### Capital in a Segregated Economy

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#### Wealth Inequality in the US



Sources and series: see piketty.pse.ens.fr/capital21c.

# Inequality and Policy

- Existing research on inequality has mostly focused on how to generate such high levels of wealth inequality endogenously in a DSGE.
  - This turns out to be really, really hard.
  - A few people have more wealth than can be accumulated in one generation.
  - Death without altruism limits patience in long run.
  - Basic policy questions yield nonrobust results.
- I am proposing a model with exogenous heterogeneity where policy analysis is simple.

#### Literature on Bequests

- Barro (1974): pure altruism  $\Rightarrow$  infinite horizon.
- Kotlikoff and Summers (1981): a large fraction of the capital stock is inherited.
  - K/Y implies parents put little value on kids.
- De Nardi (2004), De Nardi and Yang (2014): impure altruism  $\Rightarrow$  more plausible preferences.
- Feigenbaum and Li (2018): intrafamily bargaining leads to distinctly different bequest behavior between 99.9% and 0.1%.

# A Segregated Economy

- A segregated economy model is a hybrid of an infinite-horizon model and an overlapping-generations (OLG) model.
- Laborers have a finite horizon since they do not earn enough wealth to pass onto next generation.
  - They live for two periods here.
- Capitalists, on the other hand, are characterized as an infinite-lived dynasty. 4

## Preexisting Literature

- Others such as Mankiw and Pestieau have studied similar hybrid models.
- The idea, nevertheless, remains fairly obscure in the literature.
- The lessons of such hybrid models are particularly apropos in the current political climate.

## Segregated Economy vs Microfoundations

- We can easily calibrate segregated economy to match holdings of, say, the 0.1%.
  - We cannot explain how the 0.1% wound up on top or why capitalist/laborer threshold is near 0.1%.
- Straightforward to study first-order interactions between wealth distribution and tax policy.
- We can also see how 0.1% could exploit their market power, which is beyond the scope of current micro-founded models.

#### **Trickle-Down Economics**

- The infinite-horizon result of no capital taxes still holds true in the baseline price-taking model.
- Almost all of welfare gains from eliminating capital tax go to capitalists.
- Early cohorts of workers will be hurt badly during the transition.
  - It takes several generations for after-tax wages to rise.
- A Pareto-improving path has to raise taxes on capitalists first.

#### The Warren Wealth Tax

- Capitalists will disappear if they are not more patient than the workers.
- A wealth tax on capitalists would effectively increase their discount rate by the tax rate.
- For the baseline calibration, the difference in annual discount rates is roughly 3 percentage points, which is also her proposed tax rate for billionaires.

# A Trend of Diminishing Competition?

- While New Keynesian models incorporate imperfect competition, neoclassical models still routinely assume perfect competition.
- Nevertheless, consolidation of firms is a popular explanation for wage stagnation.
- Piketty (2014) emphasizes market power of executives when setting salaries.

## Smith on Labor and Capital

- "The increase of stock [capital], which raises wages, tends to lower profit."
- Smith recognized that, ceteris paribus, workers and capitalists play a zero-sum game.
  - First identification of economic class conflict.
  - Since he was unaware of the marginal principle, he could focus his attention on the game.
  - Wages are high where workers have more bargaining power, so capitalists will conspire to reduce this bargaining power.

# Smith Distortions

- When wealth becomes concentrated in the hands of a few people, it is not rational for them to ignore their pricing power.
  - For capitalists, the collusive strategy is always the same: consume more and save less.
- Laborers cannot coordinate in the same way because the optimal strategy for them changes.
  - Optimal irrational behavior is very counterfactual and also very complicated.
- Upshot is markets are no longer efficient.

# A Simple Example

- Consider a representative agent model with Cobb-Douglas production, log utility, fixed labor, and full depreciation.
- The Bellman equation is

$$v(K) = \max_{C,K'} \ln(C) + \beta v(K')$$

subject to

$$C + K' = Y = AK^{\alpha}N^{1-\alpha}$$

## A Simple Solution

• We can show by guess and verify that

$$v(K) = \frac{\alpha}{1 - \alpha\beta} \ln(K) + \text{constant}$$

• The policy function is

$$C(K) = (1 - \alpha\beta) A K^{\alpha} N^{1-\alpha}$$

## A Simple Steady State

• Next period's capital is

$$K'(K) = \alpha \beta A K^{\alpha} N^{1-\alpha} = \alpha \beta Y$$

• In the steady state, where K' = K,

$$\frac{K}{Y} = \alpha\beta.$$

## Simple Solution with a Capitalist

- Suppose now that all the capital is owned by one capitalist and labor is supplied separately.
- If labor markets are competitive, the profit earned by the capitalist will be  $\alpha K^{\alpha}N^{1-\alpha}$ .
  - The capitalist's problem is the same as before with  $A = \alpha \operatorname{except} Y$  is now  $K^{\alpha} N^{1-\alpha}$ .

$$K' = \alpha \beta (\alpha K^{\alpha} N^{1-\alpha})$$

### Macro with Capitalists

• In the steady state,

$$\frac{K}{Y} = \alpha^2 \beta$$

- If the capital-output ratio decreases by a factor of  $\alpha$ , output and wages will decrease by a factor of  $\alpha^{\frac{\alpha}{1-\alpha}}$ .
- If  $\alpha = 1/3$ , this is  $\sqrt{\alpha} = 0.573$ .

