Debt and Incomplete Financial Markets: A Case for Nominal GDP Targeting

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Motivation

- Following the financial crisis, inflation targeting has increasingly come under attack.
- But why? — it is not as if central banks have lost control of inflation as in the 1970s
- Instead, the argument seems to be that there was too much focus on inflation and not enough focus on financial markets
- This criticism presupposes there is a tradeoff between price stability and financial stability
- What are the reasons for such a tradeoff?
- Should a different nominal anchor be adopted?

Which nominal anchor?

A stable nominal anchor is a necessary condition for good monetary policy, but there are many possible nominal anchors to choose from.

In other words, what thing should have its monetary value stabilized by the central bank?

Examples:

- A basket of goods?
- A foreign currency?
- Gold?

Other alternatives have been proposed:

- Factor prices/incomes?
- Asset prices?

Why inflation targeting?

Why make a the money price of a basket of goods the nominal anchor ('inflation targeting')?

1. Minimize menu costs (target zero inflation)
2. Minimize relative price distortions (target zero inflation)
3. Minimize output gap fluctuations (if Phillips curve is stable, target zero inflation)
4. Minimize shoe leather costs (target negative inflation)
5. Minimize redistribution between borrowers and savers (avoid inflation surprises)

- Points 1–3 depend on nominal rigidities in goods prices: this nominal rigidity is what justifies making these prices the nominal anchor
- Point 4 depends on money's role as a medium of exchange
- Point 5 presupposes that financial markets are incomplete

This paper

- Focus on incompleteness of financial markets.
  - Many agents (e.g. households) can only borrow by agreeing to financial contracts with fixed repayments (debt contracts).
  - Cannot issue Arrow-Debreu securities
  - Cannot issue instruments like equity or derivatives
- Financial contracts denominated in terms of money.

- Focus on role of financial markets in sharing risk — efficient distribution of risk?
- In incomplete markets, efficient distribution of risk not reached automatically, but distribution of risk is affected by monetary policy
- Which monetary policy strategy promotes efficiency in financial markets?
- Stabilize debt-to-GDP ratio
- Do this using nominal GDP targeting

Brief literature review

Related to a number of branches of the literature:

- Effect of inflation on the real value of debt: Doepke and Schneider (2006)
- Completing the market with inflation to avoid tax fluctuations: Chari, Christiano and Kehoe (1991), Schmitt-Grohé and Uribe (2004), Siu (2004)
- Optimal monetary policy with private debt contracts: Bailey (1837), Selgin (1997), Pescatori (2007), Koenig (2011)

Ingredients of a basic model

- Overlapping generations with three-period lifetimes:
  - young
  - middle-aged
  - old
- Concave utility function
- Hump-shaped age profile of income
- Unpredictable fluctuations in GDP growth rates
- Incomplete financial markets: Only nominal non-contingent borrowing

Overlapping generations

Overlapping generations model with three-period lifetimes.

No population growth — balanced age structure:

- 1/3 young (y)
- 1/3 middle-aged (m)
- 1/3 old (o)

Total consumption over all individuals:

$$C_t = \frac{1}{3} C_{\mathrm{y},t} + \frac{1}{3} C_{\mathrm{m},t} + \frac{1}{3} C_{\mathrm{o},t}$$

- $C_{\mathrm{y},t}$ = consumption of young at time t (per person)
- $C_{\mathrm{m},t}$ = consumption of middle-aged at time t (per person)
- $C_{\mathrm{o},t}$ = consumption of old at time t (per person)

Utility

Utility of individuals born at time t:

$$\mathscr{U}_t = \log C_{\mathrm{y},t} + \beta \mathbb{E}_t \log C_{\mathrm{m},t+1} + \beta^2 \mathbb{E}_t \log C_{\mathrm{o},t+2}$$

Maximize expected utility.

- No intergenerational altruism (hence no bequests)
- β = subjective discount factor ($0 < \beta < 1$)

In the paper, a more general utility function is considered: Epstein-Zin utility (two extra parameters)

- σ = intertemporal elasticity of substitution ($0 < \sigma < \infty$)
- α = coefficient of relative risk aversion ($0 < \alpha < \infty$)
- CRRA utility is then special case $\alpha = 1/\sigma$

Income

In the simplest version of the model, real GDP is an exogenous endowment.

