

Understanding the Distributional Impact of Long-Run Inflation

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BROAD VIEW

Study impact of macroeconomic policy in heterogeneous-agent economies

This paper: Distributional ramifications of expansionary monetary policy

Methodology: Computational

WHAT DO WE KNOW?

1. *Representative* agent models: many studies.

Lesson: Optimal policy is non-inflationary, but inflation is not very costly

WHAT DO WE KNOW?

1. *Representative* agent models: many studies.

Lesson: Optimal policy is non-inflationary, but inflation is not very costly

2. *Heterogeneous* agents models: handful of studies.

Lesson: Lack of consensus on optimal policy *and* on impact.

EXAMPLES FOR MODELS CALIBRATED TO U.S. ECONOMY

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2. Does higher inflation reduce the concentration of wealth?

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2. Does higher inflation reduce the concentration of wealth?

Molico 2006: *Yes (if inflation is low)*

Dressler forthcoming: *No (if shocks are persistent)*

Erosa-Ventura 2002: *No*

Can we reconcile these disparities?

ROADMAP

1. Model

2. Main results

MODEL

Incomplete markets, no aggregate risk, ex-ante homogeneous agents.

- Idiosyncratic productivity shocks $h = h_L, h_H$; switch with probability q
- Endogenous labor supply
- Endogenous portfolio choice: hold $m \geq 0$ money and $b \geq \underline{b}$ illiquid bonds to
 - buy consumption on competitive spot markets (transactions balances)
 - self-insure against random productivity shocks (precautionary savings)

Standard concave preferences & labor-based production technology

Monetary injections: fully anticipated sequence of *lump-sum* transfers.

EFFICIENT ALLOCATION

Allocation of a planner who maximizes ex-ante lifetime expected utility

- Stationary & with full insurance: everyone consumes c^*
- Heterogeneous shock-dependent individual labor supply

Hence, focus on *stationary allocations* of the monetary economy

STATIONARY ALLOCATIONS IN THE MONETARY ECONOMY

1. Distribution of income, consumption, & (financial) wealth is time-invariant.
2. Real money stock is positive and stationary.

Remarks:

- Market clearing: faster rate of monetary expansion = greater inflation
- Efficient allocation cannot be attained since market is incomplete

EQUILIBRIUM CONCEPT

Stationary recursive competitive monetary equilibrium

Main features of allocation:

- Productivity shocks \Rightarrow heterogeneous *earnings*.
- Equilibrium dispersion in *wealth* (level, composition) & *consumption*.
- First moments of distributions are “sufficient” aggregate states.

RECURSIVE APPROACH

$$\begin{aligned}
 V(m, b, h) = & \max_{c, \ell, m', b' > \underline{b}} \{u(c) - g(\ell) + \beta EV(m', b', h')\} \\
 \text{s.t. } & c + \pi(m' + b') \leq w\ell h + m + bi + \xi + \tau, \\
 & c \leq m,
 \end{aligned}$$

Policy functions:

$$\begin{array}{c} \text{Cost of money} \\ \underbrace{u'(c)} \end{array} = \begin{array}{c} \text{Expected return on money} \\ \underbrace{\beta E[u'(c')]/\pi} \end{array} + \begin{array}{c} \text{Liquidity premium} \\ \underbrace{\lambda} \end{array} \quad \text{if } m' > 0$$

$$\begin{array}{c} \text{Illiquid} \\ \underbrace{i \times E[u'(c') - \lambda']} \end{array} = \begin{array}{c} \text{Liquid} \\ \underbrace{E[u'(c')]} \end{array} \quad \text{if } b' > \underline{b}.$$

USEFUL POINTERS

In a stationary monetary outcome:

- Uninsurable income shocks \Rightarrow wish to hold precautionary savings
- Hold money for transactions purposes or precautionary savings
- Hold bonds solely as precautionary savings

Remarks:

- $m' > 0$ (everyone holds money)
- $\lambda > 0$ for at least someone (cash constraints bind for someone)
- if $i \leq 1$, then $b' = \underline{b}$ (bonds must pay positive interest)
- if $b' > \underline{b}$, then $E[\lambda'] > 0$ (partially insure against liquidity needs)

EVOLUTION OF DISTRIBUTIONS OF STATES

Define transition function $Q : \Omega \times \mathcal{B}(\Omega) \rightarrow [0, 1]$ by

$$Q(\omega, \mathbb{B}(\Omega)) = \begin{cases} \sum_{h' \in \mathbb{H}} p(h'|h) & \text{if } (m'(\omega), b'(\omega)) \in \mathbb{M} \times \mathbb{B}, \\ 0 & \text{else} \end{cases}$$

for all $\omega = (m, b, h) \in \Omega$ and all $\mathbb{B}(\Omega) \subseteq \mathcal{B}(\Omega)$.

ϕ = associated joint probability density (a mixed density, discrete & continuous).

The next period probability distribution is given by

$$\Phi'(\mathbb{B}(\Omega)) = \sum_h \int_m \int_b Q(\omega, \mathbb{B}(\Omega)) \phi(\omega) dm db.$$

MARKET CLEARING & STATIONARITY

$$\bar{M} = \sum_h \int_m \int_b \pi m'(\omega) \phi(\omega) dm db$$

$$\sum_h \int_m \int_b c(\omega) \phi(\omega) dm db = Y(L)$$

$$\sum_h \int_m \int_b b'(\omega) \phi(\omega) dm db = 0$$

$$\Phi'(\mathbb{B}(\Omega)) = \Phi(\mathbb{B}(\Omega)).$$

PARAMETERIZATION & RESULTS

CALIBRATING AN ANNUAL MODEL FOR THE U.S.