– Output and wages fall by 43%.

# Price-Setting vs Price-Taking

- The key to this result is the assumption that the capitalist understands how his profit depends on his investment.
- If he assumes his income will be *RK*, where the gross return *R* is beyond his influence, he will choose  $K' = \beta RK$ .
- In equilibrium  $RK = \alpha Y$ , so we then get back the representative-agent result,  $K' = \alpha \beta Y$ .

### A More Realistic Model

- As things stand, in the United States, the 0.1% own ≤ 30% of the capital stock.
- If they own 20% of the capital stock, the effects of price-setting will be more modest.
- GDP is 7.5% lower and worker welfare decreases by equivalent of 6% of consumption.
  - Noise in measurements could mask price-setting.
  - If price-setting occurs, markets are not efficient.

### Lessons about Price Setting

- Just as the solution to the Cass-Koopmans-Ramsey model behaves unintuitively, this is even more so for a price-setting capitalist.
- Optimal behavior for price-setting capitalists actually reduces their share of the capital stock.
- The standard Euler equation will not apply to capitalists, which may account for difficulty of pinning down preference parameters.

# Philanthropy and Price Setting

- Increases in philanthropy after becoming wealthy are actually evidence of price-setting.
  - When a capitalist says that he is going to spend a good chunk of his wealth on stuff that will make him happy because his kids do not need so much to get by, that is in line with the price-setting model, not the price-taking model.
- Getting capitalists to **decrease** saving rate as they get wealthier requires exotic preferences.

#### The Model Structure

- In each period, a measure  $\mu$  of laborers is born, and there is a measure  $1 - \mu$  of capitalist dynasties.
- The laborers live for two periods with certainty while the dynasties live forever.
- The total population has measure  $1 + \mu$ .

#### The Laborers

- The laborers work when young and are retired when old.
- They have utility

$$U_{t}^{l} = u^{l} \left( c_{t,0}^{l}, l_{t} \right) + \beta^{l} u^{l} \left( c_{t+1,1}^{l}, 1 \right)$$

• We will only consider the case

$$u^{l}(c,l) = \eta \ln c + (1-\eta) \ln l.$$

#### Laborer's Behavior

• With these preferences, the laborer chooses

$$l = \frac{1 - \eta}{1 + \beta^l \eta}.$$

• Let the wage at t be  $w_t$  and return on capital  $r_t$ .  $c_{t,0}{}^l = \frac{1}{1+\beta^l} w_t (1-l)$   $c_{t+1,1}{}^l = \beta^l (1+r_{t+1}) c_{t,0}{}^l$ 

#### Laborers and Factor Markets

- Only the laborer's work, so the labor supply is  $N = \mu(1 - l) = \frac{1 + \beta^{l}}{1 + n\beta^{l}}\mu\eta.$
- The laborers' saving contributes to capital:  $\mu k_{t+1}{}^{l} = \mu \frac{1-l}{1+\beta^{l}} w_{t}$

• Let  $s = \frac{1-l}{1+\beta^l}$  be the saving rate out of the wage.

## The Capitalists

- A capitalist dynasty maximizes  $U_t^{\ c} = \sum_{s=0}^{\infty} (\beta^c)^t \, u^c(c_t^c)$
- Unlike the laborer, the dynasty will have previously accumulated capital.
- We consider both the cases where capitalists are price-takers and price-setters.

## Output and Wages

- Let  $K_t$  be the capital stock.
- There is a Cobb-Douglas production function  $Y_t = K_t^{\alpha} N^{1-\alpha}$ .
- We assume the labor market is competitive, so the wage is the marginal product of labor.

$$w_t = w(K_t) = (1 - \alpha) \left(\frac{K_t}{N}\right)^{\alpha}$$

## Return on Capital

• The capital market is not competitive, but competitive wages mean the return on capital is  $(K_t)^{\alpha-1}$ 

$$r_t = r(K_t) = \alpha\left(\frac{\kappa_t}{N}\right) - \delta.$$

• The gross return is

$$R_t = R_t(K) = 1 + r_t$$

## Capital Accumulation

- Let  $k_{t+1}$  denote the capitalist's demand for capital at time t + 1.
- Next period's capital stock will be

$$K_{t+1} = \mu sw(K_t) + (1 - \mu)k_{t+1}.$$

- The state of the economy at t will be  $(k_t, K_t)$ .
  - $-k_t$  characterizes the capitalist's wealth.
  - $-K_t$  characterizes the aggregate economy and determines factor prices.