- With flexible prices, endogenous labour supply will not affect results
- Sticky-price extension considered in the paper

Age-specific incomes (per person): $Y_{\mathrm{y},t}$, $Y_{\mathrm{m},t}$, $Y_{\mathrm{o},t}$. Real GDP: Y_t

Constant age shares of income (no idiosyncratic shocks):

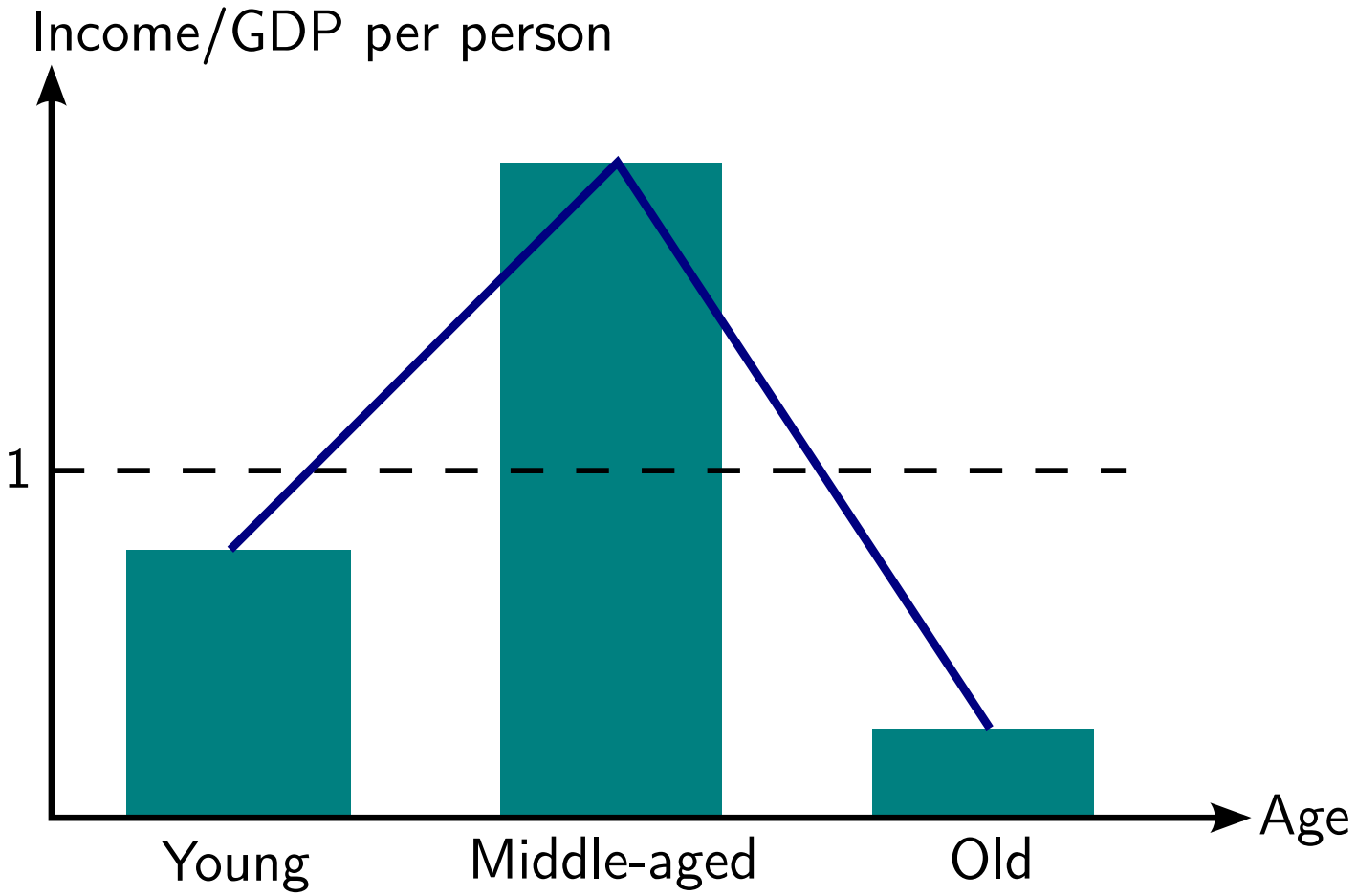
$$Y_{\mathrm{y},t} = \psi_{\mathrm{y}} Y_t \quad , \quad Y_{\mathrm{m},t} = \psi_{\mathrm{m}} Y_t \quad , \quad Y_{\mathrm{o},t} = \psi_{\mathrm{o}} Y_t \qquad \left(\frac{\psi_{\mathrm{y}} + \psi_{\mathrm{m}} + \psi_{\mathrm{o}}}{3} = 1 \right)$$

Parameterization of age profile of income:

$$\psi_{\mathrm{y}} = 1 - \beta\gamma \quad , \quad \psi_{\mathrm{m}} = 1 + (1+\beta)\gamma \quad , \quad \psi_{\mathrm{o}} = 1 - \gamma$$

- γ = gradient of income over life-cycle ($0 < \gamma < 1$)

Age profile of income



Incomplete markets

Only non-contingent nominal bonds available (net bond positions of young and middle-aged: $B_{\mathrm{y},t}$ and $B_{\mathrm{m},t}$). Nominal price of bond (face value 1) is $Q_t = \frac{1}{1+i_t}$, where i_t is nominal interest rate. Price level $= P_t$.

