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On the Welfare Effects of Credit Arrangements

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Motivation

- Recent policy debates on regulating the retail payment system are motivated by concerns about efficiency of different payment instruments.
- Some empirical studies show that the social costs of using cash is higher than other payment instruments.
  - Garcia-Swartz, Hahn and Layne-Farrar (2006), Bergman, Guibourg and Segendorf (2007).
- It is natural to think that credit arrangements can improve social welfare.
  - Benefit from credit function.
  - Low cost.

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  - Some people cannot access credit (money users) and are liquidity constrained.
  - People who use credit typically demand more and bid up the price.
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  - Money users suffer from the high price.
- This price effect is absent in the frictionless world (Arrow-Debreu economy).

Research Questions

- Does credit arrangement always improve social welfare in a competitive equilibrium?
  - If not, where is the inefficiency coming from?
- What sorts of pricing mechanisms are needed to correct it?

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- The provision of credit and payment services can be welfare-reducing.
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  - Price discrimination is typically required to internalize price effects.
  - Mitigate the social cost of inflation.

Environment I

- Each period is divided into day and night. Walrasian market in each subperiod.
- Buyers:
  - two permanent types: credit users (α) and money users $(1-\alpha)$;
  - with prob. π, want to consume during the day (i.i.d. shock at the beginning of the day).
- Sellers: 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

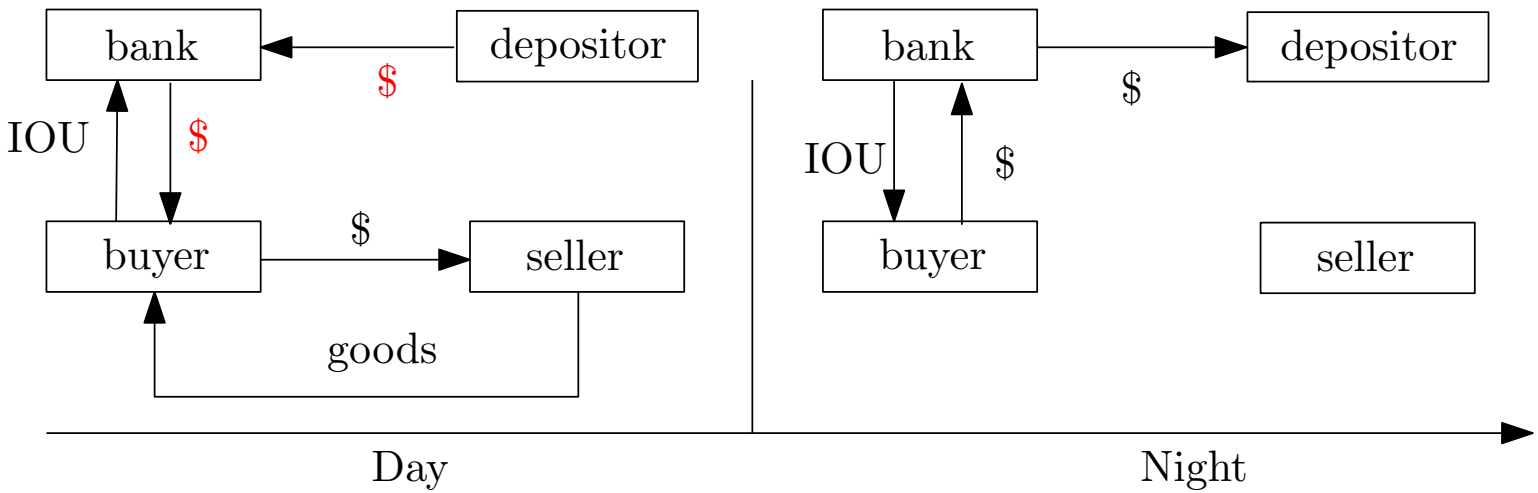
- Day:
  - Buyers (fraction of π): $u(q)$
  - Sellers: $-c(q)$
  - Anonymity + lack of double coincidence of wants $\rightarrow$ money is essential
- Night:
  - Settle credit and adjust money balances.
  - All agents can consume and produce good x
  - Quasilinear preferences: $v(x) - y$
  - Linear production function.

Environment III

- Competitive banking sector
  - Open when π is realized (before goods trading) in day.
  - Take deposits with rate r^d and make loans with rate r.
  - Open again at night for settlement.
  - WLOG, all financial contracts are one-period contracts.
  - Record only financial history, not transaction history in the goods market.

Banking

- Bank only lends out loans in terms of government money.
  $\Rightarrow$credit creation subject to liquidity constraints,



Night Market Problem

- For $j \in \{b, n, s\}$

$$W^j(m, \ell, d) = \max_{x,y,m_+} \left\{ v(x) - y + \beta V^j(m_+) \right\}$$

$$\text{s.t. } \underbrace{y + \phi(m + \tau M) + (1 + r^d)d}_{\text{total income}} = \underbrace{x + \phi m_+ + (1 + r)\ell}_{\text{total expenditure}}.$$

b : credit users
n : money users
s : sellers

Day Market Problem

- Money users:

$$V^n(m^n) = \max_{q^n} \begin{array}{c} \pi\left[u(q^n) + W^n(m^n - pq^n)\right] \\ +(1-\pi)\,W^n\left(m^n\right) \end{array} \quad s.t.\ pq^n \leq m^n.$$

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- Credit users:

$$V^b(m^b) = \max_{q^b,\ell,d} \begin{array}{c} \pi\left[u(q^b) + W^b(m^b + \ell - pq^b, \ell, 0)\right] \\ +(1-\pi)W^b(m^b - d, 0, d) \end{array}$$

$$\text{s.t. } pq^b \leq m^b + \ell,$$

$$d \leq m^b.$$

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$$\text{s.t. } pq^b \leq m^b + \ell,$$
$$d \leq m^b.$$

- Sellers:

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

Banking Problem

- The bank's problem:

$$\max_{L,D} \left(rL - r^d D \right) \; s.t. \; L \leq D.$$

  In equilibrium,

$$r \quad = \quad r^d > 0.$$

- Banks channel money balances from those who have additional liquidity to those who need liquidity.

Monetary Equilibrium

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

$$\text{credit: } u'(q^b) = (1+i)\, c'(q^s),$$

$$\text{money: } u'(q^n) = \left(1 + \frac{i}{\pi}\right) c'(q^s),$$

$$\text{market clearing: } q^s = \pi \left[\alpha q^b + (1-\alpha) q^n\right].$$

- Note
  1. $q^b > q^n$,
  2. q^b is directly affected by i.
  3. q^b and q^n interact through $c'(q^s)$.

Inflation and Welfare

- Aggregate welfare

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

Proposition

Effects of inflation: $i \uparrow$

$q^n \downarrow$	$q^b \uparrow$ *or* $\downarrow$	$q^s \downarrow$	$\mathcal{W} \downarrow$