Preferences: $u(c) = \frac{c^{1-\gamma}}{1-\gamma}$ and $g(\ell) = \frac{1}{\delta}\ell^\delta$ with $\beta = 0.97$

- $\delta = 2$ (unit wage elasticity of labor supply); $\delta \rightarrow 1$ infinite elasticity
- $\gamma = 1.3$ (matches variance of inverse velocity $\frac{M}{PY}$ in the data)

Shocks: $h_L = 0.1974$, $h_H = 0.8053$ with transition matrix

$$\begin{bmatrix} 0.935 & 0.065 \\ 0.065 & 0.935 \end{bmatrix}$$

using $std(\ln h) = 0.71$ and $\rho(\ln h) = 0.87$ (Storesletten et al. 2004)

Technology: $Y(L) = L^{0.7}$ (standard RBC model)

FINDINGS:

ECONOMIES WHERE CAN ONLY SELF-INSURE WITH MONEY

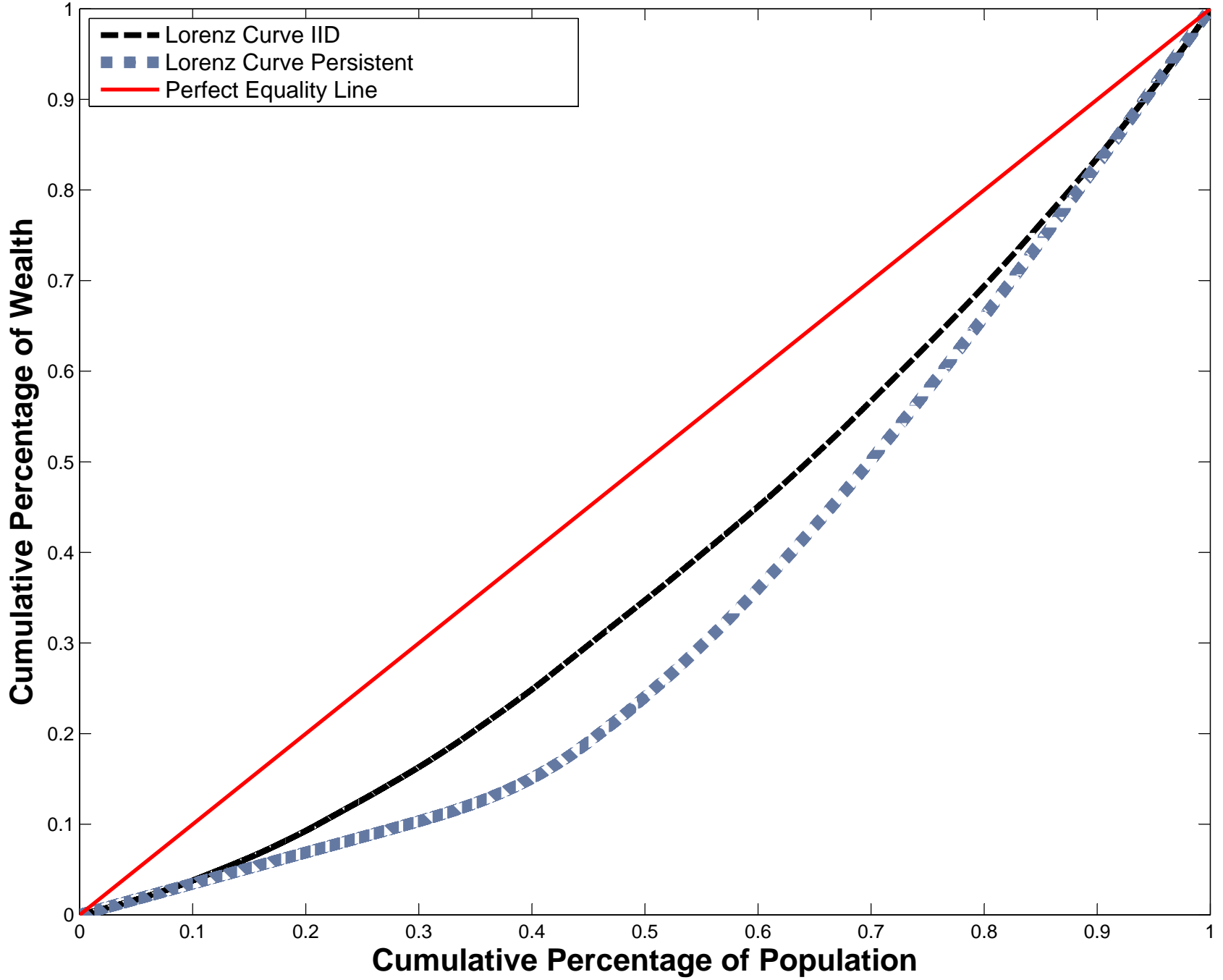
RESULT 1

*Equilibrium exhibits endogenous inequality in income, wealth, consumption.
Wealth and consumption inequality increase with the persistence of shocks.*

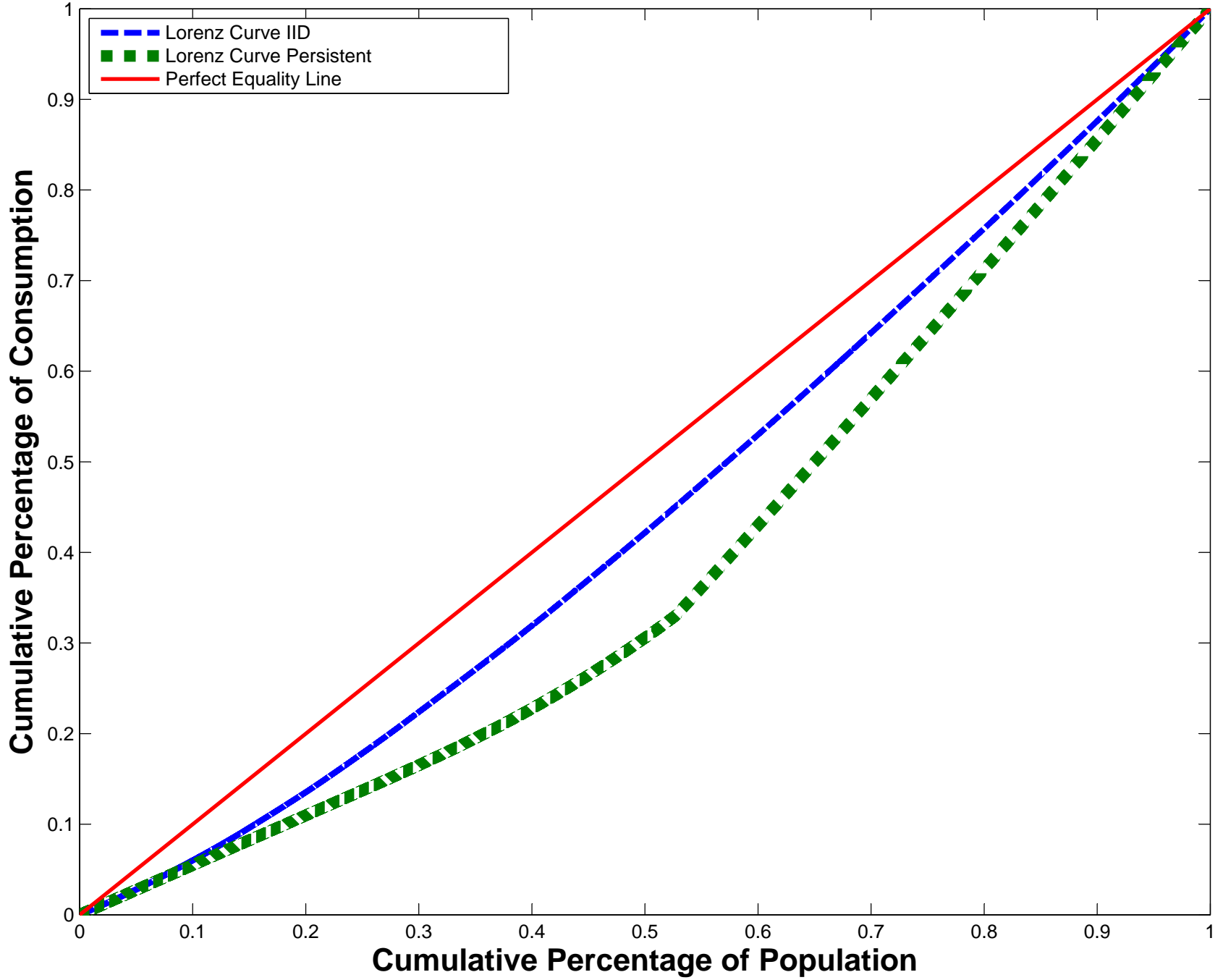
Intuition: cannot fully insure (incomplete markets), persistence reduces mobility.