### **Bellman Equation**

• The price-setting capitalist's value function obeys

 $v(k_t, K_t) = \max u^c(c_t^{\ c}) + \beta^c v(k_{t+1}, K_{t+1})$ subject to

$$k_{t+1} = R(K_t)k_t - c_t^{\ c}$$

$$K_{t+1} = \mu sw(K_t) + (1 - \mu)k_{t+1}.$$

## Price-Taking Equilibrium

- For the rest of the talk, let  $u^{c}(c) = \ln(c)$ .
- Suppose the capitalist assumes  $K_t$  follows some process that he has no influence over.
- The solution will then be

$$c_t^{\ c}(k_t, K_t) = (1 - \beta^c)R(K_t)k_t$$
$$k_{t+1}(k_t, K_t) = \beta^c R(K_t)k_t$$

•  $R^*_{pt} = (\beta^c)^{-1}$  in the price-taking steady state.

## Price-Setting FOC

• If, on the other hand, the capitalist knows the equation for  $K_{t+1}$ , the first-order condition is

$$\frac{1}{c_t^{\ c}} = \beta^c \left( \frac{R_{t+1}(K_{t+1})}{c_{t+1}^{\ c}} + (1-\mu) \frac{\partial V}{\partial K}(k_{t+1}, K_{t+1}) \right)$$

• Ignoring the second term, we get back the usual Euler equation, which is a condition for efficiency:

$$c_{t+1}^{\ c} = \beta^{c} R_{t+1}(K_{t+1}) c_{t}^{\ c}.$$

#### Effect of Smith Distortion

- *V*(*k*, *K*) decreases with *K* since the rate of return decreases with *K*.
- Thus

$$c_t^c > \frac{c_{t+1}^c}{\beta^c R_{t+1}(K_{t+1})}.$$

• A price-setting capitalist will consume more now and decrease his saving relative to a pricetaking capitalist.

### Understanding $\partial V / \partial K$

• The value function is largely determined by *R*(*K*)*k* and its future iterations.

$$\frac{d}{dk}R(K)k = R(K) + (1-\mu)R'(K)k$$
$$= R(K)\left[1 + \frac{(1-\mu)k}{K}\frac{KR'(K)}{R(K)}\right]$$

## Wealth Inequality

• Let us define

$$\kappa = \frac{(1-\mu)k}{K}$$

to be the share of capital owned by the capitalists.

• This also serves as our measure of wealth inequality.

## Understanding $\partial V / \partial K$

•  $\partial V / \partial K$  is proportional to  $\kappa$ .

$$\frac{d}{dk}R(K)k = R(K)\left[1 + \kappa \frac{KR'(K)}{R(K)}\right]$$

- The elasticity is a function of the curvature of the production function.
  - With full depreciation, it simplifies to  $\alpha 1$ , i.e. minus the share of labor.

#### Calibration

- Share of capital:  $\alpha = 1/3$
- 1 period = 30 years
- $K/Y = 3.0 \Rightarrow \beta^c = 0.965$  annual (0.343 period)
- $C/Y = 0.75 \implies \delta = 0.083$  per annum (0.926 1/per.)
- Labor hours: 40 per week  $\Rightarrow \eta = 0.216$
- Price-setting capitalists are  $0.1\% \Rightarrow \mu = 0.998$
- $\kappa = 0.20 \Rightarrow \beta^{l} = 0.935$  annual (0.133 period)

#### Steady-State Observables

Variable	PT	PS	% Change
Y	0.082333	0.076119	-0.07547
K/Y ann	3.487858	2.974172	-0.14728
r ann	0.036269	0.041658	0.148573
(dV/dK)/(dV/dk)		-0.16888	
kappa	0.322831	0.205873	-0.36229
c_cap	2.957079	1.867868	-0.36834
U_cap	1.651275	0.951587	-0.36834
c0	0.048779	0.045097	-0.07547
c1	0.018913	0.020429	0.080177
U_lab	-0.98028	-0.99502	-0.05841

# How Much Do Capitalists Contribute to Welfare of Laborers?

- Welfare would decrease for laborers by the equivalent of 8.3% of consumption if we eliminated the price-setting capitalists.
  - Capitalists contribute 30% of the capital stock but only 10% of GDP.
- The drop would be 8.0% if we recalibrate the economy with price-taking capitalists.

## Price-Taking to Price-Setting Transition – Capitalist Variables



## Price-Taking to Price-Setting Transition – Laborer Variables



# Price-Setting to Price-Taking Transition – Capitalist Variables





## Price-Setting to Price-Taking Transition – Laborer CV



## Price-Setting to Price-Taking Transition - K/Y in years



### Conclusions

- 1. If a large fraction of capital is owned by a small fraction of the population, they should rationally exploit their pricing power.
- 2. Divergence of Euler equation is proportional to fraction of capital owned by capitalists and curvature of production function.
- 3. Price-setting capitalists consume more in the short run.

#### More Conclusions

- 4. Future generations consume less, but higher return to capital reduces loss so there is an overall gain to dynastic utility.
- 5. Both the capitalist and initial generation of workers would be hurt by price-taking.
- 6. A Pareto-improving transition back to pricetaking steady state requires slower initial increase in capital.

#### Future Research

- 1. Ideally, we should have both low-skilled and high-skilled labor.
  - Effect of skill-biased technological change.
- 2. Adding uncertainty?
  - Does price-setting lessen equity premium puzzle?
- 3. Endogenizing  $\mu$