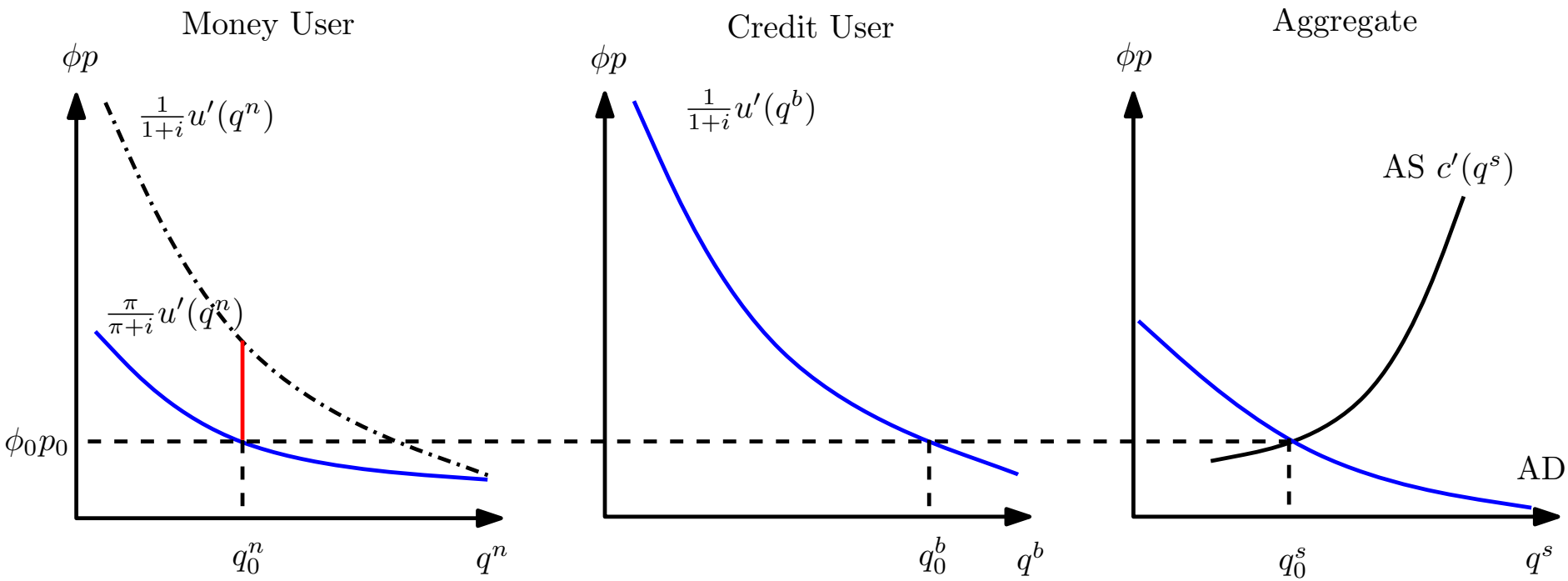
Access to Credit and Welfare

Proposition

Effects of access to credit: $\alpha \uparrow$

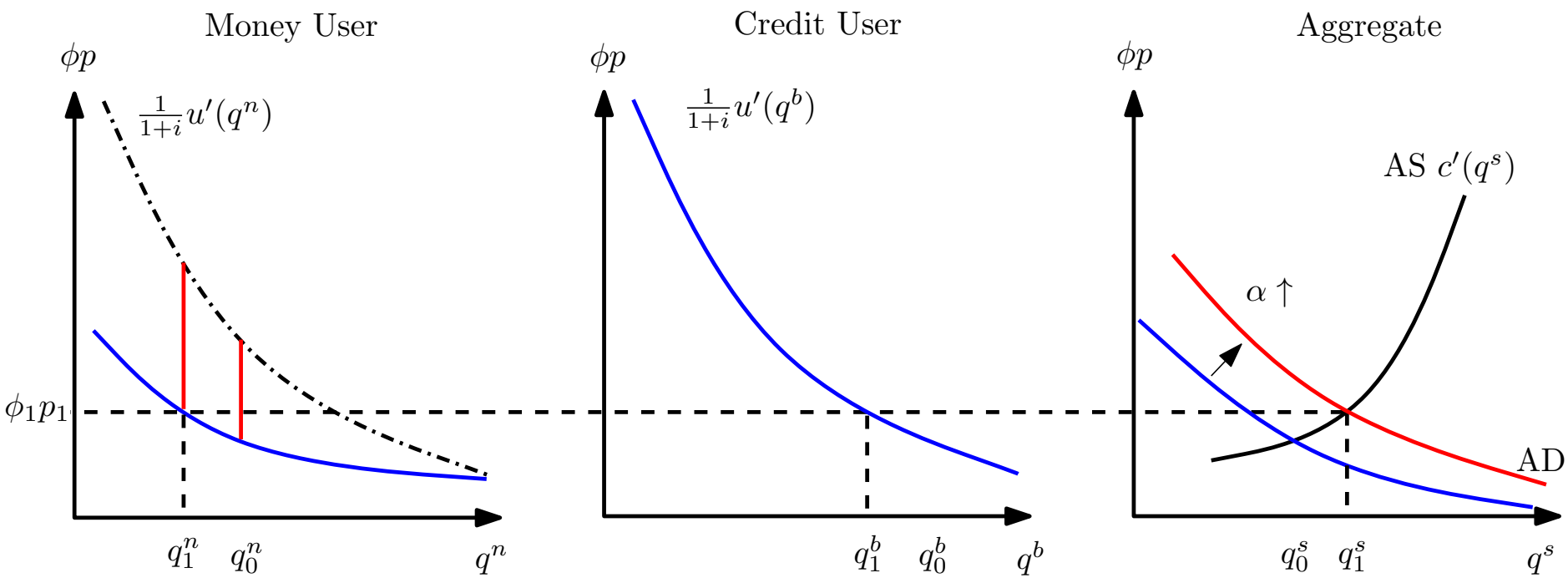
$q^n \downarrow$	$q^b \downarrow$	$q^s \uparrow$	$\mathcal{W} \downarrow$

Price Effect



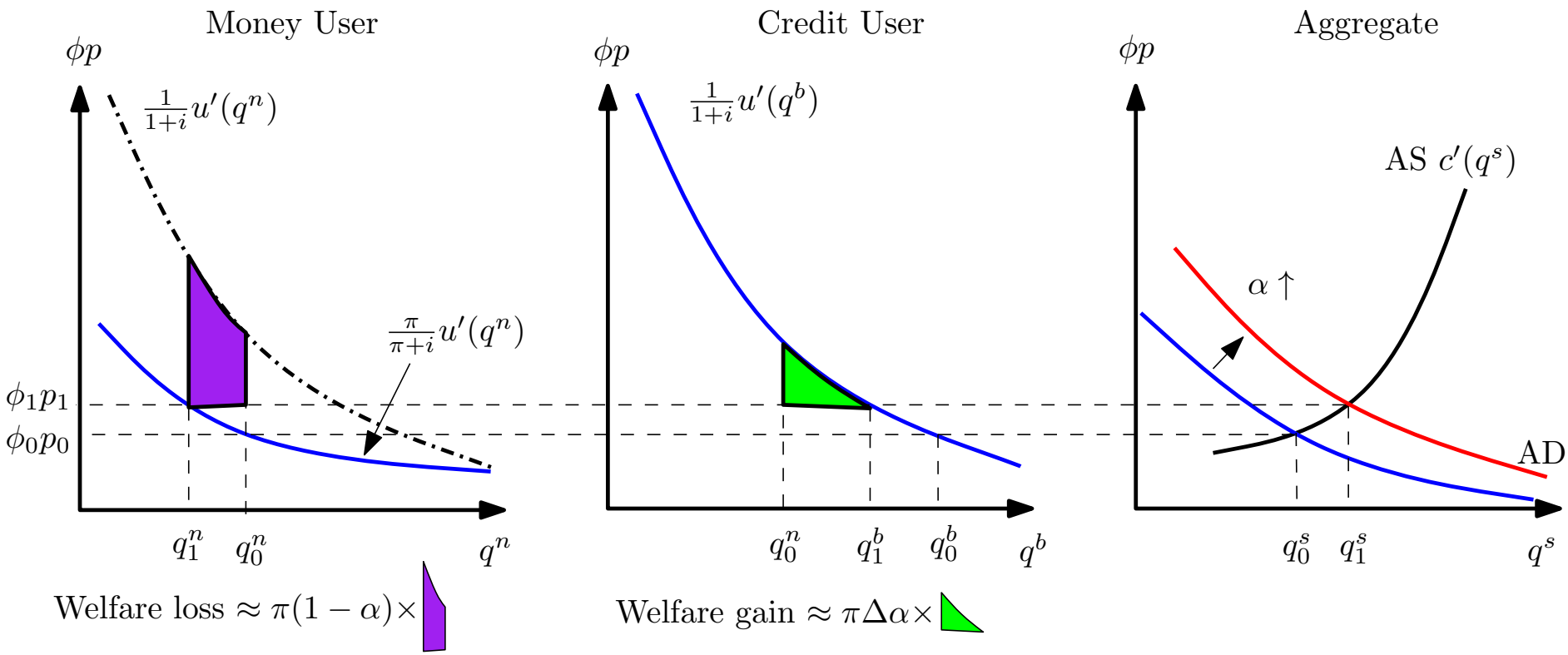
Initial α

Price Effect



Increase α by $\Delta\alpha$

Price Effect



Welfare Change

Mechanism Design

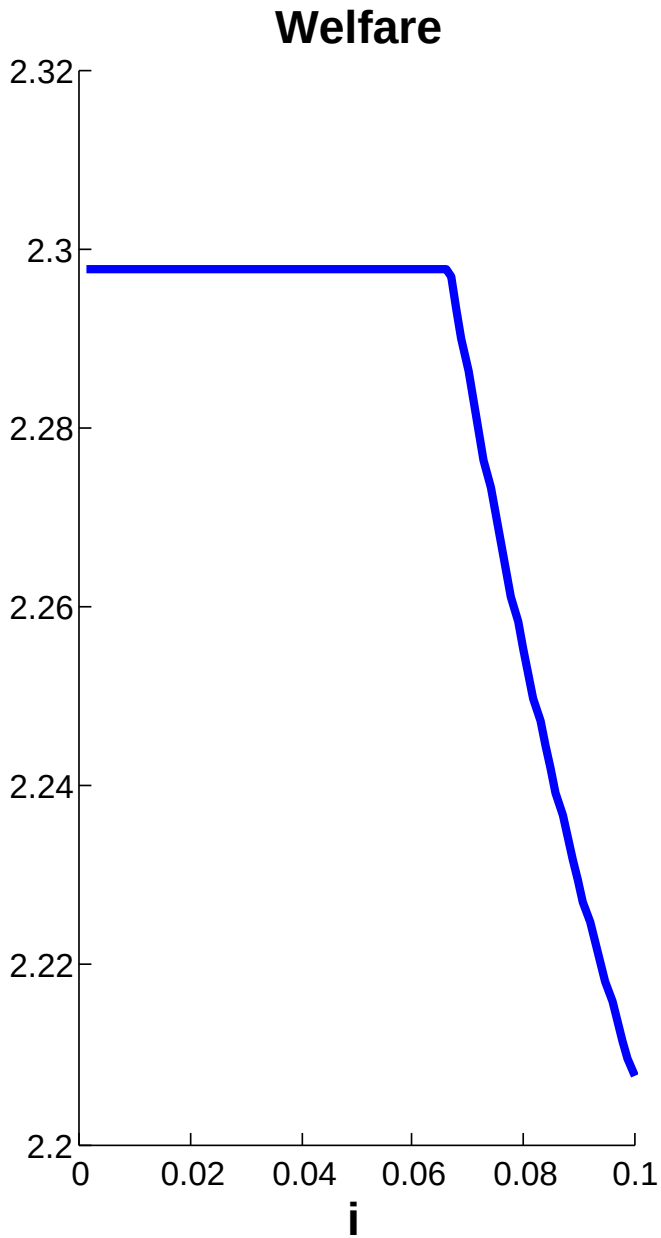
- Inefficiency comes from price effects. Can pricing arrangement be improved to mitigate inefficiencies?
- Allow the most flexible trading mechanism to give us a welfare benchmark.
- Mechanism design approach à la Hu et al. (2009) and Rocheteau (2011).
  - Abstract from all pricing inefficiencies, and focus on monetary frictions.
- All types are publicly observable except money holdings.
- A mechanism maps an agent's type j and his announced money balance to an allocation $\left(q^j, z^j\right)$.