Message: redistributive impact of monetary policy depends on shocks process

Lorenz Curve for Wealth (Gini=.215 , .313)



Lorenz Curve for Consumption (Gini = .108, .215)



RESULT 2

A faster rate of monetary expansion lowers income inequality and output.

Intuition:

- Lump-sum money injections redistribute income.
- Monetary expansion lowers savings' returns, labor supply declines, output falls.

Message: unlike representative-agent models, inflation *may* be socially beneficial
(mean - variance tradeoff)

$\pi - 1$	Persistent		lid	
	Output	$Gini_I$	Output	$Gini_I$
0%	0.897	0.274	0.954	0.317
1%	0.890	0.259	0.947	0.309
2%	0.884	0.249	0.941	0.302
3%	0.880	0.242	0.936	0.296
4%	0.877	0.236	0.931	0.290
5%	0.874	0.232	0.926	0.285
10%	0.860	0.223	0.904	0.264
15%	0.848	0.215	0.886	0.247
20%	0.836	0.208	0.870	0.233
25%	0.826	0.202	0.856	0.221
30%	0.816	0.195	0.843	0.211
35%	0.807	0.190	0.830	0.203
40%	0.799	0.184	0.819	0.195

Table 1: Money-only economy

RESULT 3

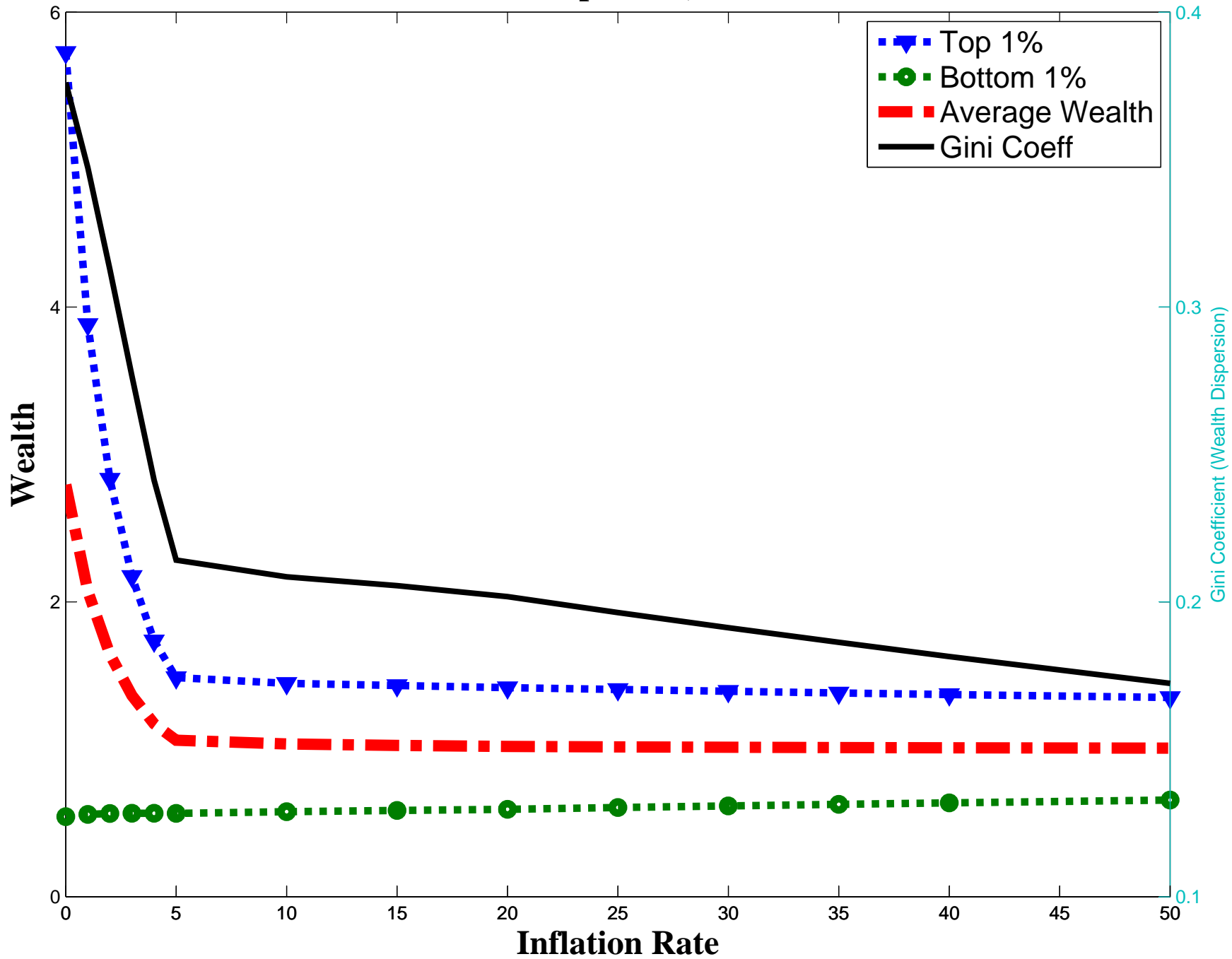
Wealth and wealth inequality decline with inflation, non-linearly.

