Optimal Monetary Policy for the Masses

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Introduction

Inequality and monetary policy

- Interest in income, financial wealth and consumption inequality has increased in the last decade.
- Can monetary policy be conducted in a way that benefits all households even in a world of substantial heterogeneity?
- The answer in this paper is "yes."

SOME RECENT LITERATURE

- Kaplan, Moll and Violante (*AER, 2018*):
  - NK model with heterogeneous households (HANK); reasonable Gini coefficients.
  - The monetary policy transmission mechanism is substantially altered relative to the representative agent model (RANK).
- Bhandari, Evans, Golosov and Sargent (Working paper, NBER, 2018):
  - Incomplete markets, nominal friction, heterogeneous households (HAIM); reasonable Gini coefficients.
  - Optimal monetary-fiscal policy (Ramsey) substantially altered relative to the standard model.
- See also the conference on "Monetary Policy and the Distribution of Income and Wealth," held at the St. Louis Fed on Sept. 11-12, 2015. See the program.

OPTIMAL MONETARY POLICY

- We construct a stylized economy with considerable wealth, income and consumption inequality.
- The role of monetary policy in this model is to make sure private credit markets are working correctly (i.e., complete).
- Optimal monetary policy in this model looks like "nominal GDP targeting"—that is, countercyclical price-level movements.
- This result continues to hold even when there is "massive" heterogeneity—enough heterogeneity to approximate income, financial wealth and consumption inequality in the U.S.
- Hence, *the main result is that nominal GDP targeting constitutes "optimal monetary policy for the masses" in this environment.*

KEY THEMES

- Monetary policy is part of the general equilibrium and therefore has effects on income, financial wealth and consumption inequality.
- The role of monetary policy when credit markets play an important role is to "induce the correct real interest rate period-by-period"—this real interest rate is the one that would occur if there were no nominal frictions.
- The life cycle contributes importantly to Gini coefficients for income, consumption and wealth in this model.
- The model equilibrium features both poor-hand-to-mouth and wealthy-hand-to-mouth households with high MPC.
- The model accommodates arbitrarily rich and arbitrarily poor households.

Environment

General-equilibrium life-cycle economy

- Each period, a new cohort of households enters the economy, makes economic decisions over the next 241 quarters, then exits the economy.
- Households have log-log preferences defined over consumption and leisure.
- Households are randomly assigned one of many possible personal productivity profiles when they enter the model.
- The profile is symmetric—it begins low, rises and peaks exactly in the middle of life, then declines back to the low level.
- Productivity units determine the value of an hour worked in a competitive labor market.
- No capital, no discounting, no population growth, no default, no borrowing constraints, no government spending and no taxes; no ELB and no money demand (see Azariadis et al. *JEDC*, 2019).

Life-cycle productivity profiles

- Households entering the economy draw a scaling factor $x \sim \mathcal{U}\left(\xi^{-1}, \xi\right)$ and receive a life-cycle productivity profile that is a scaled version of the baseline profile, e_s :

$$e_{s,i} = x \cdot e_s,$$

where $\xi \geq 1$ determines the within-cohort dispersion and

$$e_s = f(s) = 2 + \exp\left[-\left(\frac{s-120}{60}\right)^4\right].$$

- All idiosyncratic risk is borne by agents at the beginning of the life cycle.
- Huggett, Ventura and Yaron (*AER*, 2011) argue that differences in initial conditions are more important than differences in shocks.
- We also consider $\ln(x) \sim \mathcal{N}\left(\mu, \sigma^2\right)$, creating an economy with arbitrarily rich and poor households.

Baseline life-cycle productivity

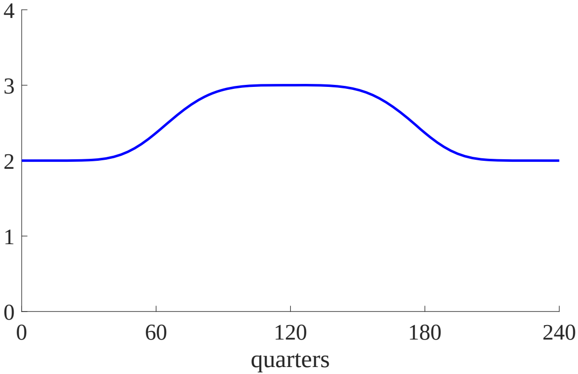

Figure: Baseline endowment profile. The profile is symmetric and peaks in the middle period of the life cycle.