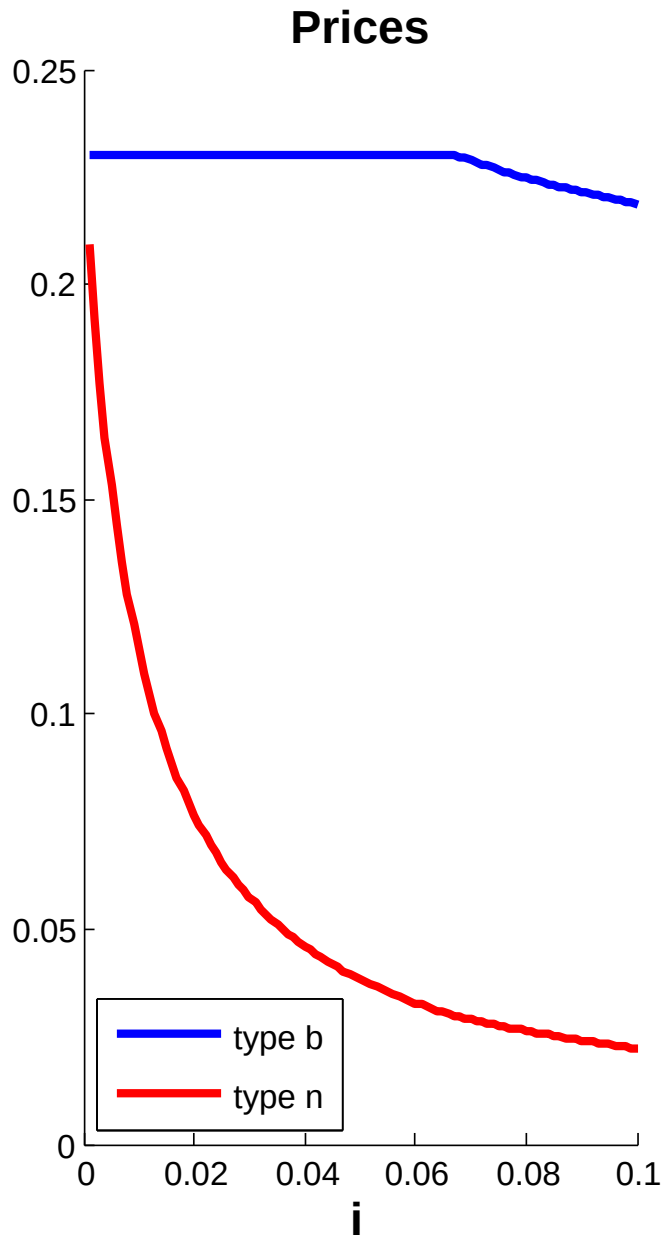
Optimal Mechanism

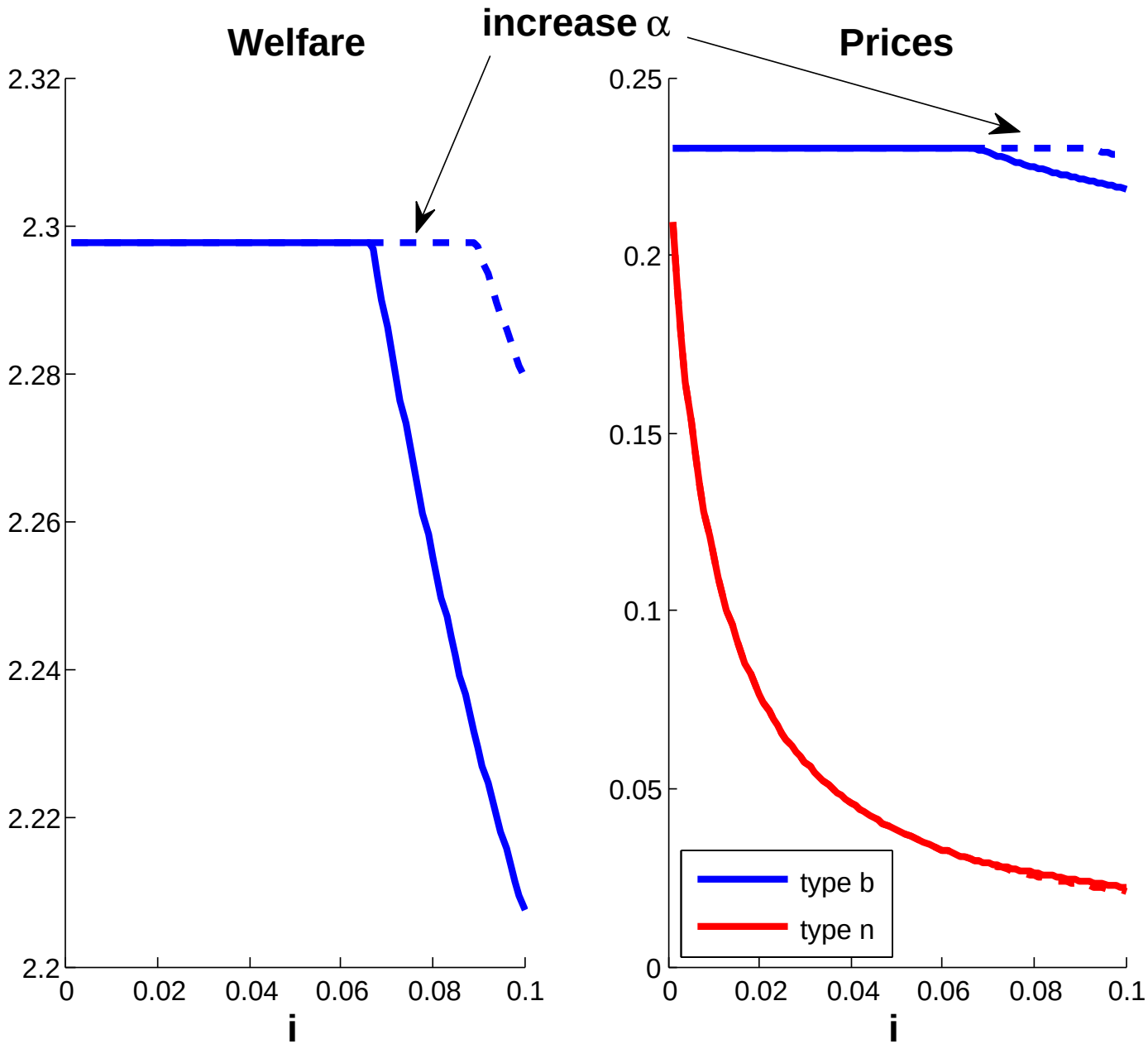
- To ensure that no one misreports his money holdings, a mechanism can be designed as
  - the allocation does not depend on seller's report;
  - to support the desired allocation $\left(q^j, z^j\right)$ for a type j buyer, the mechanism will propose $\left(q^j, z^j\right)$ if the announce money balance is no less than z^j, and will propose $(0, 0)$ otherwise.
- Implementation concept: immune to individual deviation (Nash).
- Focus on the mechanism that maximizes the social welfare subject to technological constraints and incentive constraints by different agents.

Comparison with Competitive Pricing

- Mechanism can achieve the first best even in the presence of small inflation.
- The reason:
  - not restricted to linear pricing;
  - can be contingent (q, z) on the agent's type and on the (self-reported) money holding;
  - prohibits side trades.


Welfare
2.32
2.3
2.28
2.26
2.24
2.22
2.2
0
0.02
0.04
0.06
0.08
0.1
i


Prices
0.25
0.2
0.15
0.1
0.05
0
0
0.02
0.04
0.06
0.08
0.1
i
type b
type n


Welfare
increase α
Prices
2.32
2.3
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2.26
2.24
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type b
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Extension: Credit as a Means of Payment

- Credit creation is not subject to liquidity constraint.
- Banks can issue inside money loan as a payment instrument.
- Findings:
  - Welfare reduces even more in a competitive equilibrium.
  - Under optimal pricing mechanism, credit serving a means of payment dominates the benchmark economy.