Intuition:

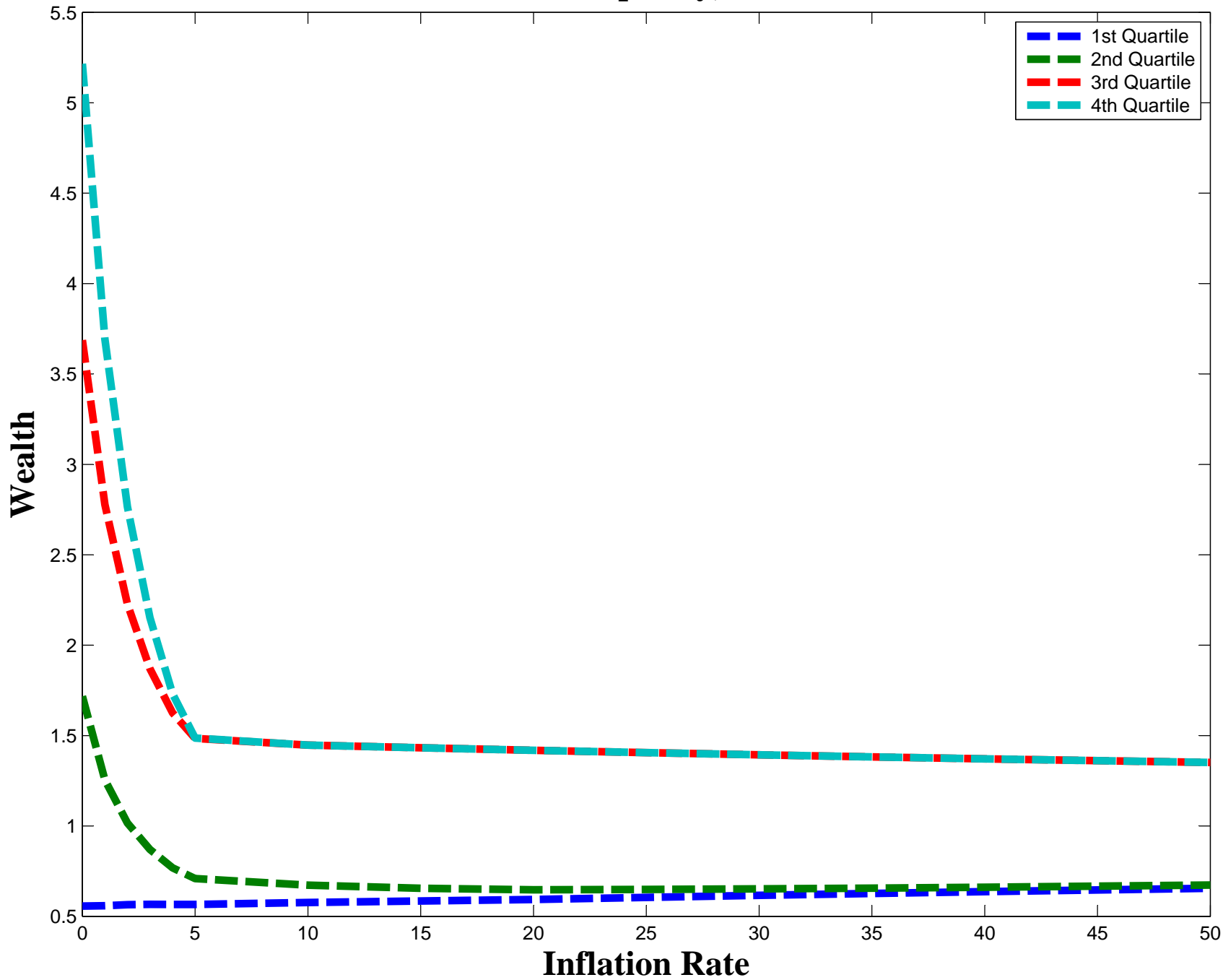
- Self-insurance value of savings falls, precautionary balances fall
- Monetary expansion = tax for rich, transfer for poor
- Small departures from zero inflation generate the fastest declines.

Message: expansionary monetary policy can be a tool to redistribute wealth

Wealth Dispersion, Persistent shocks



Wealth Inequality, Persistent Shocks



RESULT 4

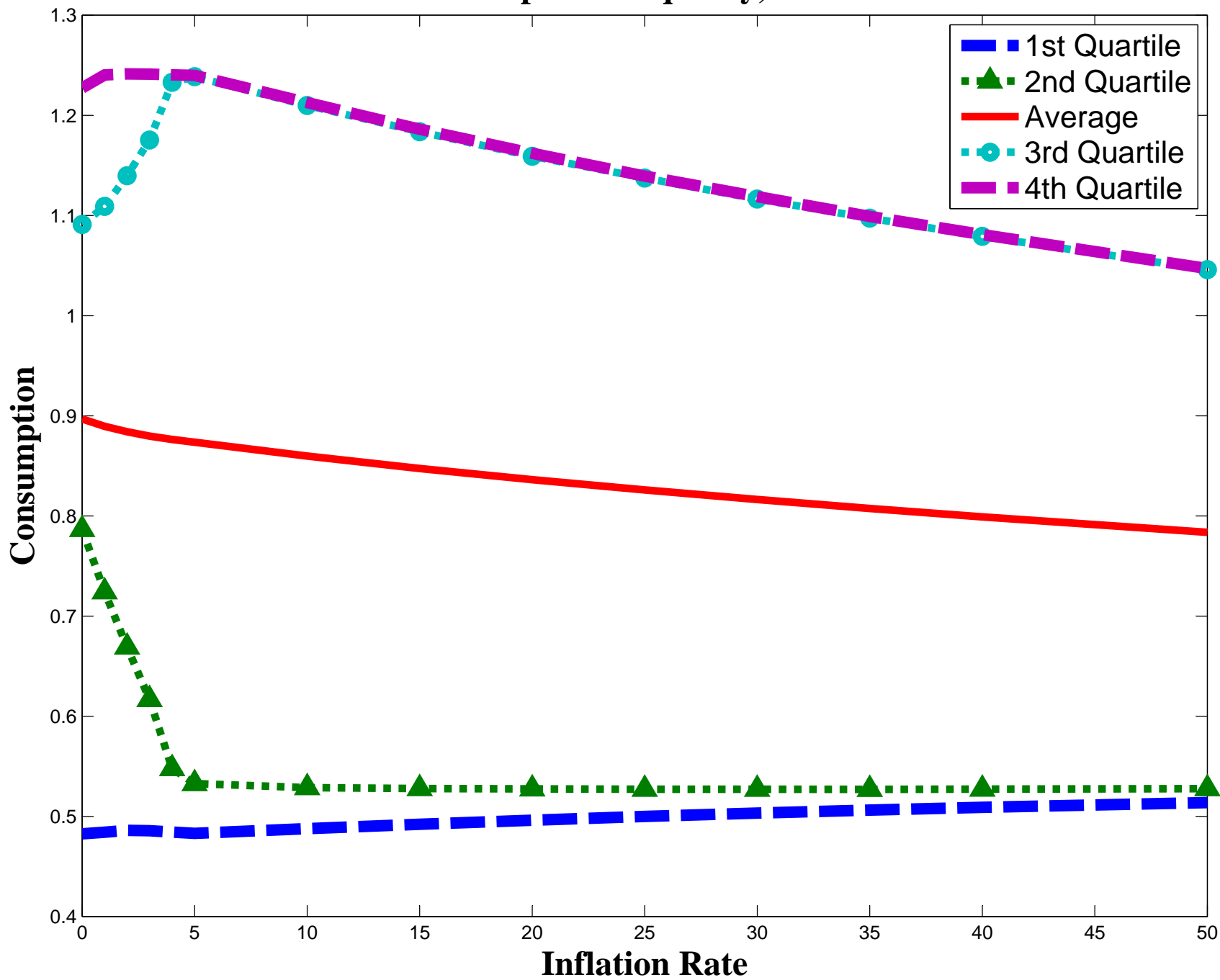
A faster rate of monetary expansion may elevate consumption inequality.