Budget constraints:

- Young: $C_{\mathrm{y},t} + \frac{Q_t}{P_t} B_{\mathrm{y},t} = Y_{\mathrm{y},t}$
- Middle-aged: $C_{\mathrm{m},t} + \frac{Q_t}{P_t} B_{\mathrm{m},t} = Y_{\mathrm{m},t} + \frac{1}{P_t} B_{\mathrm{y},t-1}$
- Old: $C_{\mathrm{o},t} = Y_{\mathrm{o},t} + \frac{1}{P_t} B_{\mathrm{m},t-1}$

Euler equations:

- Young: $\frac{1}{C_{\mathrm{y},t}} = \beta \frac{1}{Q_t} \mathbb{E}_t \left[\frac{P_t}{P_{t+1}} \frac{1}{C_{\mathrm{m},t+1}} \right]$
- Middle-aged: $\frac{1}{C_{\mathrm{m},t}} = \beta \frac{1}{Q_t} \mathbb{E}_t \left[\frac{P_t}{P_{t+1}} \frac{1}{C_{\mathrm{o},t+1}} \right]$

Market clearing:

- Goods: $\frac{1}{3} C_{\mathrm{y},t} + \frac{1}{3} C_{\mathrm{m},t} + \frac{1}{3} C_{\mathrm{o},t} = Y_t$; Bonds: $\frac{1}{3} B_{\mathrm{y},t} + \frac{1}{3} B_{\mathrm{m},t} = 0$

Complete markets

Prices of state-contingent securities (relative to probabilities) $= K_{t+1}$. State-contingent portfolios (paying off at time $t+1$) $= S_{\mathrm{y},t+1}$, $S_{\mathrm{m},t+1}$. All in real terms.

Budget constraints:

- Young: $C^*_{\mathrm{y},t} + \mathbb{E}_t K_{t+1} S_{\mathrm{y},t+1} = Y_{\mathrm{y},t}$
- Middle-aged: $C^*_{\mathrm{m},t} + \mathbb{E}_t K_{t+1} S_{\mathrm{o},t+1} = Y_{\mathrm{m},t} + S_{\mathrm{y},t}$
- Old: $C^*_{\mathrm{o},t} = Y_{\mathrm{o},t} + S_{\mathrm{m},t}$

Euler equations:

- Young: $\beta \left(\frac{C^*_{\mathrm{y},t}}{C^*_{\mathrm{m},t+1}} \right) = K_{t+1}$
- Middle-aged: $\beta \left(\frac{C^*_{\mathrm{m},t}}{C^*_{\mathrm{o},t+1}} \right) = K_{t+1}$

These must hold in all states of the world.

Market clearing:

- Goods: $\frac{1}{3} C_{\mathrm{y},t} + \frac{1}{3} C_{\mathrm{m},t} + \frac{1}{3} C_{\mathrm{o},t} = Y_t$; Securities: $\frac{1}{3} S_{\mathrm{y},t} + \frac{1}{3} S_{\mathrm{m},t} = 0$

Definitions

Specific to assumptions on financial markets:

	Incomplete markets	Complete markets
Gross issuance of securities	$B_t \equiv -B_{\mathrm{y},t} = B_{\mathrm{m},t}$	$S_t \equiv -S_{\mathrm{y},t} = S_{\mathrm{m},t}$
Real value of loans	$L_t \equiv Q_t B_t / P_t$	$L_t^* \equiv \mathbb{E}_t K_{t+1} S_{t+1}$
Real value of debt liabilities	$D_t \equiv B_{t-1} / P_t$	$D_t^* \equiv S_t$

Common to both cases:

- Real return (ex post): $r_t \equiv (D_t - L_{t-1})/L_{t-1}$
- Real interest rate (ex ante): $\rho_t = \mathbb{E}_t r_{t+1}$
- Loans-to-GDP ratio: $l_t \equiv L_t / Y_t$
- Debt-to-GDP ratio: $d_t \equiv D_t / Y_t$
- Consumption-GDP ratios: $c_{\mathrm{y},t} \equiv C_{\mathrm{y},t}/Y_t$, $c_{\mathrm{m},t} \equiv C_{\mathrm{m},t}/Y_t$, $c_{\mathrm{o},t} \equiv C_{\mathrm{o},t}/Y_t$

General definitions:

- Real GDP growth: $g_t \equiv (Y_t - Y_{t-1})/Y_{t-1}$
- Inflation rate: $\pi_t \equiv (P_t - P_{t-1})/P_{t-1}$

System of equations

1. **Real interest rate** (ex-ante real return): $\rho_t = \mathbb{E}_t r_{t+1}$
2. **Debt-to-GDP ratio**: $d_t = \left(\frac{1+r_t}{1+g_t}\right) l_{t-1}$
3. **Budget identities**:

$$c_{\mathrm{y},t} = 1-\beta\gamma+l_t \quad , \quad c_{\mathrm{m},t} = 1+(1+\beta)\gamma-d_t-l_t \quad , \quad c_{\mathrm{o},t} = 1-\gamma+d_t$$

