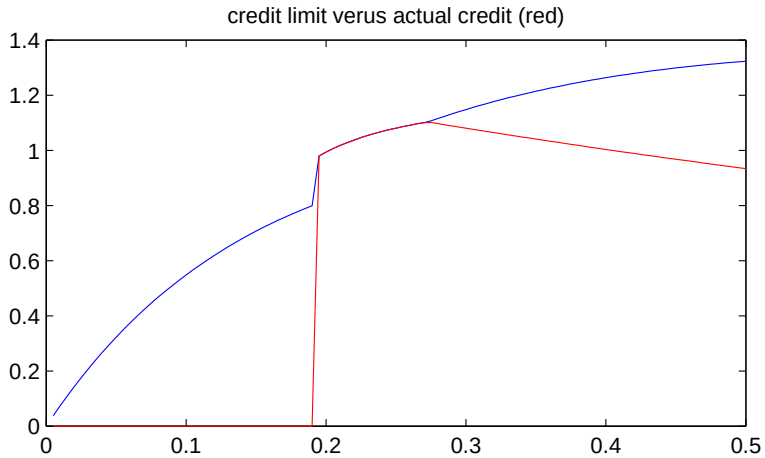
- Interaction of money and credit:
  - quantity effect (improve welfare),
  - price effect (lower welfare).
- Increasing access to credit is not necessary welfare improving.
- The form of credit arrangement matters.
- Robustness:
  - production technology matters,
  - pricing mechanism may (not) matter depending on the equilibrium concept.
  - lack of enforcement does not matter.
- Future work: endogenize credit usage.
  - Over use of credit may happen.