Intuition: liquidity constraints differentially tight, borrowing not allowed.

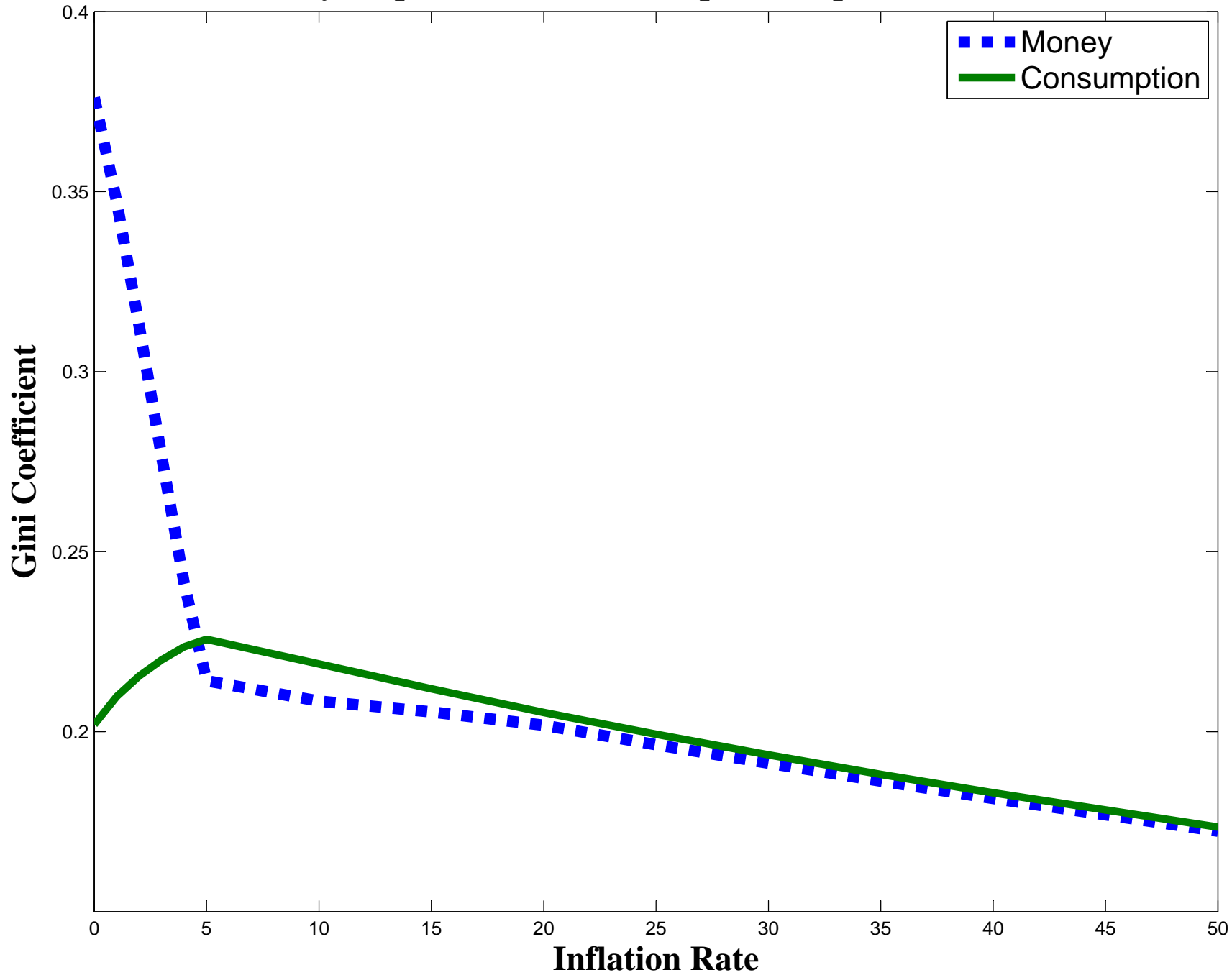
- Marginal value of money rapidly increases for the poor
- Rich do not have binding constraints