4. **Euler equations**:

$$\beta\mathbb{E}_t\left[\left(\frac{1+r_{t+1}}{1+g_{t+1}}\right)\left(\frac{c_{\mathrm{y},t}}{c_{\mathrm{m},t+1}}\right)\right] = \beta\mathbb{E}_t\left[\left(\frac{1+r_{t+1}}{1+g_{t+1}}\right)\left(\frac{c_{\mathrm{m},t}}{c_{\mathrm{o},t+1}}\right)\right] = 1$$

5. **Another equation to close the model**:
   i. **Incomplete markets — Monetary policy** & **Fisher equation**: $1+r_t = (1+i_{t-1})/(1+\pi_t)$
   ii. **Complete markets — Risk-sharing eq.**: $c_{\mathrm{m},t+1}/c_{\mathrm{y},t} = c_{\mathrm{o},t+1}/c_{\mathrm{m},t}$
6. **Goods-market clearing** (redundant): $(1/3)(c_{\mathrm{y},t}+c_{\mathrm{m},t}+c_{\mathrm{o},t}) = 1$

Steady state

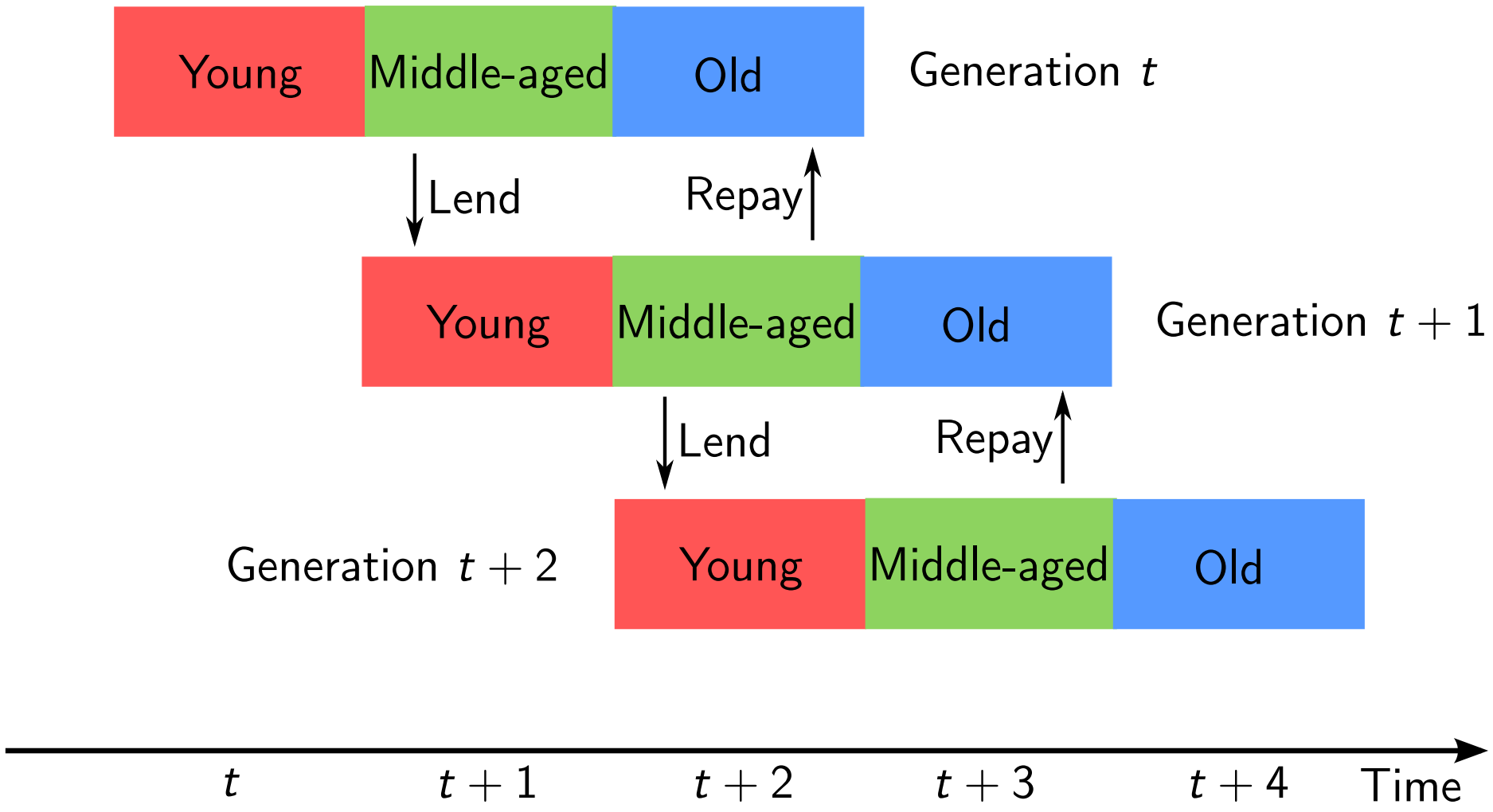
Non-stochastic steady state (assumes for simplicity steady-state real GDP growth of zero)— same for both incomplete and complete markets:

- **Consumption-GDP ratios**: $\bar{c}_{\mathrm{y}} = \bar{c}_{\mathrm{m}} = \bar{c}_{\mathrm{o}} = 1$
- **Loans-to-GDP ratio**: $\bar{l} = \beta\gamma$
- **Debt-to-GDP ratio**: $\bar{d} = \gamma$
- **Real interest rate**: $\bar{\rho} = (1 - \beta)/\beta$
- **Real return**: $\bar{r} = (1 - \beta)/\beta$

Steady state is unique for log utility function.

