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# OPTIMAL MONETARY POLICY FOR THE MASSES

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# Introduction

## INEQUALITY AND MONETARY POLICY

- Interest in financial wealth, income 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 (*ECMA*, 2021):
  - 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.*

# 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  $x \sim F_x$  and receive a life-cycle productivity profile that is a scaled version of the baseline profile,  $e_s$  :

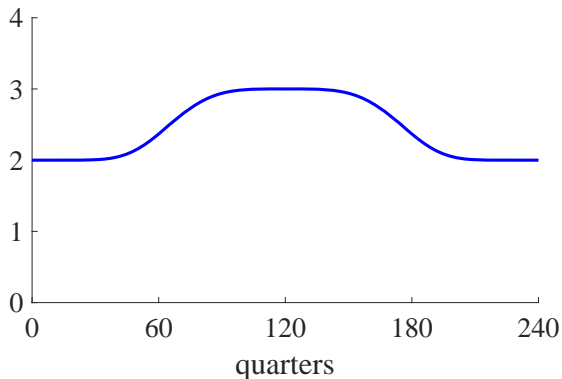
$$e_{s,i} = x \cdot e_s,$$

where  $e_s$  is symmetric, i.e.,  $e_j = e_{T-j}$ , for  $j = 0, \dots, 119$ .

- 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.

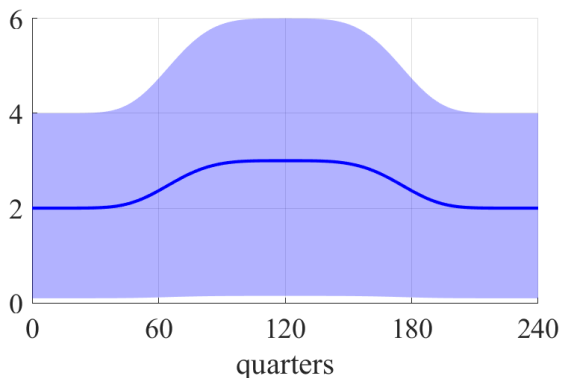


## BASLINE LIFE-CYCLE PRODUCTIVITY



**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:** Endowment distribution by cohort (shaded area) and a representative endowment profile (line):  $e_{s,i} = e_s \cdot x$ ,  $x \sim \mathcal{U}(a, b)$ .

## 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

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

- 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

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

subject to the budget constraint

$$\begin{aligned} c_{t,i}(t+s) + \frac{a_{t,i}(t+s)}{P(t+s)} &\leq e_{s,i} [1 - l_{t,i}(t+s)] w(t+s) + \\ &+ R^n(t+s-1, t+s) \frac{a_{t,i}(t+s-1)}{P(t+s)}, s = 0, \dots, T \\ a_{t,i}(t-1) &= a_{t,i}(T) = 0. \end{aligned}$$

## LINEAR PRODUCTION TECHNOLOGY

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

$$Y(t) = Q(t) L(t), \quad (2)$$

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

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

$$Q(t+1) = \lambda(t, t+1) Q(t), \quad (3)$$

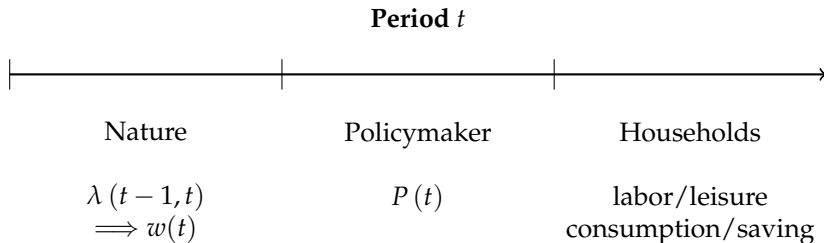
$$\lambda(t, t+1) = (1 - \rho) \bar{\lambda} + \rho \lambda(t-1, t) + \sigma \epsilon(t+1), \quad (4)$$

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,

$$w(t+1) = \lambda(t, t+1) w(t). \quad (5)$$

## TIMING PROTOCOL



## WHAT MONETARY POLICY DOES

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

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

where  $\lambda$  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, income, 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  $A(t) = 0 \forall t$ .