THE MASS OF LIFE-CYCLE PRODUCTIVITY

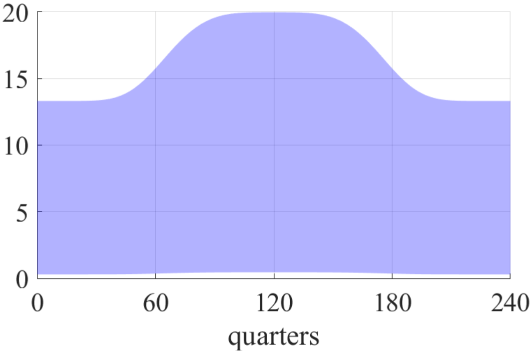

FIGURE: The mass of endowment profiles: $e_{s,i} \sim e_s \cdot \mathcal{U}\left[\xi^{-1}, \xi\right]$, $e_s = 2 + \exp\left[-\left(\frac{s-120}{60}\right)^4\right]$, $\xi = 6.5$.

Nominal interest rate contracts

- The overlapping-generations structure creates a large private credit market essential to good macroeconomic performance.
- *Loans are dispersed and repaid in the unit of account—that is, in nominal terms—and are not contingent on income realizations.*
- Households meet in a large competitive credit market where they contract by fixing the nominal interest rate one period in advance.
- The non-state contingent nominal interest rate is given by

$$R^n(t, t+1)^{-1} = E_t\left[\frac{c_t(t)}{c_t(t+1)}\frac{P(t)}{P(t+1)}\right]. \tag{1}$$

- This rate can be understood as expected nominal GDP growth.
- In the equilibria we study, this expectation is the same for all households, even for those born at different dates or with different levels of productivity.

HOUSEHOLDS' PROBLEM

- The problem of households i entering the economy at date t is

$$\max_{\{c_{t,i}(t+s),\ell_{t,i}(t+s)\}_{s=0}^{T}} E_t \sum_{s=0}^{T} \left[\eta \ln c_{t,i}(t+s) + (1-\eta) \ln \ell_{t,i}(t+s)\right]$$

subject to the budget constraint

$$c_{t,i}(t+s) + \frac{a_{t,i}(t+s)}{P(t+s)} \leq e_{s,i}\left[1 - l_{t,i}(t+s)\right] w(t+s) +$$

$$+R^n(t+s-1, t+s)\frac{a_{t,i}(t+s-1)}{P(t+s)}, s = 0, \ldots, T$$

$$a_{t,i}(t-1) = a_{t,i}(T) = 0.$$

Linear production technology

- Aggregate real output $Y(t)$ is given by

$$Y(t) = Q(t)\,L(t), \tag{2}$$

where $L(t)$ is the aggregate labor input and $Q(t)$ is the level of productivity.

- Productivity grows at a stochastic rate $\lambda(t, t+1)$,

$$Q(t+1) = \lambda(t, t+1)\,Q(t), \tag{3}$$

$$\lambda(t, t+1) = (1-\rho)\,\bar{\lambda} + \rho\lambda(t-1, t) + \sigma\epsilon(t+1), \tag{4}$$

where $\bar{\lambda} > 1$ represents the average gross growth rate, $\rho \in (0, 1)$, $\sigma > 0$, and $\epsilon(t+1)$ is a truncated normal with bounds $\pm b$, $b > 0$, such that the ZLB is avoided.

- The real wage $w(t)$ grows at the same rate as productivity,

$$w(t+1) = \lambda(t, t+1)\,w(t). \tag{5}$$

TIMING PROTOCOL

Period t

Nature	Policymaker	Households
$\lambda(t-1,t) \Longrightarrow w(t)$	$P(t)$	labor/leisure consumption/saving

What monetary policy does

- The countercyclical price-level rule delivers complete markets allocations:

$$P(t) = \frac{R^n(t-1,t)}{\lambda(t-1,t)} P(t-1), \tag{6}$$

where λ is the realized productivity shock and R^n is the contract rate—similar to Koenig (*IJCB*, 2013) and Sheedy (*BPEA*, 2014).