Imperfect Enforcement: Nominal Loan

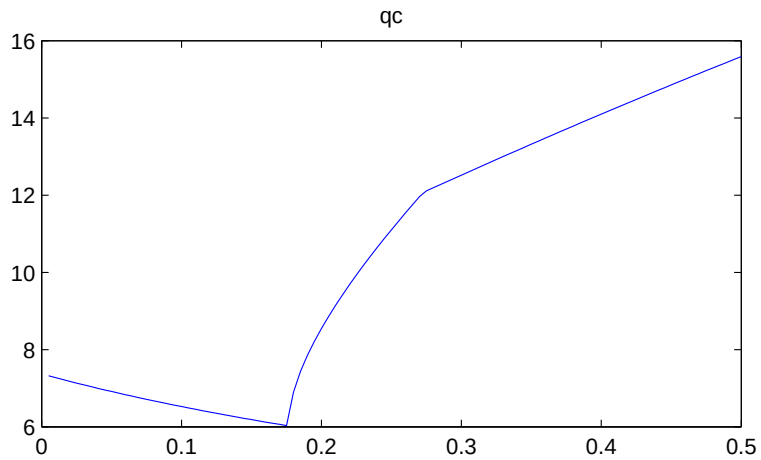


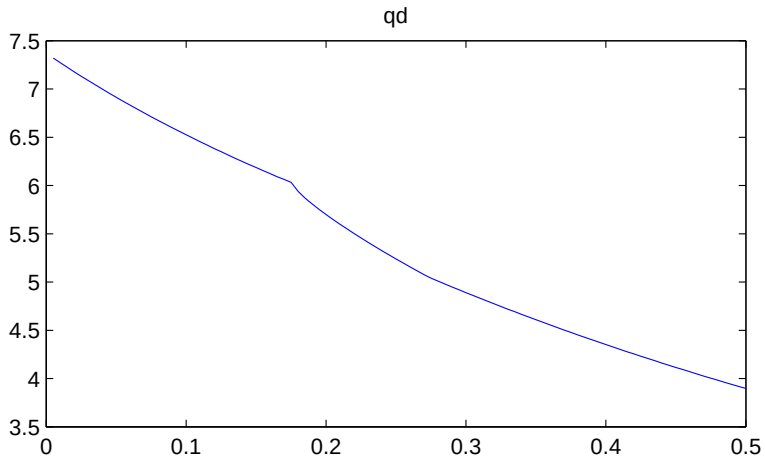


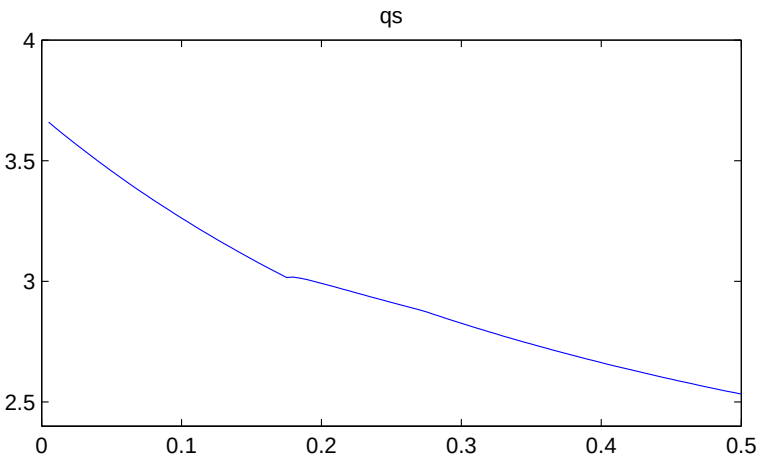


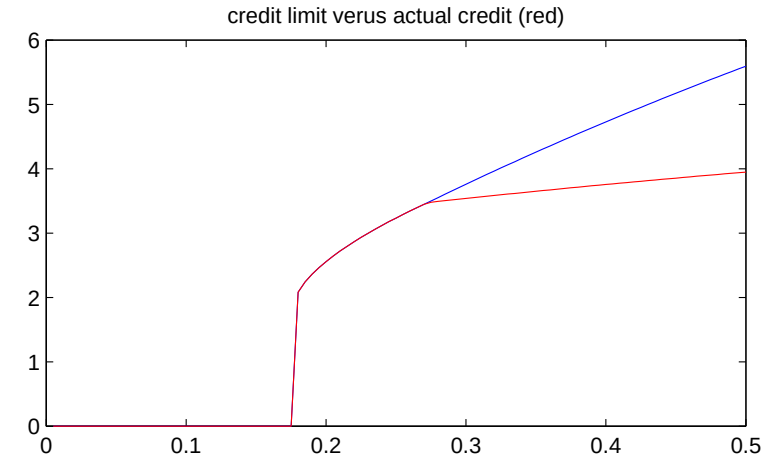


Imperfect Enforcement: Real Loan