Message: inflation-induced wealth redistribution may have unintended impact

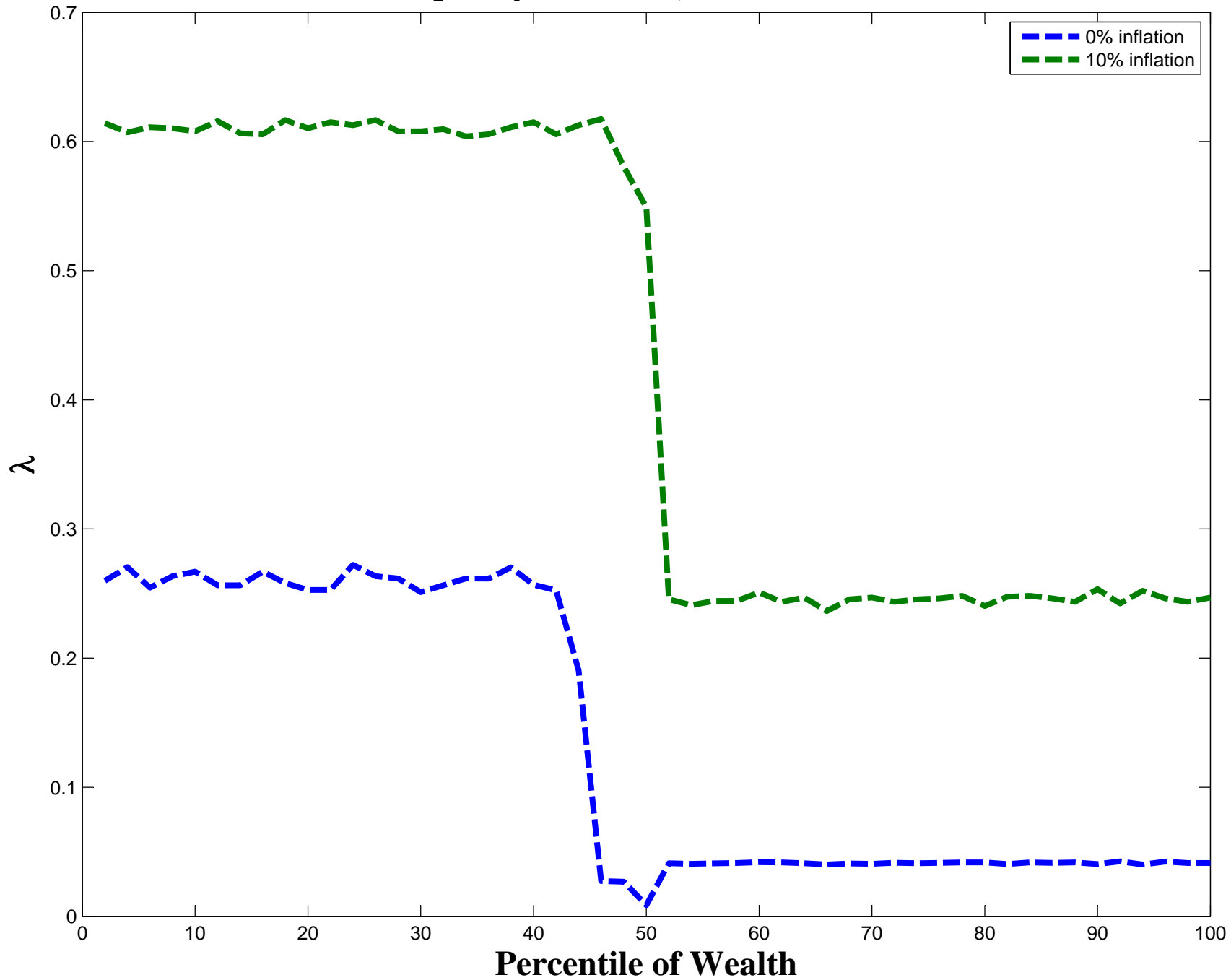
Consumption Inequality, Persistent Shocks



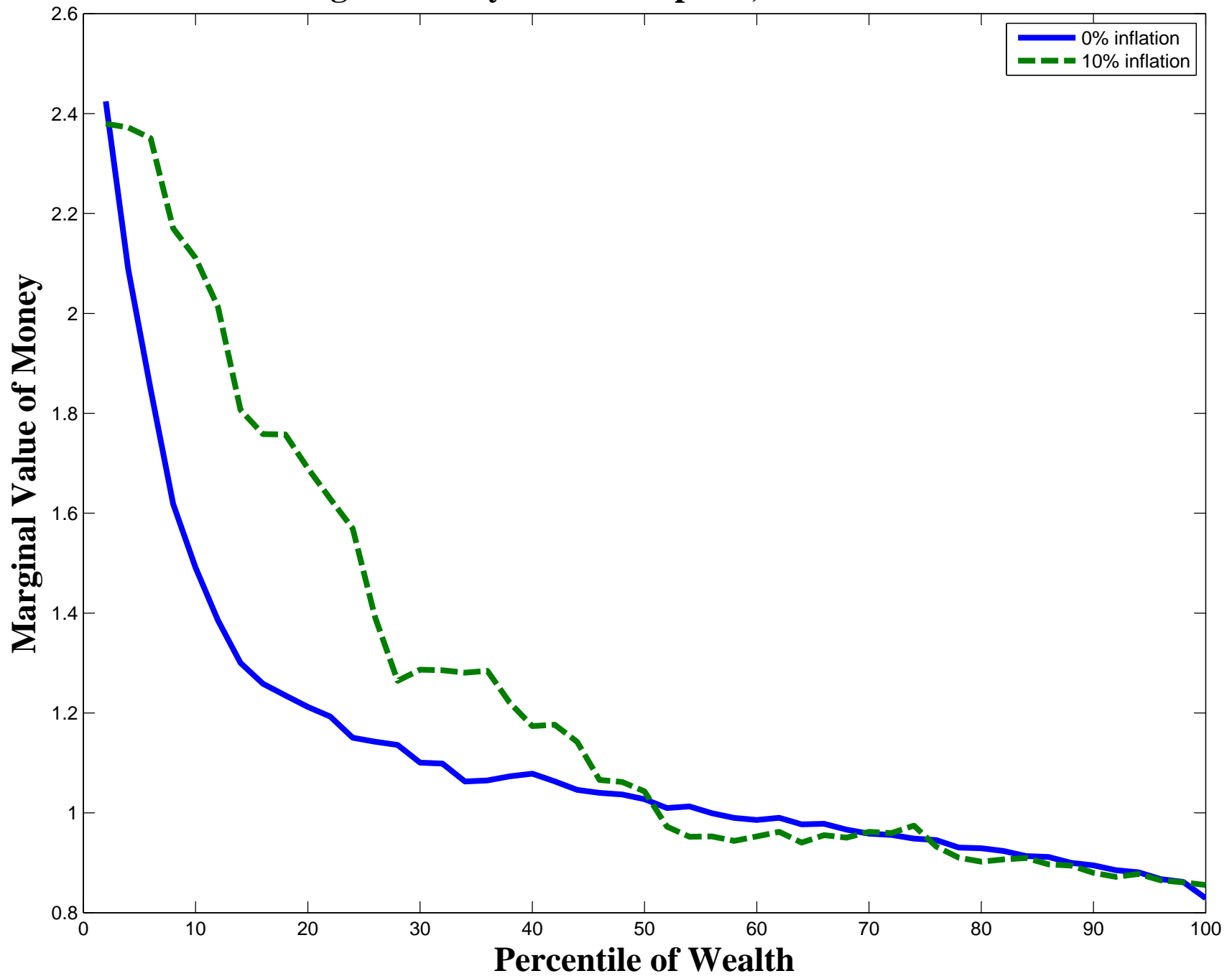
Money Dispersion and Consumption Dispersion, Persistent Shocks



Liquidity Premium, Persistent Shocks



Marginal Utility of Consumption, iid shocks



RESULT 5

Average welfare is non-linearly associated with inflation.