- Given this policy rule, households consume equal amounts of available production given their productivity, "*equity share contracting*," which is optimal under homothetic preferences.
- This price-level rule renders the households' date-t decision problem deterministic because it perfectly insures the household against shocks to income.
- Consumption and asset holdings fluctuate from period to period but in proportion to the real wage, $w(t)$.

Stationary equilibria

- We let $t \in (-\infty, +\infty)$.
- We only consider stationary equilibria under perfectly credible policy rules governing $P(t)$.
- We let $R(t)$ be the gross real rate of return in the credit market.
- A stationary equilibrium is a sequence $\{R(t), P(t)\}_{t=-\infty}^{+\infty}$ such that markets clear, households solve their optimization problems, and the policymaker credibly adheres to the stated policy rule.
- The key condition is that aggregate asset holding $A(t) = 0 \; \forall t$.

Optimality

Theorem

Assume a planner who places equal weight on all households for all time and discounts forward and backward in time at the stochastic rate of growth of the economy.

(a) *If the planner can constrain the assignment of productivity profiles to a single baseline profile as defined above, then the planner will conclude that the competitive equilibrium described above is a social optimum.*

(b) *If the planner cannot constrain the assignment of productivity profiles, the planner will conclude that the competitive equilibrium described above is a constrained social optimum.*

Characterizing the Equilibrium

Stationary equilibria

Theorem

Assume symmetry as defined above. Assume the monetary authority credibly uses the price-level rule (6) $\forall t$. Then the gross real interest rate is equal to the gross rate of aggregate productivity growth, and hence the real growth rate of the economy, $\lambda\left(t-1,t\right),\forall t$.

Corollary (Equity share contracting)

Any two households that share the same productivity profile consume the same amount at each date, and consumption growth is equalized for all households.

Corollary

Desired labor supply over the life cycle depends on the shape of the productivity profile alone and not on the scaling factor x.

HOURS WORKED OVER THE LIFE CYLE

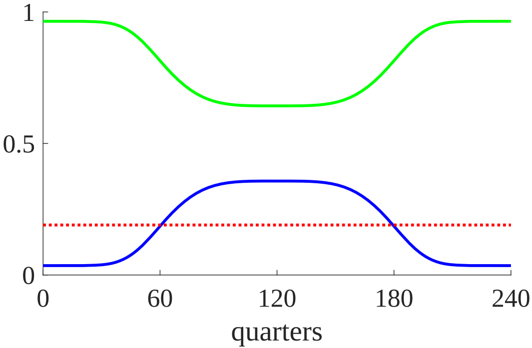

FIGURE: Leisure decisions (green), labor supply (blue) and fraction of work time in U.S. data, 19% (red). The labor/leisure choice depends on the current-to-lifetime average productivity ratio. Productivity profiles of the form $e_{s,i} = x \cdot e_s$ imply labor/leisure choices depend on age only.

CONSUMPTION MASS

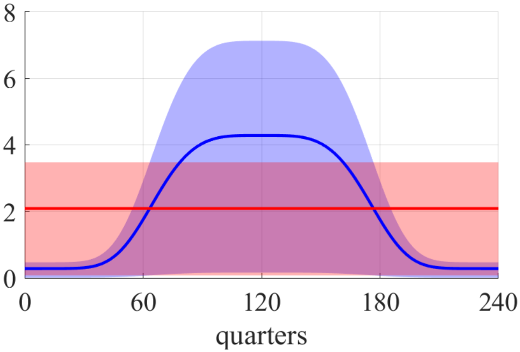

FIGURE: Cross section: Consumption mass (red) and labor income mass (blue). Under optimal monetary policy, the private credit market reallocates uneven labor income into perfectly equal consumption for each productivity profile. The consumption Gini is 31.8%, similar to values calculated from U.S data.

Consumption evolution

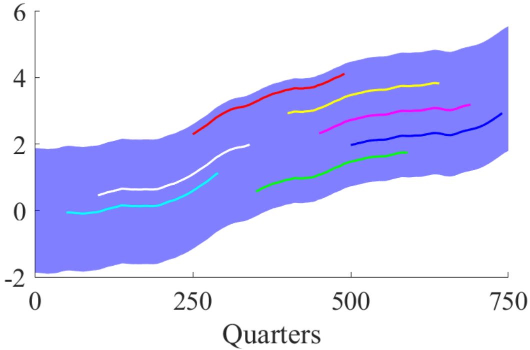

Figure: Time series: Evolution of the distribution of log consumption (shaded area) and examples of individual log consumption profiles (colored lines). Under optimal monetary policy, individual consumption profiles share the same stochastic trend as aggregate consumption.