# Characterizing the Equilibrium

## THE MODEL'S SIMPLE SOLUTION

### 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,  $\lambda(t-1, t)$ ,  $\forall t$ .*

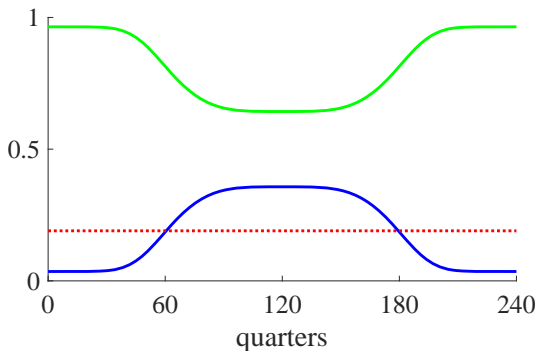
### COROLLARY (EQUITY SHARE CONTRACTING)

*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

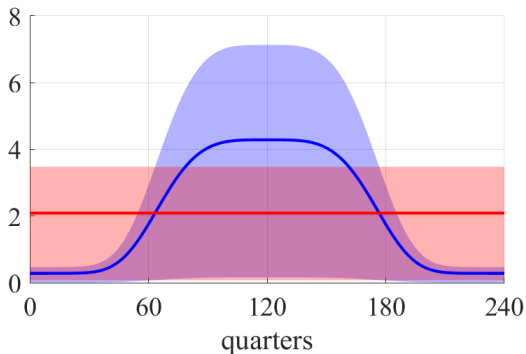
*Desired labor supply over the life cycle depends on the shape of the productivity profile alone and not on the scaling factor  $x$ .*

## HOURS WORKED OVER THE LIFE CYCLE



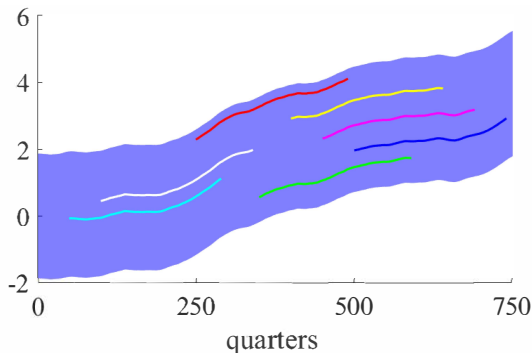
**FIGURE:** Leisure decisions (green), labor supply (blue) and fraction of work time in U.S. data, 19% (red). The labor/leisure choice depends on the current-to-lifetime average productivity ratio. Productivity profiles of the form  $e_{s,i} = x \cdot e_s$  imply labor/leisure choices depend on age only.

## CONSUMPTION MASS



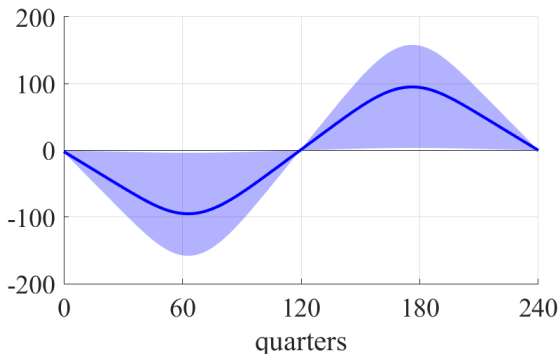
**FIGURE:** Cross section: Consumption mass (red) and labor income mass (blue). Under optimal monetary policy, the private credit market reallocates uneven labor income into perfectly equal consumption for each productivity profile.