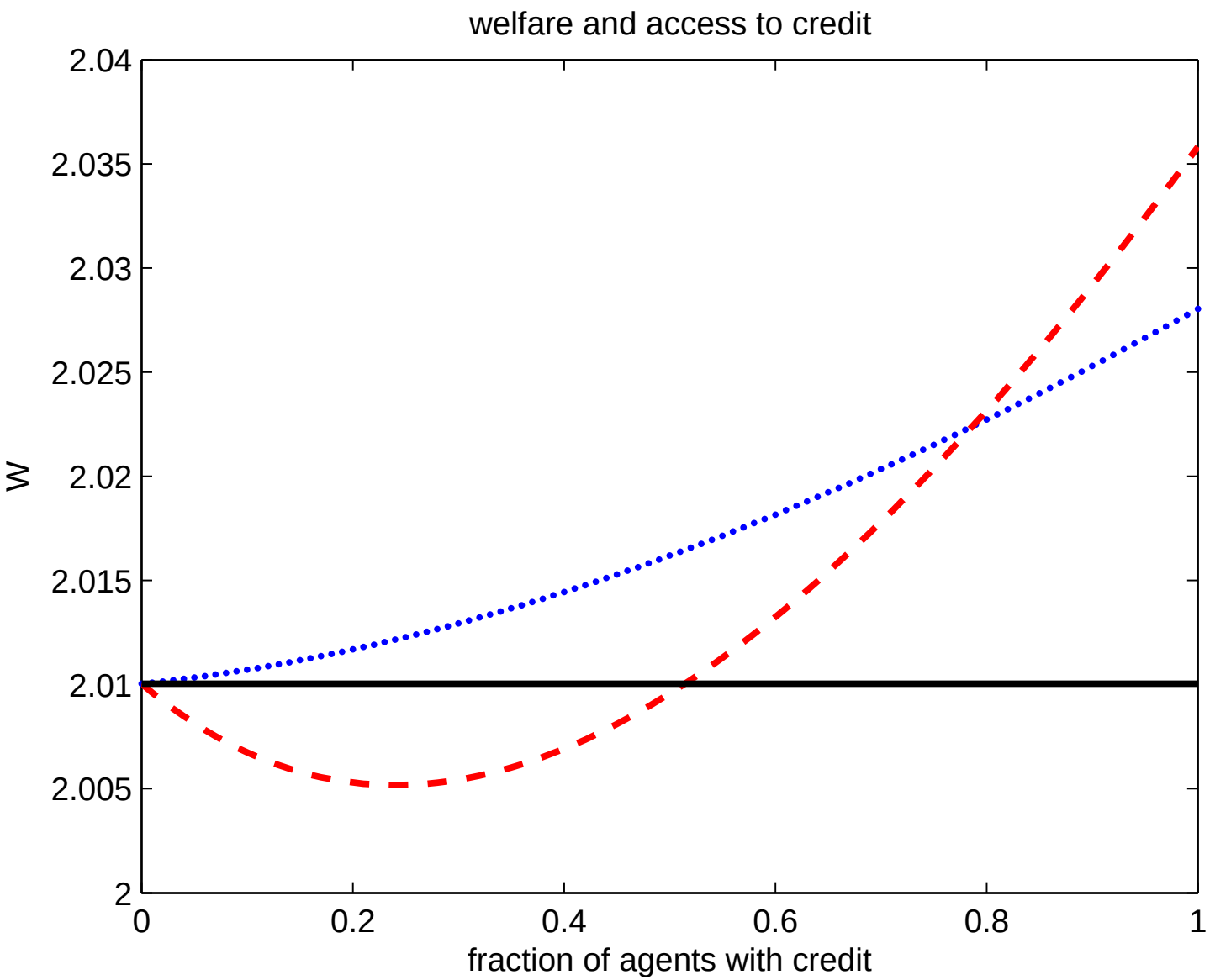




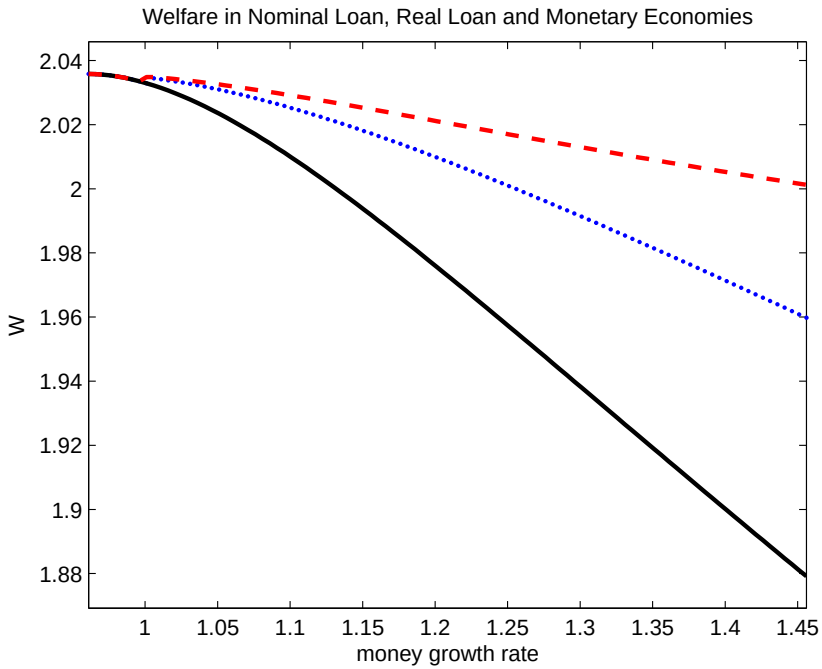




Imperfect Enforcement: Welfare Comparison I



Imperfect Enforcement: Welfare Comparison II



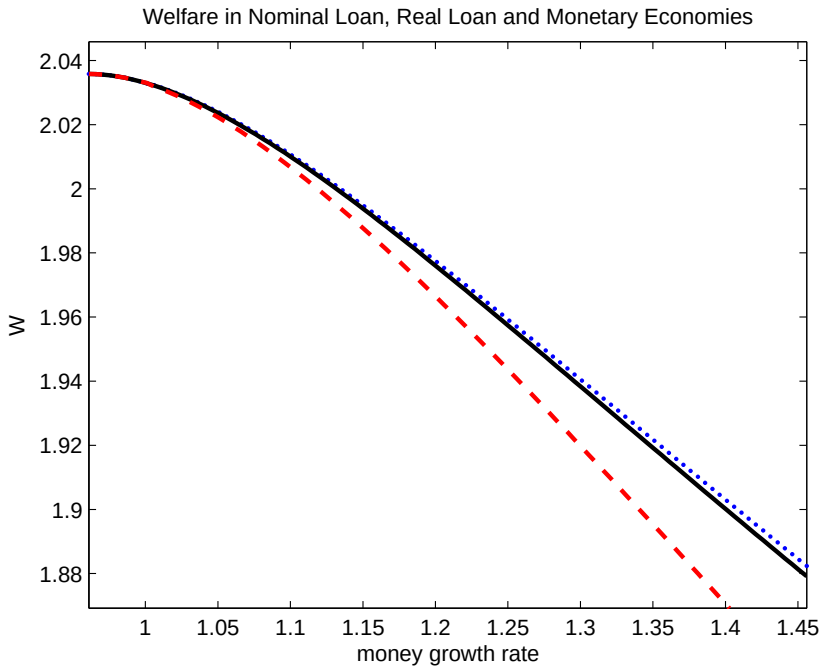


Figure: Left: $\alpha = 0.9$, Right: $\alpha = 0.1$