NET ASSET HOLDING MASS

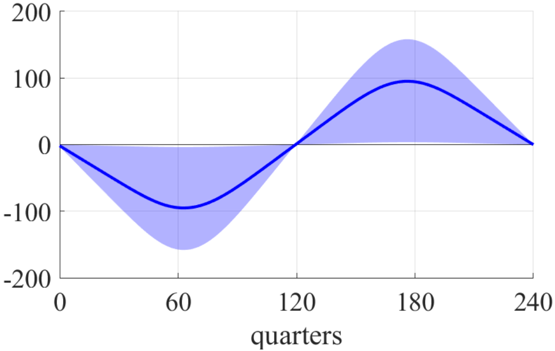

FIGURE: Cross section: Net asset holding mass by cohort. Borrowing, the negative values to the left, peaks at stage 60 of the life cycle (age $\sim$ 35), while positive assets peak at stage of life 180 (age $\sim$ 65). The financial wealth Gini is 72.7%, similar to values calculated in U.S. data.

THREE NOTIONS OF INCOME FIGURES

1. Labor income,

$$Y_1 = e_{s,i}\left[1-\ell_t\left(t+s\right)\right]w\left(t+s\right),$$

2. Labor income plus non-negative capital income,

$$Y_2 = e_{s,i}\left[1-\ell_t\left(t+s\right)\right]w\left(t+s\right)+ \\ +\max\left\{\left[\lambda\left(t+s,t+s-1\right)-1\right]\frac{a_{t,i}\left(t+s-1\right)}{P\left(t+s-1\right)},0\right\},$$

3. The non-negative component of total income,

$$Y_3 = \max\left\{\begin{array}{c} e_{s,i}\left[1-\ell_t\left(t+s\right)\right]w\left(t+s\right)+ \\ +\left[\lambda\left(t+s,t+s-1\right)-1\right]\frac{a_{t,i}(t+s-1)}{P(t+s-1)},0 \end{array}\right\}.$$

- Gini coefficients of income distributions: $G_{Y_1}=56.2\%$, $G_{Y_2}=51.6\%$, $G_{Y_3}=59.6\%$.

Marginal propensity to consume

Theorem

The marginal propensity to consume out of income depends on age but is independent of the scaling factor draw. In particular, the MPC out of labor income is

$$MPC_1(s) = \frac{dc}{dy_1} = \frac{\eta \bar{e}}{e_s - (1-\eta)\bar{e}}.$$

MARGINAL PROPENSITY TO CONSUME

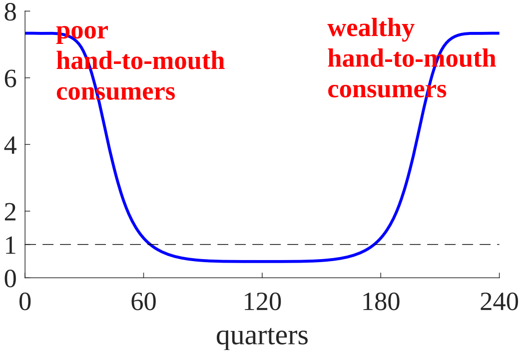

FIGURE: Cross section: Marginal propensity to consume out of labor income by cohort. Young and old households are not very productive and have a high MPC. Young households are accumulating debt and can be thought of as "poor hand-to-mouth." Older consumers are relatively wealthy and can be thought of as "wealthy hand-to-mouth."

Inequality

DATA ON INEQUALITY IN THE U.S.

- Consumption (Heathcote, Perri and Violante, *RED*, 2010): $G_{C,\text{U.S.}} = 32\%$.
- Income (CBO, 2016): pre-taxes/transfers $G_{Y,\text{U.S.}} = 51\%$; post-taxes/transfers $G_{Y,\text{U.S.}} = 43\%$.
- Financial wealth (Davies, Sandström, Shorrocks and Wolff, *EJ*, 2011): $G_{W,\text{U.S.}} = 80\%$.