## 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  $\sim 65$ ).

## THREE NOTIONS OF INCOME FIGURES

- 1 Labor income,

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

- 2 Labor income plus non-negative capital income,

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

- 3 The non-negative component of total income,

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

## MARGINAL PROPENSITY TO CONSUME

- Consumption is linear in the real wage

$$c_{t,i}(t+s) = \eta x \bar{e} w(t+s).$$

- Labor income is linear in the real wage

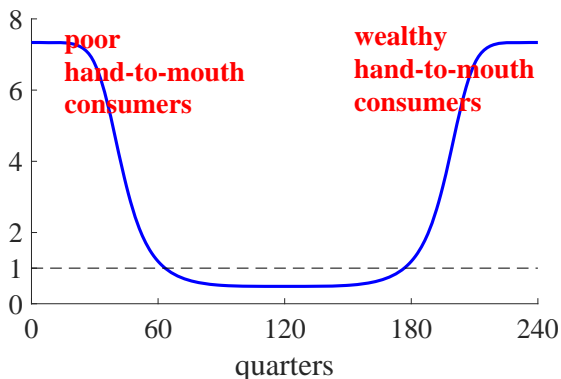
$$Y_{1,t,i}(t+s) = x e_s [1 - \ell_t(t+s)] w(t+s).$$

- Hence, the MPC can be calculated as follows:

$$MPC = \frac{dc/dw}{dY_1/dw} = \frac{\eta \bar{e} x}{e_s x \left[ 1 - (1 - \eta) \frac{\bar{e}}{e_s} \right]} = \frac{\eta \bar{e}}{e_s - (1 - \eta) \bar{e}}.$$



## YOUNG AND OLD AGENTS HAVE HIGH MPC



**FIGURE:** Cross section: Marginal propensity to consume out of labor income by cohort. Notice that the MPC does not depend on the endowment scaling factor,  $x$ .

# Calibration

## CALIBRATION

- Baseline endowment profile:

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

- Lognormal endowment scaling factor:  $\ln(x) \sim \mathcal{N}(\mu, \sigma^2)$ .
  - Allows for arbitrarily rich and arbitrarily poor households.
  - All distributions (wealth, income and consumption) are mixtures of lognormals (and  $\delta$  functions).
  - Gini coefficients can be computed with “paper and pencil.”

Details

## CALIBRATION

- Within-cohort dispersion,  $\sigma$ : match the consumption Gini coefficient for the U.S.  $G_{C,U.S.} = 32\% = \text{erf}(\sigma/2)$ .
- Utility parameter  $\eta$  : match the average fraction of time worked in U.S. data,

$$1 - \frac{\sum_{s=0}^T \ell_{t,i}(t+s)}{T+1} = 1 - (1-\eta) \frac{\sum_{s=0}^T \frac{\bar{e}}{e_s}}{T+1} = 19\%.$$

- Annual average productivity growth 3%, i.e.,  $\bar{\lambda} = 1.0075$ .

# Inequality

## DATA ON INEQUALITY IN THE U.S.

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

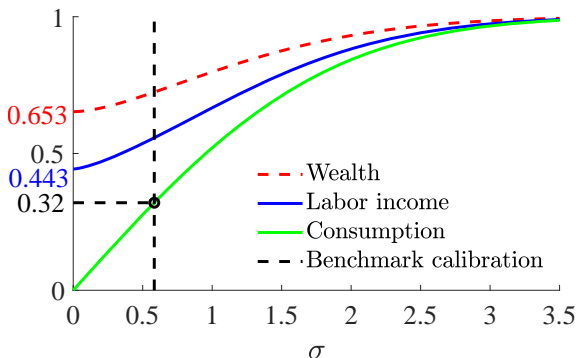
## INEQUALITY IN THE MODEL

- 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.
- Gini coefficients:

	<b>Wealth</b> W	$Y_1$	<b>Income</b> $Y_2$	$Y_3$	<b>Consumption</b> C
U.S. data	80%		51%		32%
Model	72.4%	55.7%	51.1%	59.0%	32%

**TABLE:** Gini coefficients in the U.S. data and in the model.

# PRODUCTIVITY DISPERSION AND GINI COEFFICIENTS



**FIGURE:** As the dispersion of productivity profiles,  $\sigma$ , increases, the Gini coefficients increase. The ordering  $G_W > G_Y > G_C$  is preserved.