Equilibrium is not dynamically inefficient (real interest rate positive, real GDP growth is zero).

Equilibrium saving and borrowing patterns



The 'natural debt-to-GDP ratio'

What is the 'right' level of debt in the economy? — introduce the concept of the 'natural debt-to-GDP ratio'

Natural debt-to-GDP ratio (d_t^*) $\equiv$ Ratio of (state-contingent) debt liabilities to GDP in hypothetical world of complete financial markets

- Analogous to natural rate of unemployment, natural rate of interest, natural level of output, etc.
- Actual debt-to-GDP ratio tends to the natural debt ratio in the absence of further shocks
- Natural debt-to-GDP ratio is independent of monetary policy
- Actual debt-to-GDP ratio depends on monetary policy
- Closing the gap between the actual and natural debt ratios is desirable

What is the natural debt-to-GDP ratio?

Two results:

Proposition

With logarithmic utility, the natural debt-to-GDP ratio is always constant

Proposition

With Epstein-Zin-Weil utility (for any risk aversion coefficient and elasticity of intertemporal substitution for which the steady state is unique), if shocks to real GDP are permanent then the natural debt-to-GDP ratio is always constant

In these cases, the optimal financial instrument for borrowers is to issue equity shares in GDP (or equivalently, their labour income).

With non-logarithmic utility and predictable variation in real GDP growth rates, the natural debt-to-GDP ratio can fluctuate. For reasonable calibrations, the fluctuations are small in relation to the shocks to GDP.

Pareto-efficient allocations

Consider social planner's problem:

- Can make any (state-contingent) transfers between individuals
- Subject only to resource constraint:

$$\frac{1}{3}C_{\mathrm{y},t} + \frac{1}{3}C_{\mathrm{m},t} + \frac{1}{3}C_{\mathrm{o},t} = Y_t$$

- Maximizes welfare function:

$$\mathscr{W}_{t_0} = \mathbb{E}_{t_0-2}\left[\frac{1}{3}\sum_{t=t_0-2}^{\infty}\beta^{t-t_0}\Omega_t\mathscr{U}_t\right]$$

- Pareto weights $= \Omega_t$
- Necessary condition for efficiency (for any weights Ω_t): $\frac{C_{\mathrm{m},t+1}}{C_{\mathrm{y},t}} = \frac{C_{\mathrm{o},t+1}}{C_{\mathrm{m},t}}$
- Many Pareto-efficient allocations for different weights

Monetary policy

Monetary policy has a single instrument (the nominal interest rate i_t). This affects inflation π_t, and also has real effects.

Proposition

1. *Monetary policy can achieve the complete-markets equilibrium even if financial markets are incomplete*
2. *The complete-markets equilibrium is the only efficient allocation that can be achieved through the use of monetary policy*

Assume central bank cares only about Pareto efficiency. Then must work with Pareto weights Ω_t^* that support complete-markets equilibrium. Task is then to close the gap between the actual debt-to-GDP ratio and the corresponding 'natural' debt ratio.

Nominal GDP targeting

Consider a target for nominal GDP $M_t \equiv P_t Y_t$.

Given the natural debt-to-GDP ratio d_t^*, optimal monetary policy is:

$$M_t = \frac{\bar{M}}{d_t^*} \text{ for any } \bar{M}$$

In cases with a constant natural debt-to-GDP ratio, optimal to fix completely the level of nominal GDP: $M_t = \bar{M}$

Intuition:

- Non-contingent debt does not automatically allow for risk sharing
- But even if future real GDP is uncertain, monetary policy can always make the level of future nominal income perfectly predictable
- Eliminates inefficiency of non-contingent contracts (for aggregate shocks)
- Fluctuations in inflation move real value of nominally non-contingent debt liabilities in line with complete-markets equilibrium

Consequences for financial markets of inflation targeting

In the model, inflation targeting is inefficient because it implies that non-contingent nominal contracts also have non-contingent real repayments.

In addition to inefficient risk sharing, a policy of strict inflation targeting also leads to greater volatility in financial variables such as volumes of lending and interest rates.

Tension between price stability and financial stability.

Consequences for inflation of nominal GDP targeting

If there are fluctuations in real GDP, nominal GDP targeting implies that the price level must fluctuate:

- Higher inflation in recessions
- Lower inflation, or deflation, in booms

Note: In the model, adopting inflation-indexation of debt contracts would be (ex ante) worse.