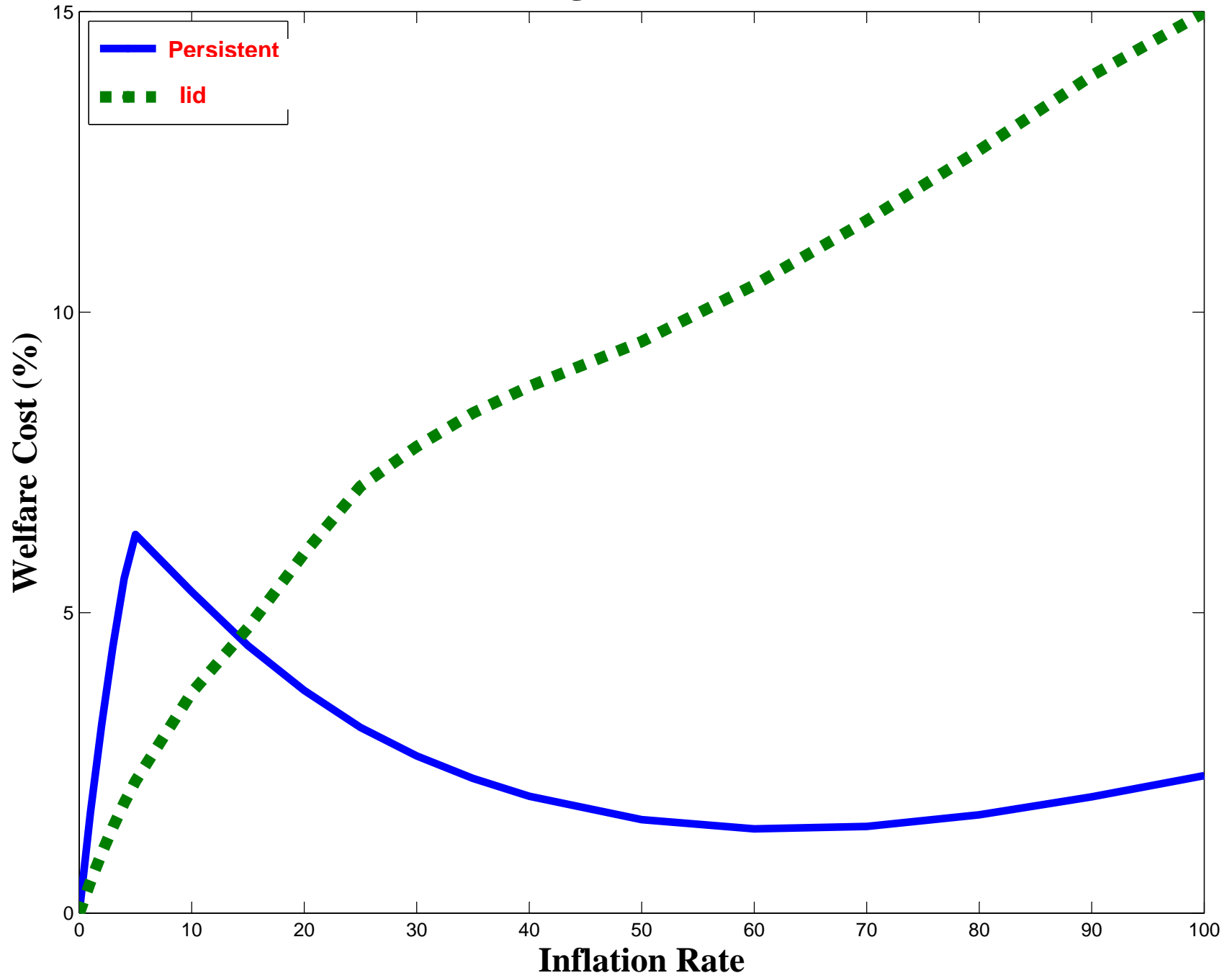
The association is non-monotone when shocks are persistent.

Intuition: planner would dissipate consumption to reduce its dispersion

- Inflation redistributes consumption, but dissipates some (Results 1, 4).
- Persistent shocks magnify inequality (Result 3).

Message: labor elasticity & shocks' structure affect mean-variance tradeoff

Average Welfare Cost



$\pi - 1$	$\Delta\pi$	$Q1$	$Q2$	$Q3$	$Q4$
0%	0.000	0.000	0.000	0.000	0.000
1%	1.674	-0.786	2.219	2.061	3.328
2%	3.143	-0.866	4.103	3.266	6.126
3%	4.438	-0.582	6.029	3.802	8.355
4%	5.569	-0.168	8.373	3.533	10.113
5%	6.300	0.096	9.020	4.281	11.251
10%	5.348	-0.918	7.856	3.827	10.888
15%	4.451	-1.821	6.739	3.479	10.388
20%	3.705	-2.636	5.833	3.184	10.053
25%	3.090	-3.284	5.000	3.014	9.776
30%	2.615	-3.783	4.289	2.912	9.631
35%	2.241	-4.219	3.725	2.884	9.547
40%	1.945	-4.571	3.230	2.888	9.533

Table 2: Distribution of Welfare costs (persistent shocks, $\delta = 2$)

FINDINGS:

INTRODUCING A MARKET FOR DEBT SECURITIES

RESULT 6

When money is not the only asset, the liquidity of portfolios declines with inflation and household's wealth.

Intuition: reduce exposure to inflation tax by minimizing monetary savings.

- Money primarily serves a *transactions* role.
- *Precautionary* savings mostly composed of bonds

Message: financial innovation affects portfolios composition, impact of policy

$\pi - 1$	<i>1stQ</i>	<i>2ndQ</i>	<i>3rdQ</i>	<i>4thQ</i>
0%	1.000	0.922	0.404	0.255
1%	1.000	0.906	0.394	0.255
2%	1.000	0.899	0.394	0.253
3%	1.000	0.901	0.395	0.251
4%	1.000	0.903	0.395	0.250
5%	1.000	0.905	0.395	0.249
10%	1.000	0.907	0.400	0.246
15%	1.000	0.910	0.402	0.247
20%	1.000	0.910	0.399	0.246
25%	1.000	0.910	0.401	0.244
30%	1.000	0.908	0.399	0.241
35%	1.000	0.909	0.400	0.240
40%	1.000	0.899	0.398	0.240

Table 3: Money/Tot. Assets ratio (persistent shocks, $\delta = 2$)

RESULT 7

Consumption inequality is lower and wealth inequality is greater when households can access a credit market, as opposed to when they cannot.