Inequality in the model

- Large amount of heterogeneity that depends in part on life-cycle productivity dispersion.
- Financial wealth is defined as the non-negative part of net assets.
- We also consider lognormal productivity, $\ln(x) \sim \mathcal{N}(\mu, \sigma^2)$:
  - Allows for arbitrarily rich and arbitrarily poor households.
  - All distributions (wealth, income and consumption) are mixtures of lognormals (and δ functions).
  - Gini coefficients can be computed with "paper and pencil."

Details

GINI COEFFICIENTS

	Wealth		**Income**		**Consumption**
	W	Y_1	Y_2	Y_3	C
U.S. data	80%		51%		32%
Uniform	72.7%	56.2%	51.6%	59.6%	31.8%
Lognormal	72.4%	55.7%	51.1%	59.0%	32%

TABLE: Gini coefficients in the U.S. data and in the model with uniform and lognormal productivity.

Productivity dispersion and Gini coefficients

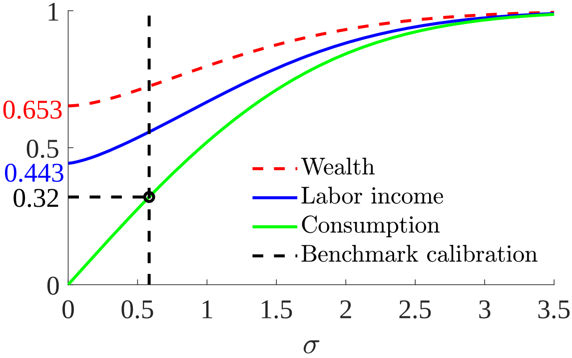

Figure: As the dispersion of productivity profiles, σ, increases, the Gini coefficients increase. The ordering $G_W > G_Y > G_C$ is preserved.

Policy

INTERPRETING MONETARY POLICY

- The price-level rule characterizes policy by countercyclical price-level movements.
- But the policy can also be interpreted more conventionally in interest rate terms.
- The nominal rate is determined one period in advance as the expected rate of nominal GDP growth.
- Wicksellian natural real rate = aggregate productivity growth rate, λ.
- The nominal rate is always ratified ex post by the policymaker.
- This makes the real rate = aggregate productivity growth rate = Wicksellian natural real rate of interest.
- “Just like the simple NK model.”

NOMINAL GDP TARGETING

- No persistence in productivity growth, $\rho = 0$: The expected rate of NGDP growth never changes, and the economy never deviates from the NGDP path. “Perfect NGDP targeting.”
- Persistence in productivity growth, $\rho > 0$: The expected rate of NGDP growth fluctuates persistently with the shock, and it takes longer to return to the balanced growth NGDP path.
- Nominal and real rates fall in a recession.

Effects of a shock

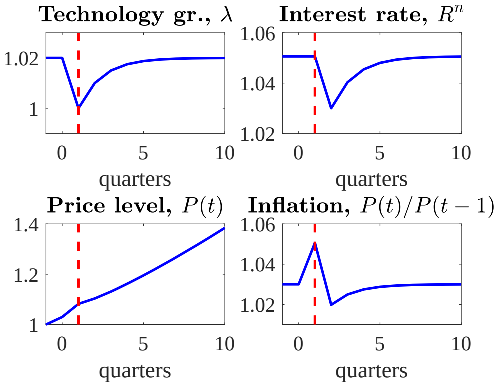

Figure: Monetary policy responds to a decrease in aggregate productivity, λ, by increasing the price level in the period of the shock. Subsequently, inflation converges to its BGP value, π^*, from below. The nominal interest rate drops in the period after the shock.

Conclusions

Summary

- This paper attributes observed levels of U.S. inequality to life-cycle effects in conjunction with heterogeneous life-cycle productivity profiles.
- All households in this model, regardless of their assigned life-cycle productivity profile, face a problem of smoothing consumption in a world with a credit market friction, "non-state contingent nominal contracting."
- The monetary authority can remove this impediment to consumption smoothing for all households: "optimal monetary policy for the masses."
- Does monetary policy affect inequality? Yes, it improves consumption allocations, alters the asset holding distribution and alters the income distribution by altering hours worked.