Extension: Imperfect Enforcement

- Suppose that repayment of credit cannot be enforced. The only punishment is to exclude from the banking sector forever. There exists an endogenous credit limit, $\bar{\ell}$.
- Three types of equilibrium:
  - pure monetary equilibrium,
  - constrained credit equilibrium,
  - unconstrained credit equilibrium.
- In a constrained credit equilibrium, the presence of the credit limit brings an additional link between q^b and q^n.
- Increase in α

$q^n \downarrow$	$q^b \uparrow$	$q^s \uparrow$	$\mathcal{W} \uparrow$

Conclusion

- Micro-founded model to evaluate the welfare implications of different payment arrangements.
  - Emphasize the role of frictions.
- The provision of credit and payment services is not necessarily welfare-improving.
  - Agents may fail to internalize the effects of their actions due to liquidity constraints.
- The welfare implications of different payment/credit arrangements depend critically on fundamental technologies
  - trading,
  - production,
  - enforcement.
- The optimal trading mechanism typically exhibits nonlinear pricing and price discrimination across different types.

Related Literature

- Evans and Schmalensee (2005), Bolt and Chakravorti (2008), Hayashi (2008), McAndrews and Wang (2008), Shy and Wang (2011), and Verdier (2011).
- Carlton and Frankel (1995), Gans and King (2003).
- Garcia-Swartz, Hahn and Layne-Farrar (2006), Bergman, Guibourg and Segendorf (2007).

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

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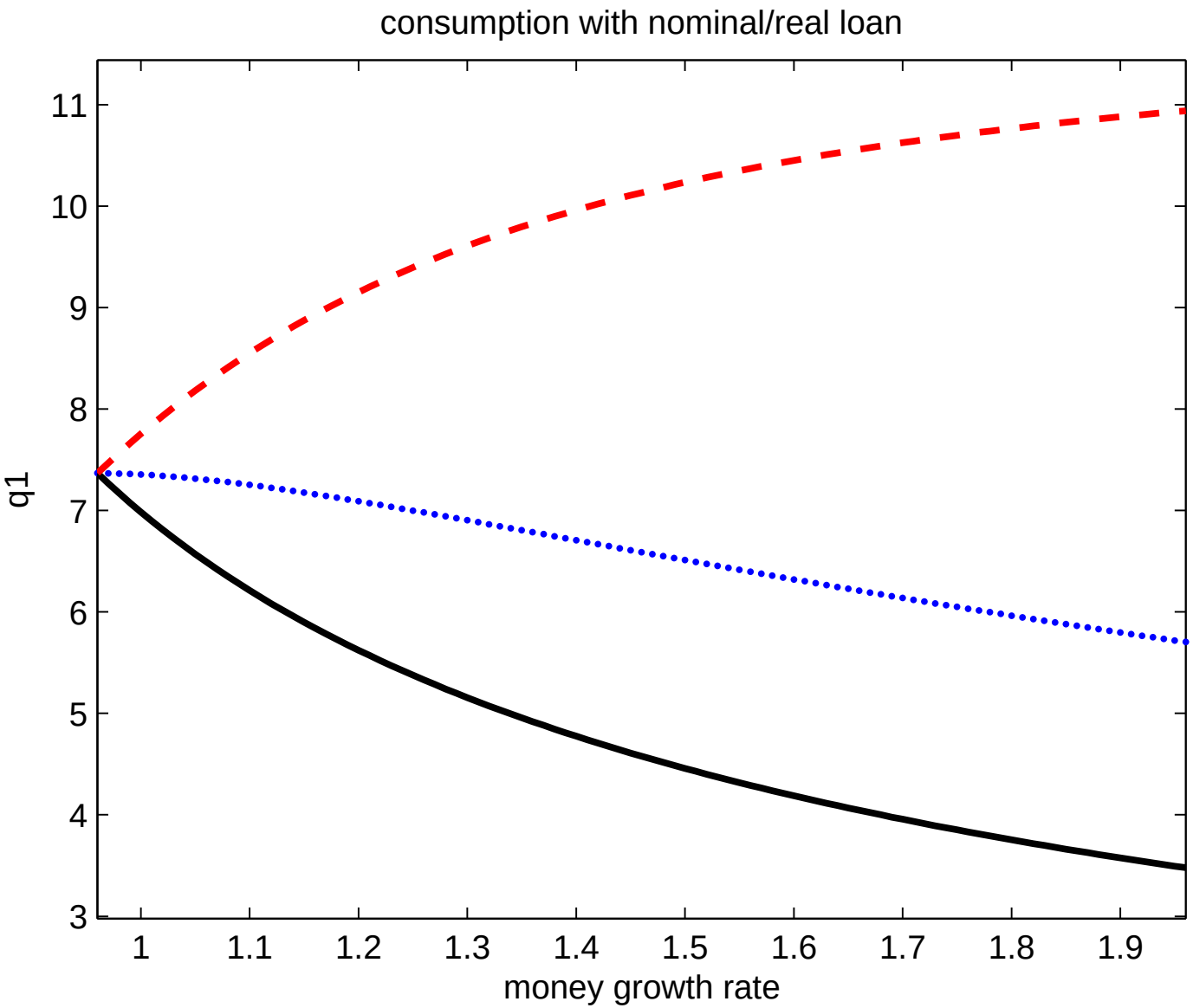
Consumption: agents who can access credit



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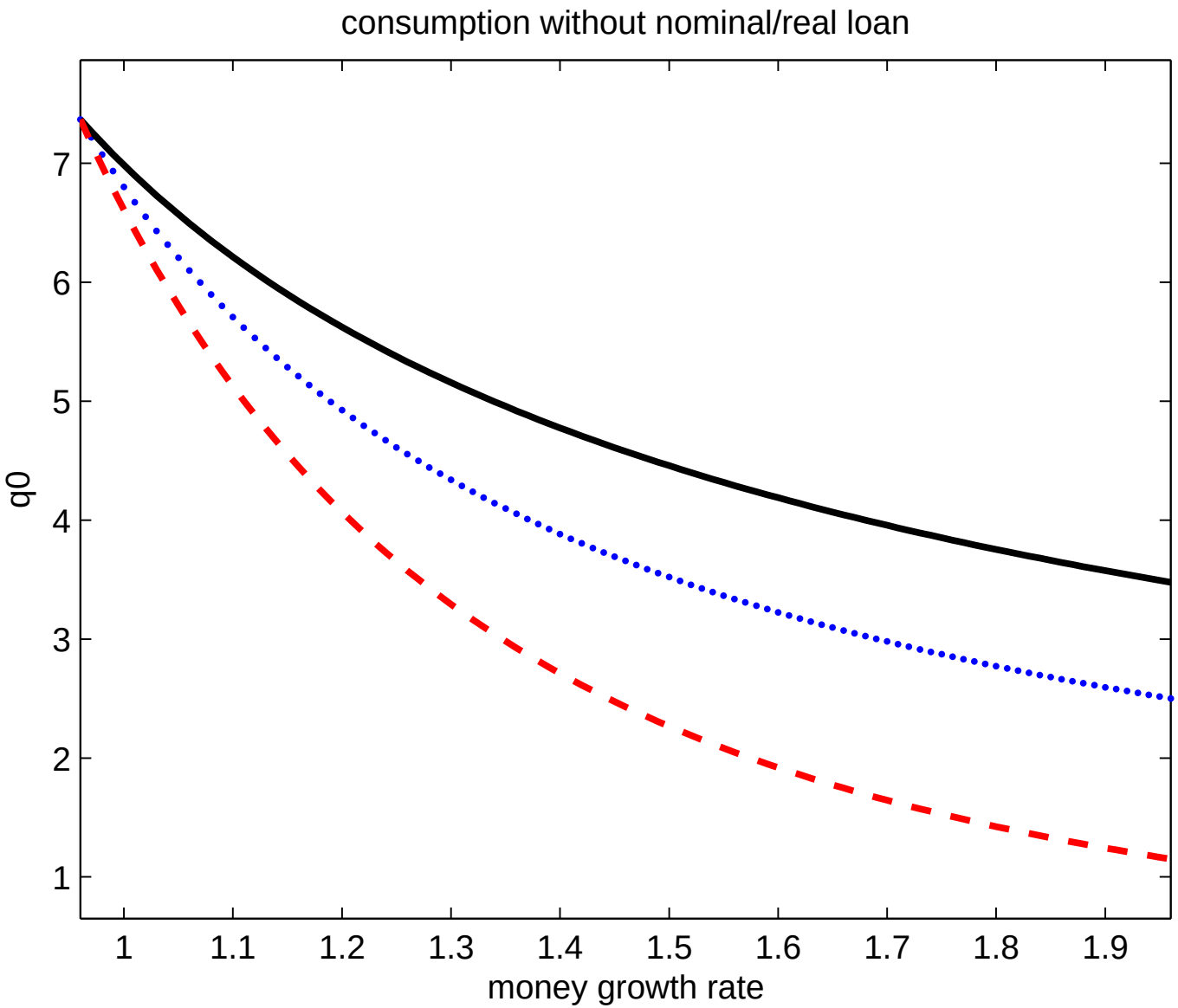