Note: In U.S. post-war data, the price level has been countercyclical (goes part of the way towards the key feature of nominal GDP targeting)

Note: The basic model featured none of the usual welfare costs of inflation. Can add these.

Monetary policy trade-offs

Nominal GDP targeting requires fluctuations in inflation when there are fluctuations in real GDP growth. But these inflation fluctuations would be distortionary if prices were sticky.

Can expand the incomplete-markets model:

- Production economy
- Sticky prices

Quantitatively, is it more important to stabilize the nominal value of incomes or the nominal value of a basket of goods?

Ingredients of model

- Differentiated goods (CES aggregator, elasticity ε)
- Production using homogeneous labour subject to TFP shocks
- Aggregate supply of labour fixed for simplicity
- Monopolistic competition in goods markets
- Some firms set prices in advance of shocks, others have flexible prices (relative number of firms with predetermined prices fixed by a parameter κ)

Objective function for monetary policy

Need an objective function to analyse tradeoffs between competing goals of policy.

Can derive utilitarian social welfare function (using Pareto-weights that support complete-markets allocation with flexible prices) — leads to a loss function with the following terms:

1. 'Debt gap' (deviation of debt/GDP ratio from its value with complete markets)
2. Inflation surprise

Optimal monetary policy

What should monetary policy target?

- Incomplete markets suggests nominal GDP
- Sticky prices suggests inflation

With both frictions, optimal policy is a compromise between the two targets. Let $\hat{\omega}$ denote the weight on the policy that would be optimal with fully flexible prices.

- If $\hat{\omega} = 0$ then strict inflation targeting is optimal
- If $\hat{\omega} = 1$ then no change relative to optimal policy found in flexible-price model

Calibrate parameters and look at the implications for value of $\hat{\omega}$.

Calibration issues: Debt maturity

- Debt maturity parameter μ (elasticity of real value of debt w.r.t. inflation): if time period is T years and inflation is steady over those T years then set $\mu = T_{\mathrm{f}}/T$, where T_{f} is the average duration of debt

Calibration issues: Price stickiness

- Adjust predetermined pricing parameter κ to match welfare costs of steady inflation predicted by Calvo model — set $\kappa = (T_{\mathrm{p}}/T)^2$, where T_{p} is the average duration of a price spell

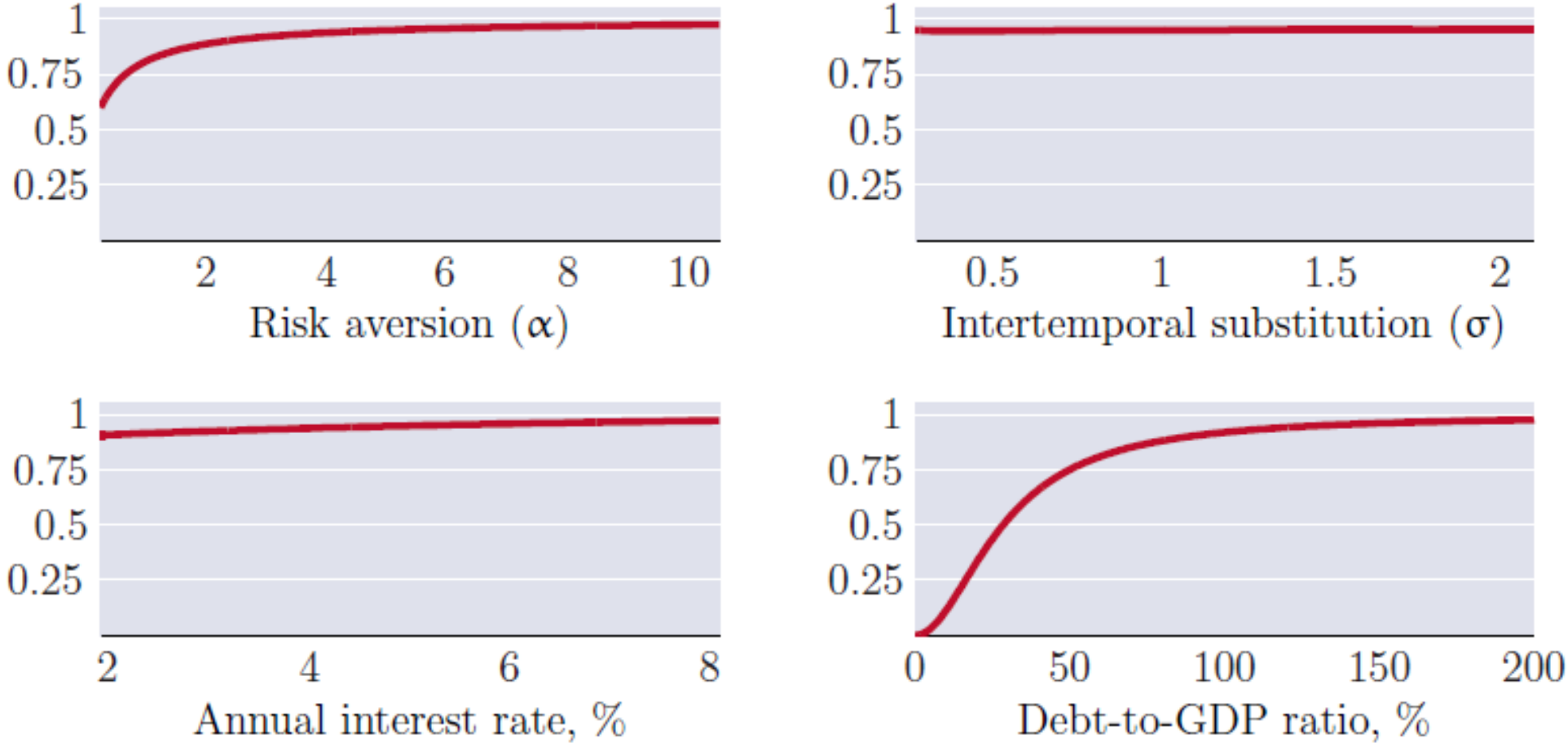
With Calvo pricing, welfare cost of inflation is bounded by:

$$\mathscr{L}_{\pi,t_0} \leq \frac{\varepsilon}{2}\left(\frac{T_{\mathrm{p}}}{T}\right)^2 \sum_{t=t_0}^{\infty} \beta^{t-t_0}\mathbb{E}_{t_0}\pi_t^2$$

Baseline calibration

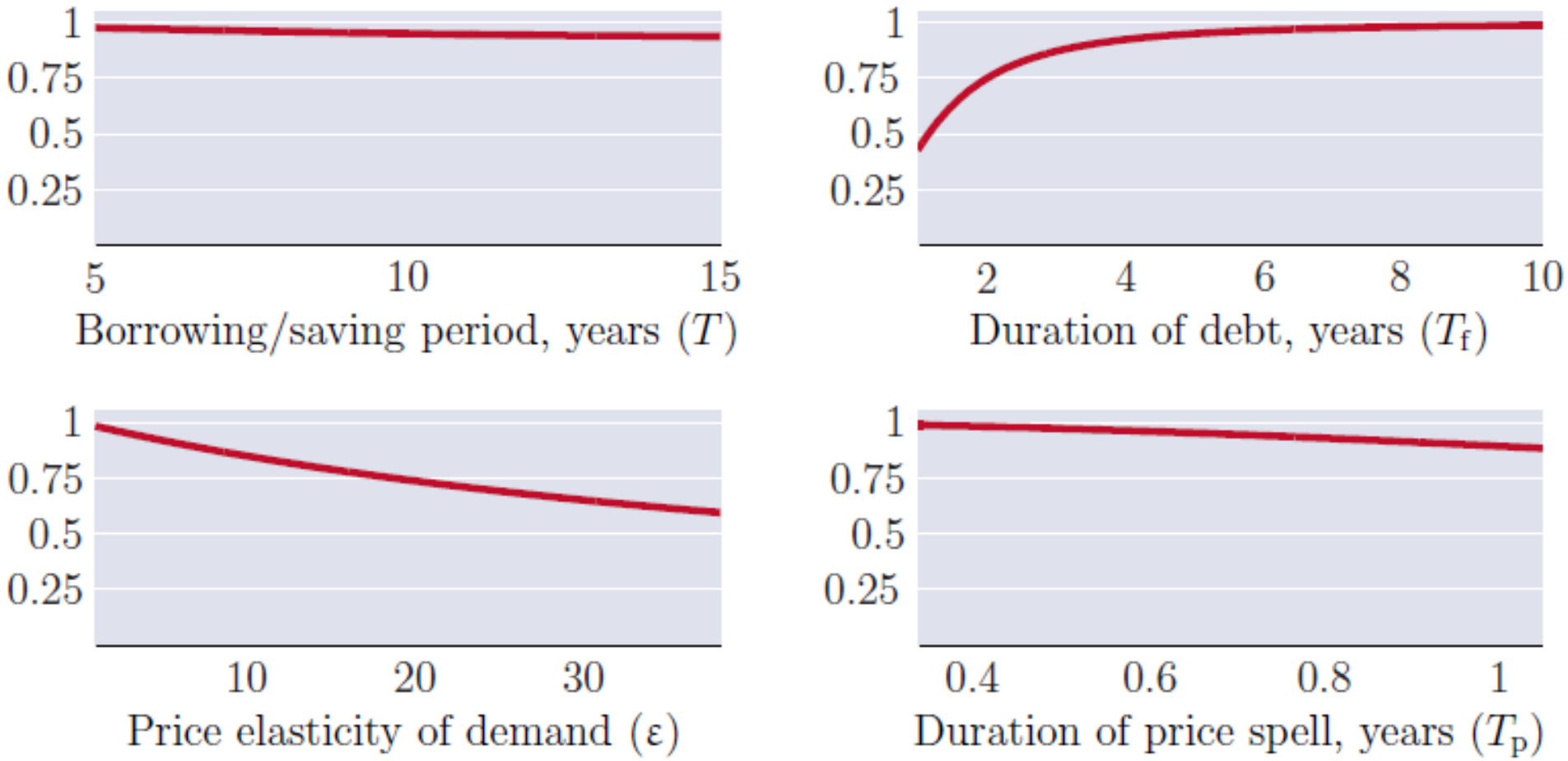
Parameter	Value
Relative risk aversion (α)	5
Intertemporal substitution (σ)	0.9
Price elasticity of demand (ε)	3
Borrowing/saving period (T)	10 years
Annual real interest rate	7%
Debt-to-income ratio	130%
Duration of debt (T_{f})	5 years
Duration of a price spell (T_{p})	0.67 years
Real GDP growth (per capita)	1.7%