Intuition: unequal precautionary savings \Rightarrow wealth disparities

- Possibility to borrow/lend improves risk-sharing, lowers consumption inequality.
- Possibility to borrow raises wealth inequality.

Message: financial innovation raises wealth concentration, improves smoothing

	Money-Only		Money & bonds		
$\pi - 1$	$Gini_c$	$Gini_m$	$Gini_c$	$Gini_w$	$Gini_m$
0%	0.202	0.376	0.191	0.724	0.158
1%	0.210	0.347	0.190	0.732	0.173
2%	0.215	0.313	0.189	0.736	0.183
3%	0.220	0.277	0.188	0.739	0.185
4%	0.224	0.241	0.186	0.741	0.185
5%	0.226	0.214	0.185	0.740	0.184
10%	0.219	0.208	0.179	0.738	0.179
15%	0.212	0.206	0.173	0.737	0.173
20%	0.205	0.202	0.168	0.736	0.168
25%	0.199	0.196	0.163	0.734	0.163
30%	0.194	0.191	0.158	0.731	0.158
35%	0.188	0.186	0.154	0.729	0.154
40%	0.183	0.181	0.150	0.724	0.150

Table 4: Inequality (persistent shocks, $\delta = 2$)

RESULT 8

When money is not the only asset, a faster rate of monetary expansion reduces consumption inequality but does not decrease wealth inequality.

Intuition:

- Lump-sum money injections redistribute income.
- Counter inflation-tax by holding illiquid portfolios.
- Borrow to relax increasingly binding liquidity constraints.

Message: financial innovation blunts redistributive impact of inflation tax

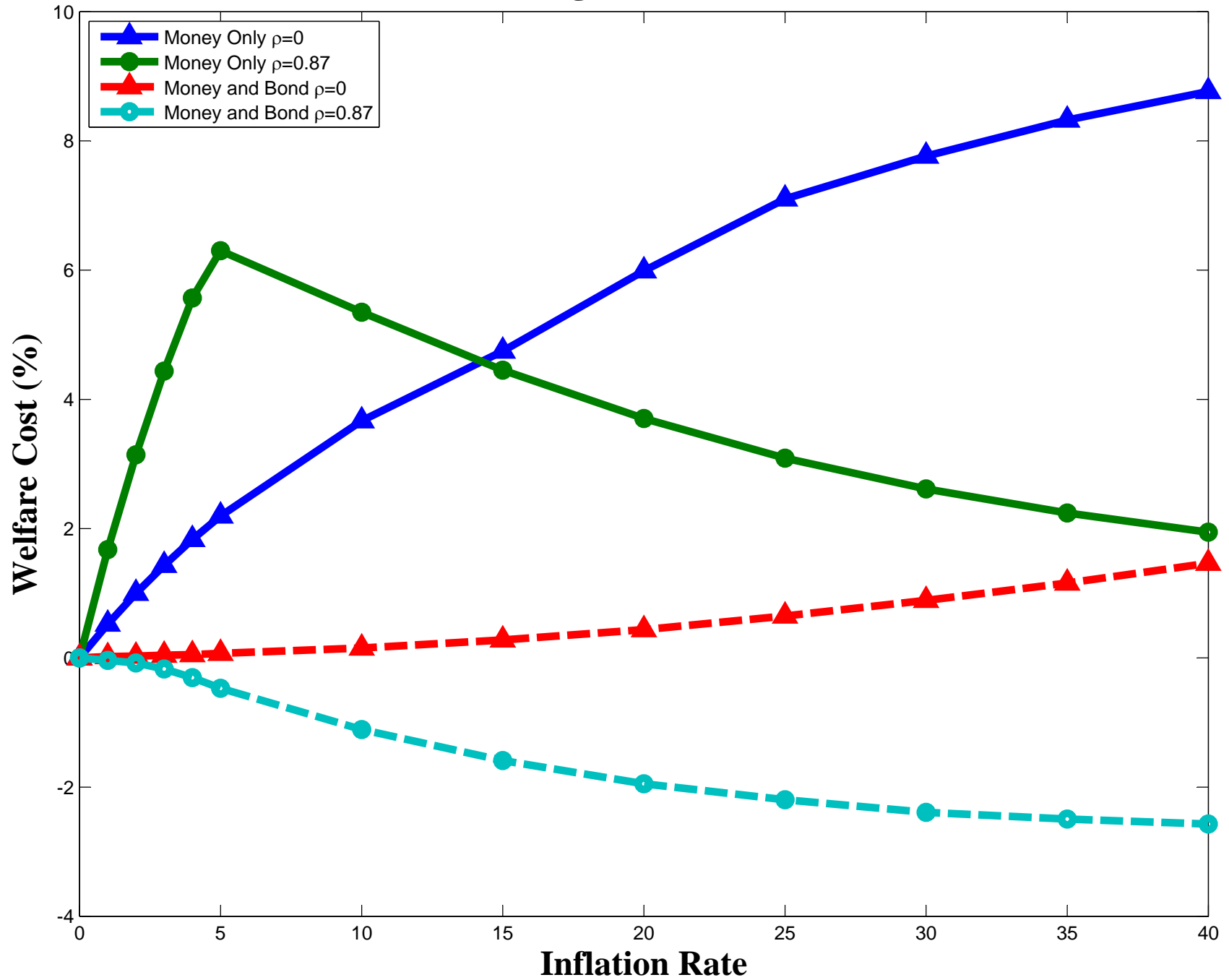
RESULT 9

When shocks are persistent and the labor supply is inelastic, expansionary monetary policy may raise average welfare.

Intuition:

- Endogenous inequality is greater with persistent shocks.
- Output less responsive to inflation with inelastic labor
- Expansionary policy redistributes income, gives incentives to lend.

Average Welfare Cost



WHAT HAVE WE LEARNED?

LESSON 1

Identified three elements that affect impact of expansionary monetary policy

- Shocks persistence: influences degree of endogenous inequality.
- Financial structure: influences inflation-induced wealth redistribution.
- Elasticity of labor supply: influences inflation-induced output loss.

Control trade-off between inflation-induced output *redistribution* and *loss*.

LESSON 2

Nonlinearity: small departures from zero inflation have greatest distributive impact.

- Policy impact depends on size and liquidity of precautionary savings
- Size and liquidity rapidly drop as inflation increases
- At that point redistribution depends only on mechanism to inject money

LESSON 3

Inflating to reduce wealth inequality may *increase* consumption inequality.

- Liquidity constraints are heterogeneously tight
- Access to credit market may be restricted

FUTURE WORK

- Monetary policy through open market operations
- Introduce aggregate shocks—a computational challenging task
- Introduce a real asset for self-insurance