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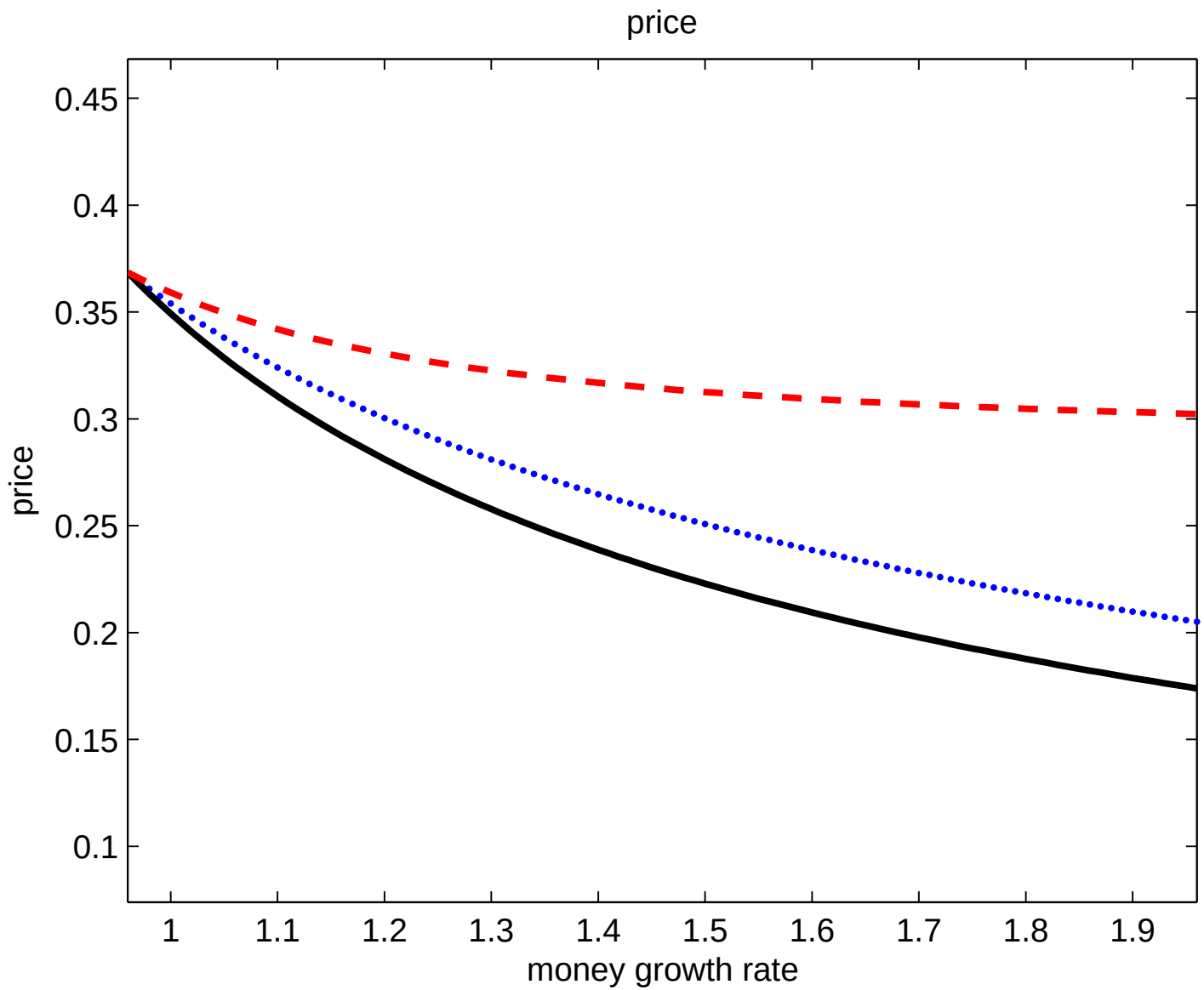
Price



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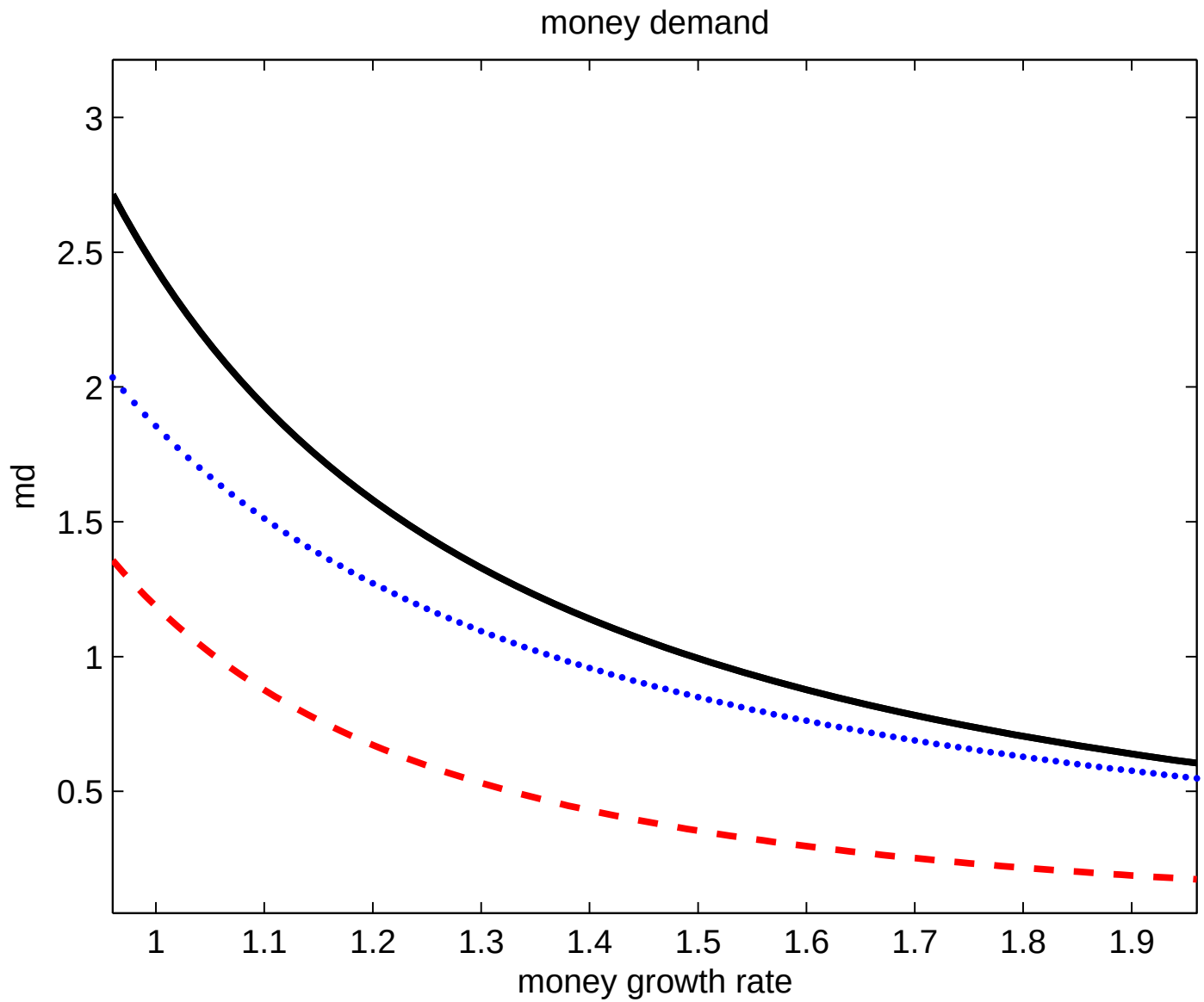
Real Demand for Money