# Policy

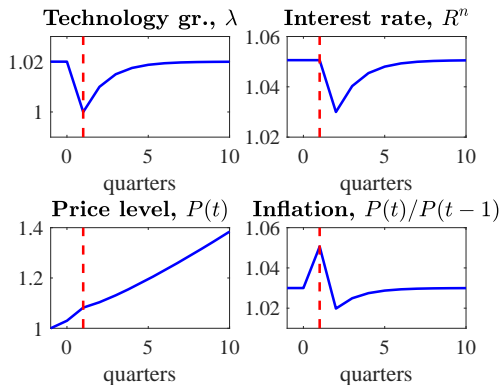
## INTERPRETING MONETARY POLICY

- 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,  $\lambda$ .
- 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



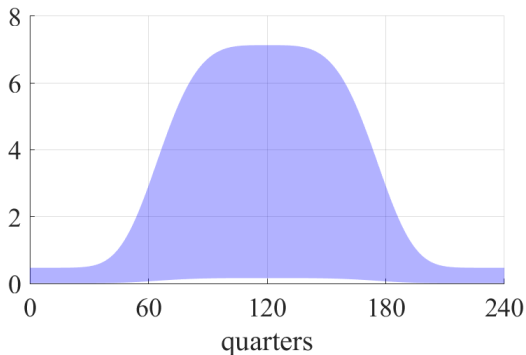
**FIGURE:** Monetary policy responds to a decrease in aggregate productivity,  $\lambda$ , by increasing the price level in the period of the shock. Subsequently, inflation converges to its BGP value,  $\pi^*$ , from below. The nominal interest rate drops in the period after the shock.

# Conclusions

## SUMMARY

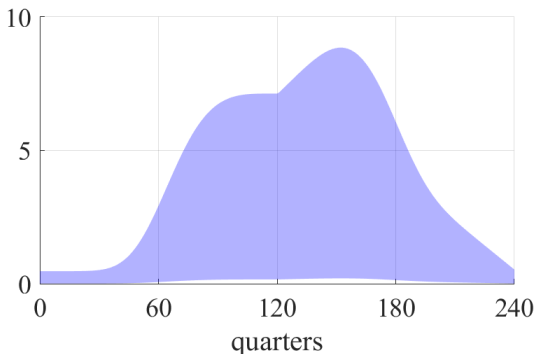
- This paper attributes observed levels of U.S. inequality to life-cycle effects in conjunction with heterogeneous life-cycle productivity profiles.
- All households in this model, regardless of their assigned life-cycle productivity profile, face a problem of smoothing consumption in a world with a 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: Profiles of labor income profiles  $e_{s,i} (1 - \ell) w$ .

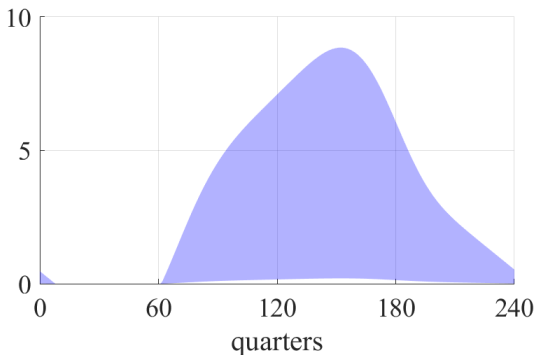
## LABOR INCOME + NON-NEGATIVE CAPITAL INCOME



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



## NON-NEGATIVE TOTAL INCOME



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

## LOGNORMAL PRODUCTIVITY: GINI COEFFICIENTS

Distribution of consumption, income and wealth

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

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

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

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

$$W_s \sim \begin{cases} \ln \mathcal{N} \left( \mu + \ln(w) + \ln \left[ \frac{1}{\delta} \left( \sum_{k=0}^s e_k - \bar{e} \right) \right], \sigma^2 \right), & s = 120, \dots, 239 \\ & s = 0, \dots, 119; s = 240 \end{cases}$$

## LOGNORMAL PRODUCTIVITY: GINI COEFFICIENTS

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

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

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

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