Labor income mass

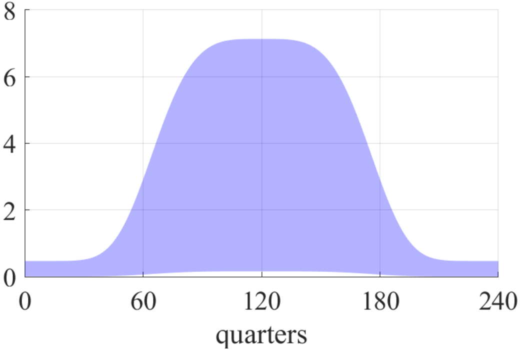

Figure: Cross section: Labor income profiles $e_{s,i}\,(1-\ell)\,w$.

LABOR INCOME + NON-NEGATIVE CAPITAL INCOME

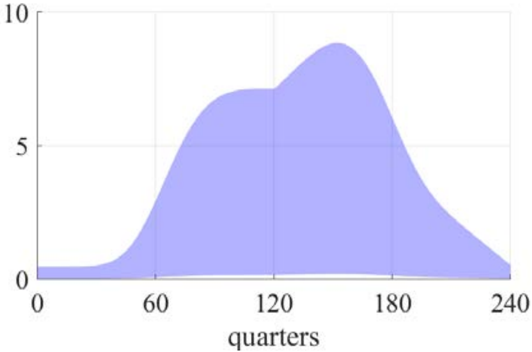

FIGURE: Cross section: Profiles of labor income and non-negative capital income $e_{s,i}\left(1-\ell\right)w+\max\left\{\left(\lambda-1\right)\frac{a}{P},0\right\}$.

Non-negative total income

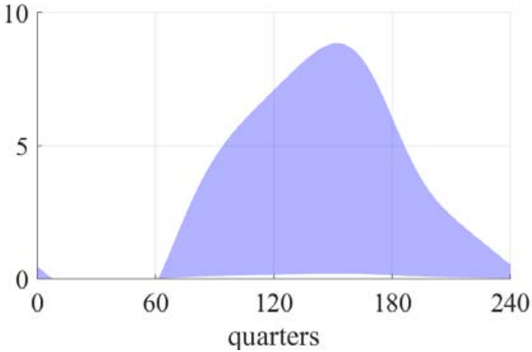

FIGURE: Cross section: Profiles of non-negative total income $\max\left\{e_{s,i}\left(1-\ell\right)w+\left(\lambda-1\right)\frac{a}{P},0\right\}$.

Back

Lognormal productivity: Gini coefficients

Distribution of consumption, income and wealth

$$\ln c \sim \mathcal{N}\left(\mu + \ln(w) + \ln(\eta \bar{e}), \sigma^2\right),$$

$$F_{Y_1} = \sum_{s=0}^{240} \frac{F_{Y_{1,s}}}{241},$$

$$Y_{1,s} \sim \ln \mathcal{N}\left(\mu + \ln(w) + \ln\left[\left(e_s - (1-\eta)\,\bar{e}\right)\right], \sigma^2\right),$$

$$F_W = \sum_{s=0}^{240} \frac{F_{W_s}}{241},$$

$$W_s \sim \begin{cases} \ln \mathcal{N}\left(\mu + \ln(w) + \ln\left[\left(\sum_{k=0}^{s} e_k - \bar{e}\right)\right], \sigma^2\right), & s = 120, ..., 239 \\ \delta & s = 0, ..., 119;\ s = 240 \end{cases}$$

Lognormal productivity: Gini coefficients

Consider a mixture of N lognormal distributions, $\ln X_i \sim N\left(\mu_i, \sigma_i^2\right)$:

$$X \sim F(x) = \sum_{i=1}^{N} w_i \Phi\left(\frac{\ln(x) - \mu_i}{\sigma_i}\right),$$
$$m = E(X) = \sum_{i=1}^{N} w_i \exp\left(\mu_i + \frac{\sigma_i^2}{2}\right).$$

The Gini coefficient is given by (Young, unpublished manuscript, LSE, 2011):

$$G = \sum_{i=1}^{N} \sum_{j=1}^{N} \frac{w_i w_j m_i}{m} \left[2\Phi\left(\frac{\sigma_i^2 + \mu_i - \mu_j}{\sqrt{\sigma_i^2 + \sigma_j^2}}\right) - 1\right].$$

Back