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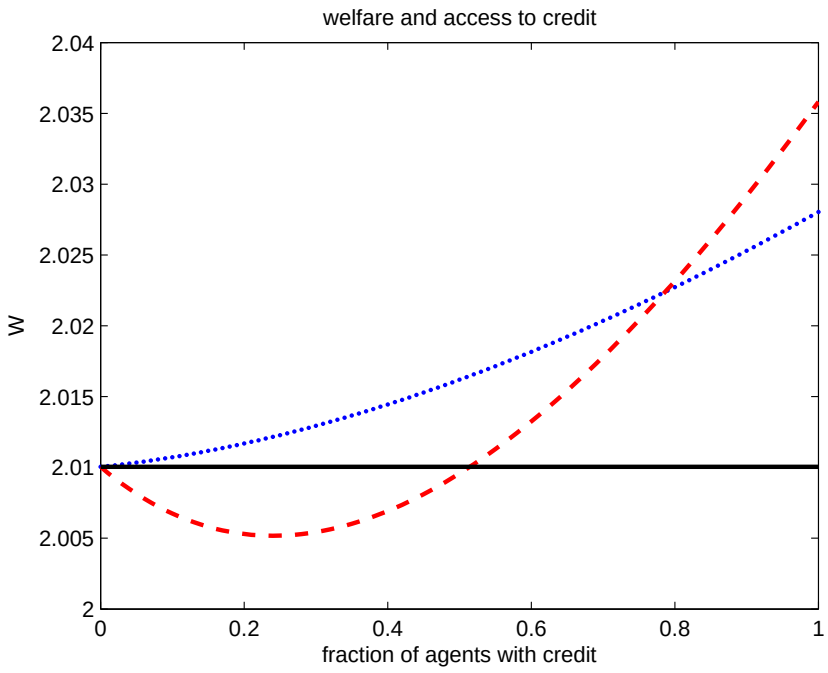
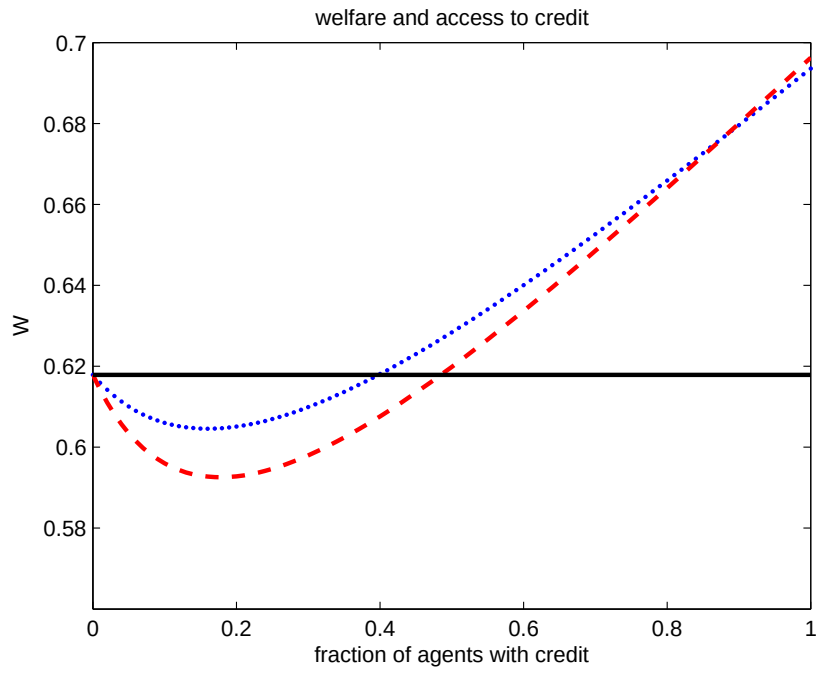
Access to Credit





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

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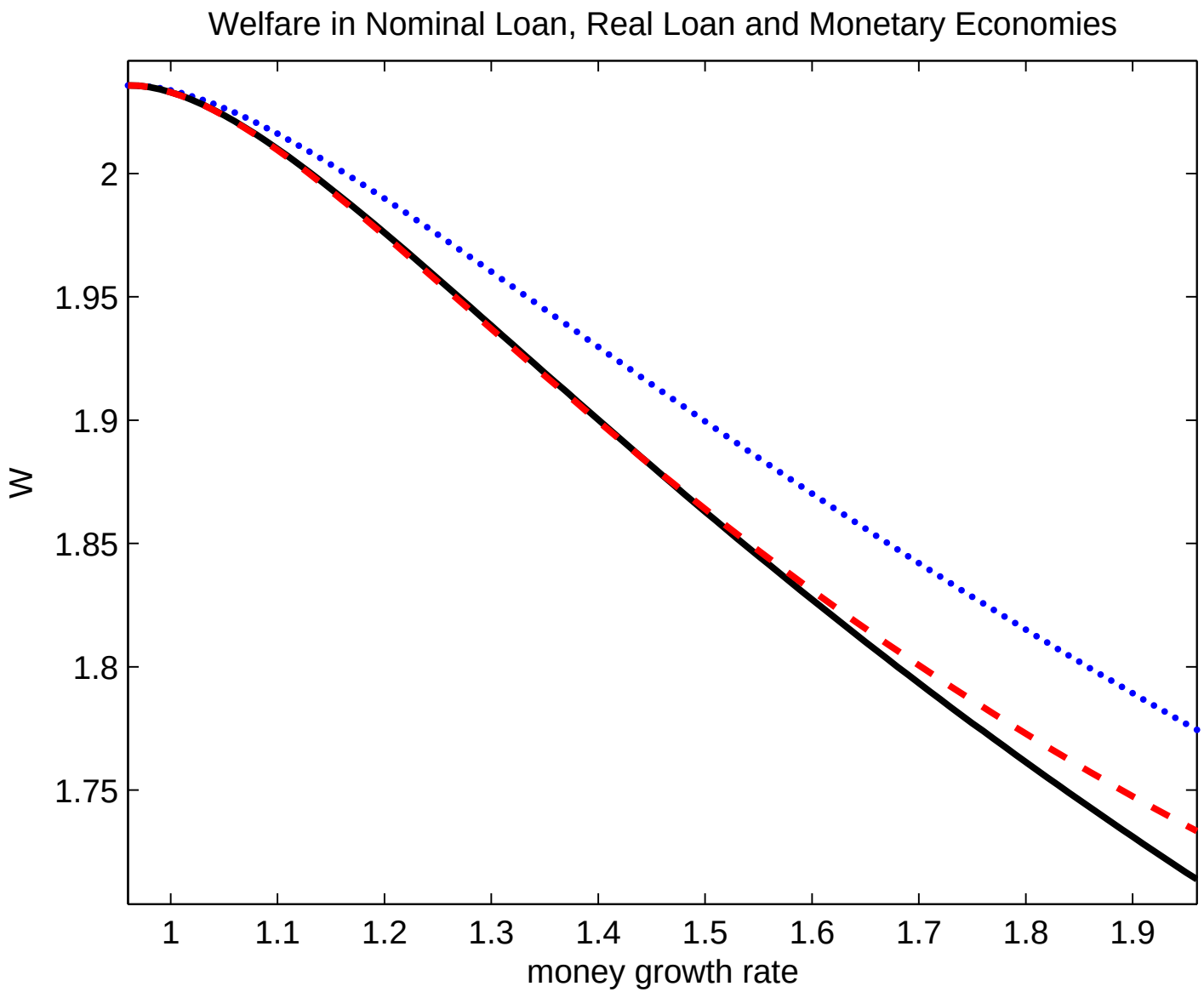
Inflation: Benchmark



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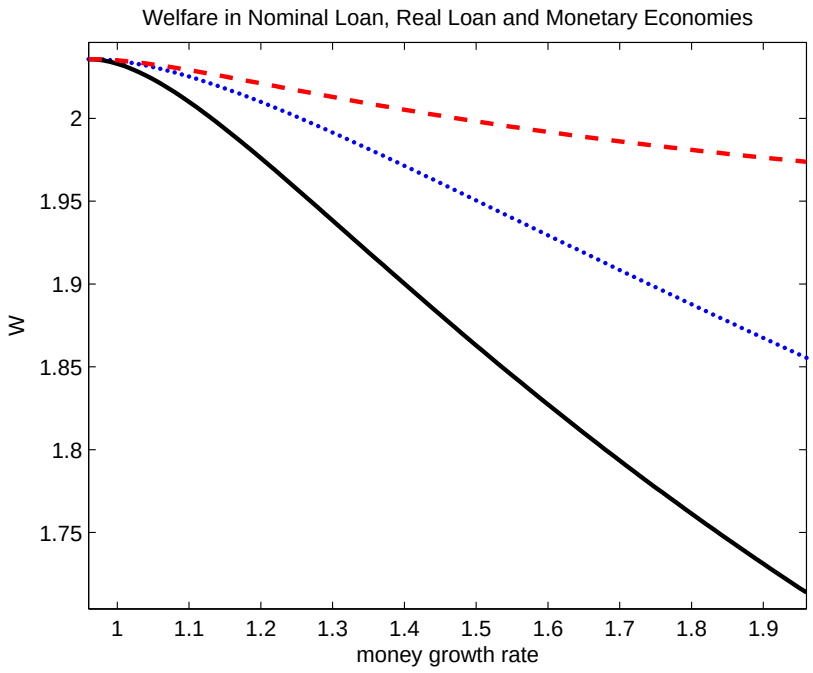
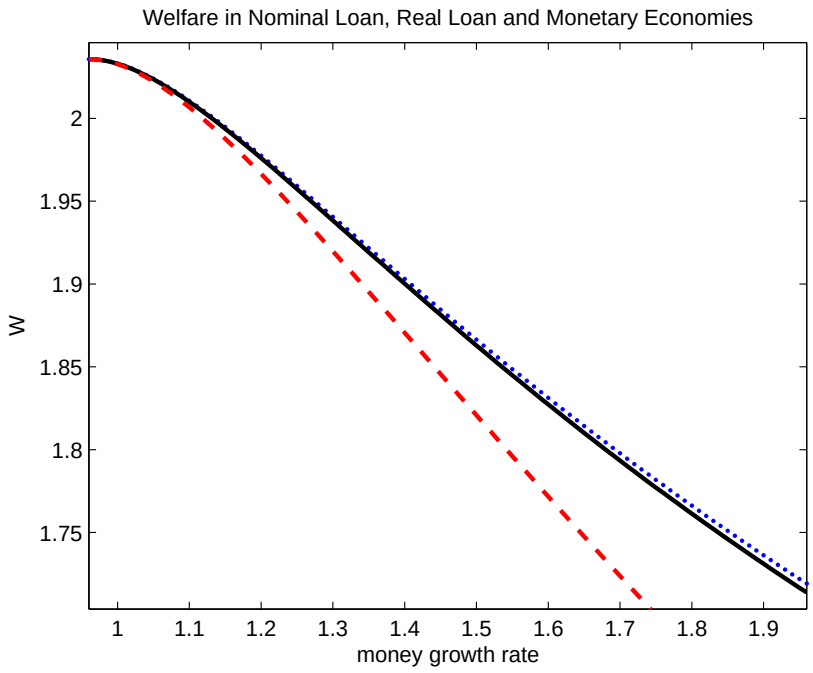
Inflation: Different α