Policy trade-offs



0 = **strict inflation targeting** 1 = **nominal GDP targeting**

Policy trade-offs, cont.



0 = **strict inflation targeting** 1 = **nominal GDP targeting**

Discussion (I)

- Plausibility of incomplete markets assumption?
  - Costs of writing fully state-contingent contracts
  - Unlike corporate finance, households do not have access to an instrument like equity that allows for risk-sharing without writing all contingencies into a contract ex ante.
  - Hedging? — Borrowers need something negatively correlated with real GDP: go short on 'GDP securities' à la Shiller?
  - Renegotiation of contracts ex post? — Evidence suggests too little renegotiation of household debt (Piskorski, Seru and Vig, 2010; Ghent, 2011), and not clear this even helps with ex ante insurance
  - Empirical rejection of tests of risk-sharing condition (e.g. Hayashi, Altonji and Kotlikoff, 1996)
- Plausibility of nominal non-contingency of liabilities?
  - Doepke and Schneider (2006): household balance sheets have large gross nominal positions on both the asset and liability sides (especially after taking into account indirect exposure on asset side through ownership of firms, financial intermediaries, etc.)
  - Indexation of private debt contracts is extremely rare — at least in countries like the U.S. (Shiller, 1997)

Discussion (II)

- Why does nominal GDP targeting lead to efficiency?
  - Implies negative correlation between price level and real GDP
  - Inflation unexpectedly rises when real GDP unexpectedly falls, and vice versa
  - Unexpected inflation movements change real value of nominally non-contingent liabilities
  - Hence obtain contingency in real liabilities
  - Extent of market incompleteness is thus endogenous to monetary policy
- But don't we all know that inflation-induced redistribution between creditors and debtors is a bad thing?
  - The argument is that redistributions are unfair and increase risk, making it harder to plan for the long term.
  - For **arbitrary** redistributions, this is a good argument.
  - But inflation fluctuations with nominal GDP targeting are not arbitrary: they correlate perfectly with the economy's fundamentals.
  - Does not increase risk, only changes distribution of risk
  - Incomplete markets do not allow for full insurance when inflation is stable, but can when nominal GDP is stabilized
  - Insurance is logically impossible without the possibility of transfers.

Discussion (III)

- But the central bank shouldn't try to second-guess people — if they wanted insurance, they'd have written full state-contingent contracts
  - If we accept this then even arbitrary redistributions from monetary policy shocks are not a problem: if people didn't want this redistribution they would have included indexation clauses.
  - Argument presupposes markets complete, but good reasons to believe full state-contingent contracts difficult to achieve — hence cannot interpret observed contracts as revealing what people would choose in a frictionless world
  - Even if markets were complete, non-contingent real contracts would only be observed if there are extreme differences in risk aversion between borrowers and savers — implausible, and although evidence on measuring risk aversion finds heterogeneity between individuals, this does not correlate well with observed individual characteristics.

Discussion (IV)

- Is any of this original?
  - No. Ancient tradition in monetary economics of regarding a negative co-movement between money prices and productivity as desirable in promoting fairness between debtors and creditors. This 'productivity norm' goes back at least to Bailey (1837), but discussion of these effects disappears from the literature in the early twentieth century.
- Does this paper add anything?
  - The early literature is vague and subjective: what exactly is 'fair'?
  - This paper provides a formal analysis in terms of efficiency and completing otherwise incomplete financial markets
  - Can also quantify the importance of these effects relative to other frictions that have been stressed in monetary economics (e.g. relative price distortions or menu costs from inflation fluctuations when there are nominal rigidities)

Concluding remarks

The model is far too simple to apply to the financial crisis. But some policy implications do resonate with recent experience:

- Stagnation is bad.
- Inflation is bad, all else equal.

But:

- Conditional on stagnation, inflation can be good.

In other words:

- Negative correlation between real GDP growth and inflation is good (countercyclical price level).
- Stable inflation can be bad, deflation in a recession (a procyclical price level) is even worse.

However, note that:

- The policy implications are symmetric: Deflation should also go together with a boom.
- So monetary policy must do more to 'take away the punch bowl' during a boom, even if inflation were stable.