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

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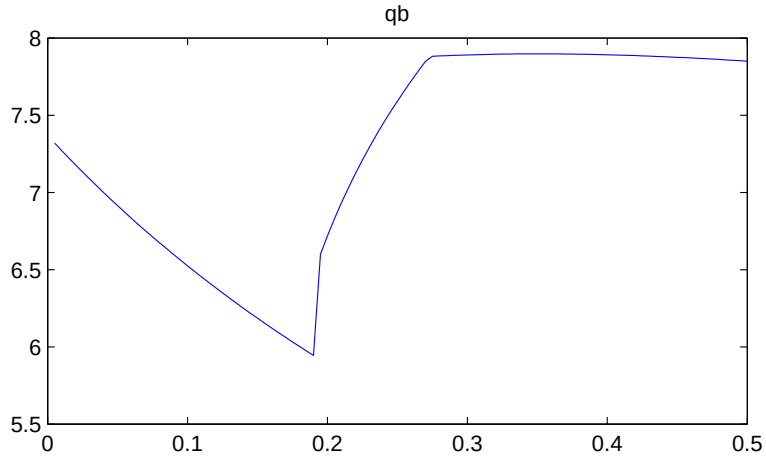
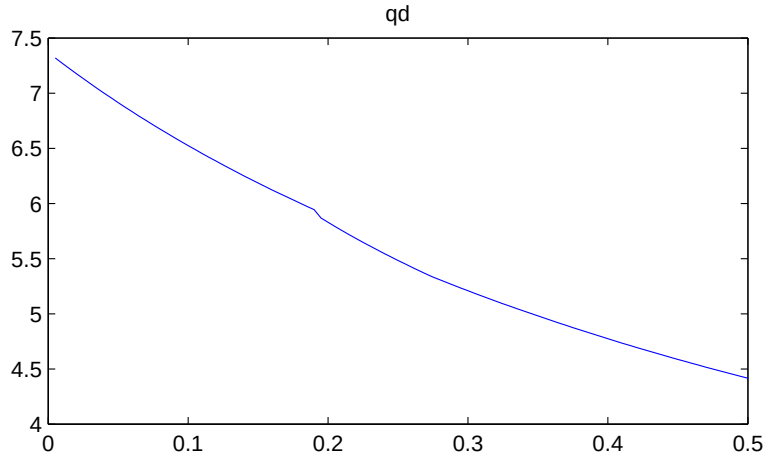
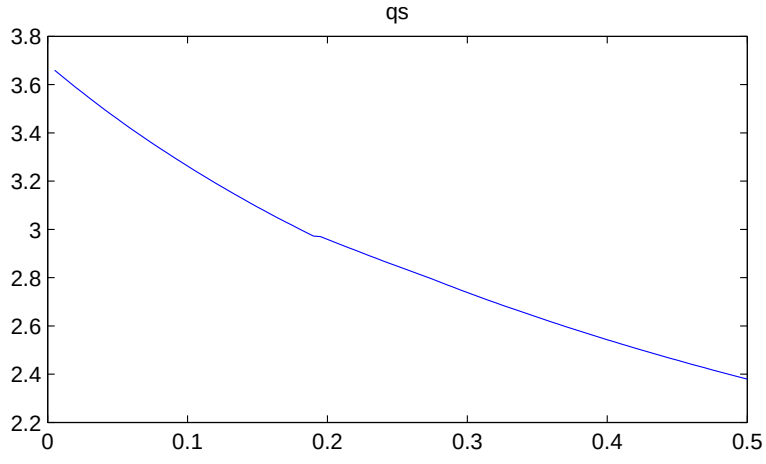
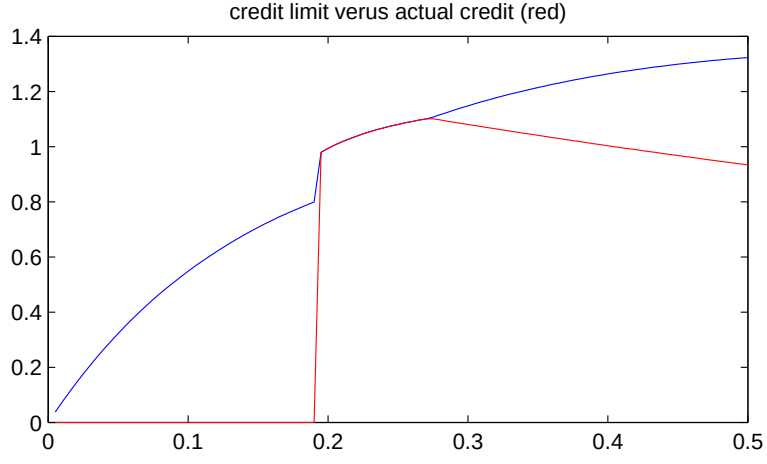
Imperfect Enforcement: Economy 1









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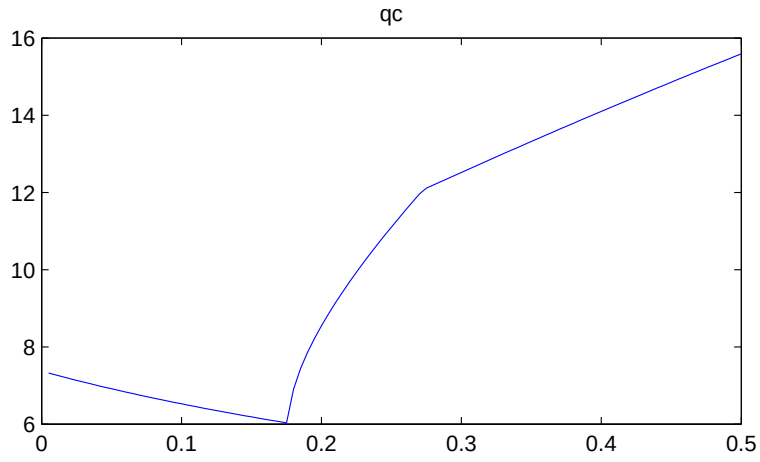
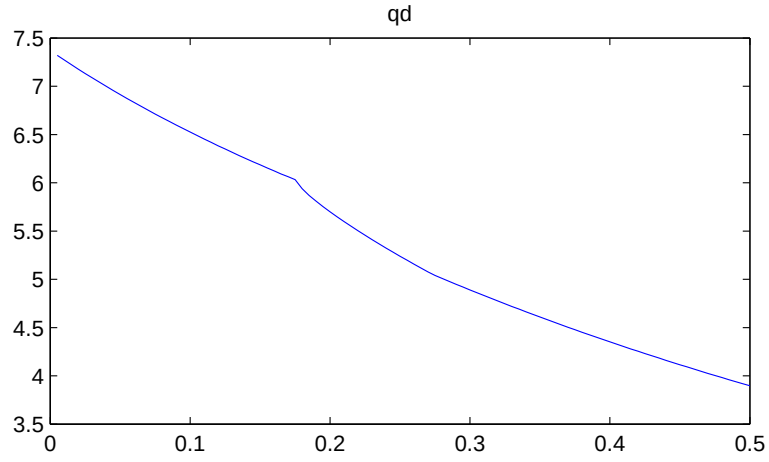
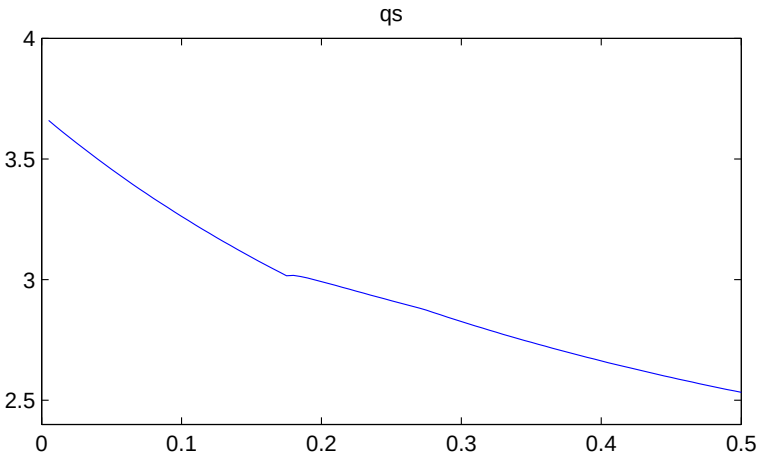
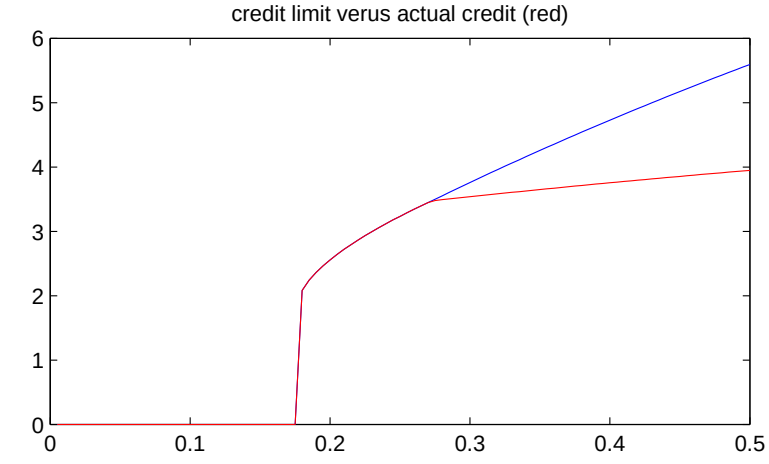
Imperfect Enforcement: Economy 2

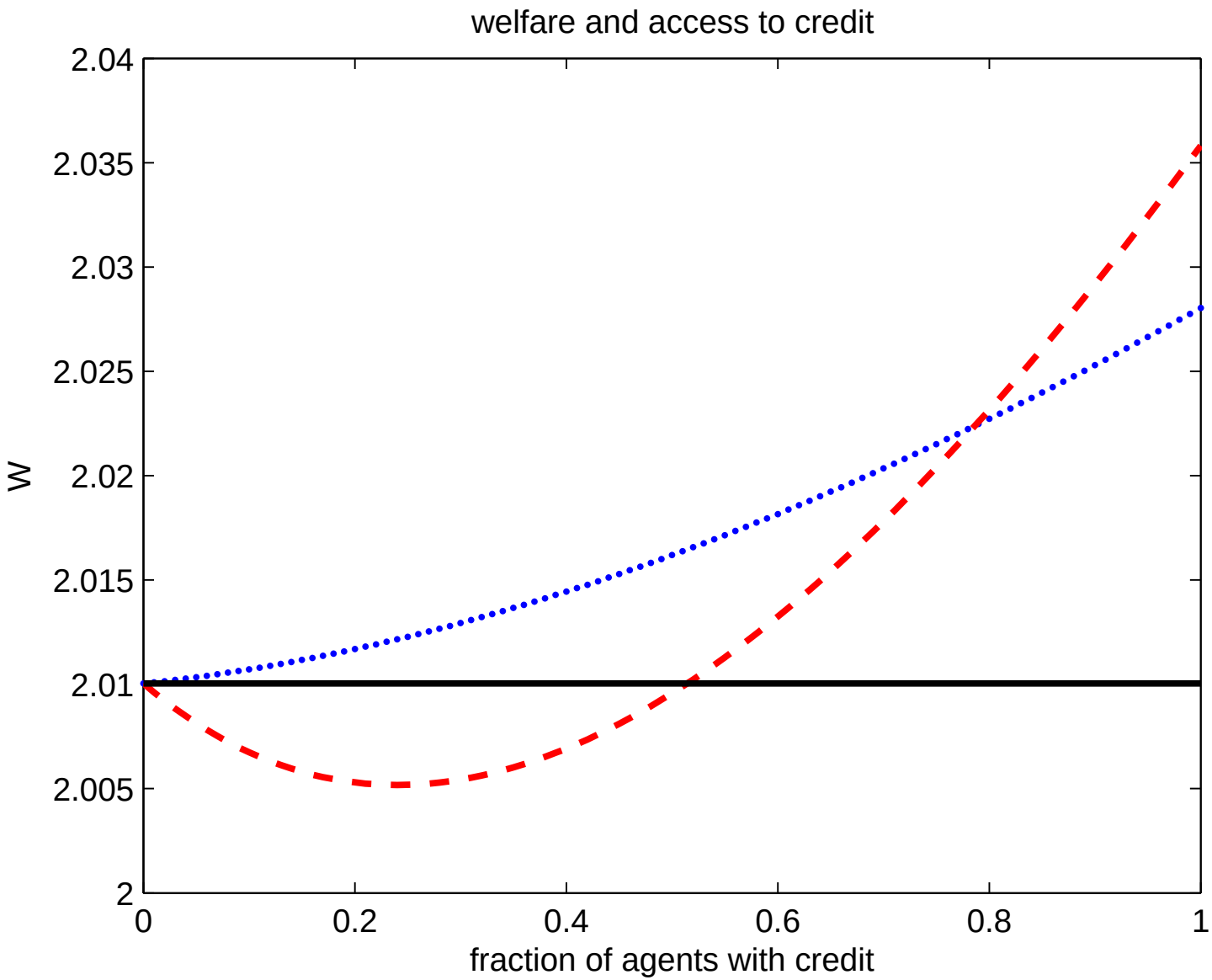








Imperfect Enforcement: Welfare Comparison I



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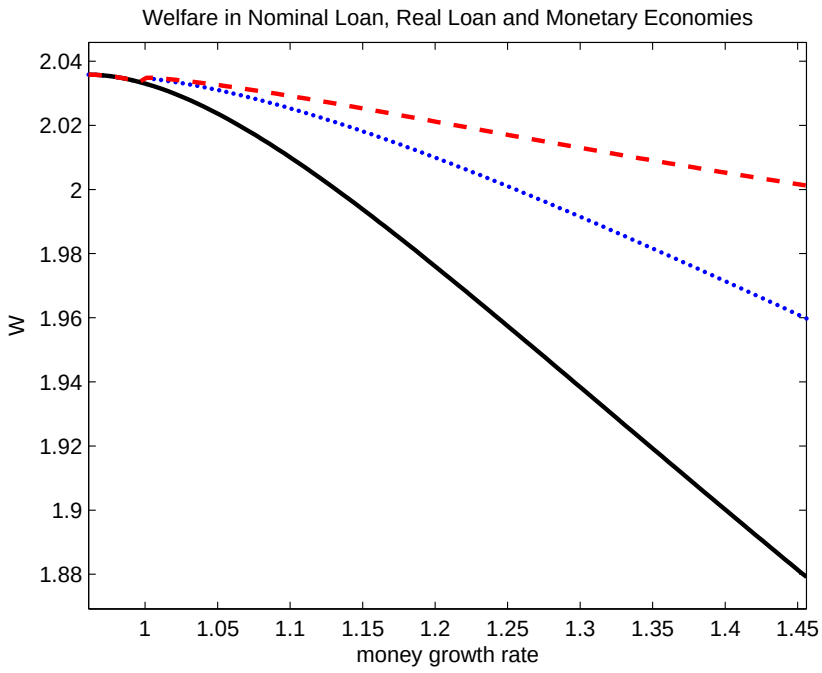
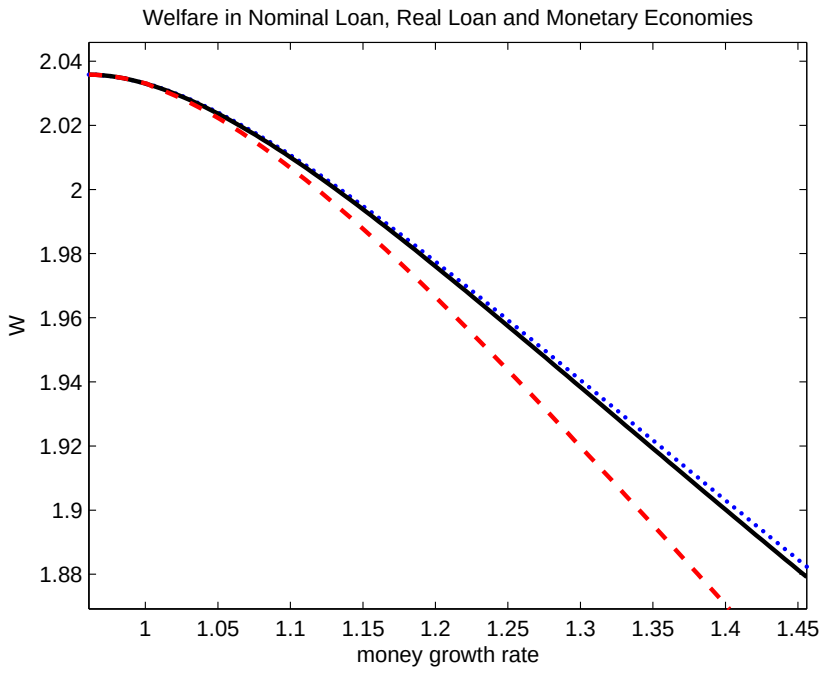
Imperfect Enforcement: Welfare Comparison II





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