# Welfare Evaluations of Policy Reforms with Heterogeneous Agents

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# The goal of macroeconomic policy

What is the goal of macroeconomic policies?

- Higher GDP?
- Lower inflation?
- Lower government budget deficit?
- More consumption?
- No, it has to be higher welfare of consumers.

# A digression: why do we care about GDP?

In reality, we care a lot about (per capita) real GDP and use it as a measure of welfare. Why?

- Theoretical foundation:
  - Under certain assumptions (and adjustments), real GDP is higher if and only if the discounted present value of representative agent's utility is higher. (see Weitzman, 2003).
- Empirical support:
  - Consumption-leisure utility has high correlation with per capita GDP (Jones and Klenow, 2011)
  - Surveyed "happiness" has high correlation with per capita GDP (Stevenson and Wolfers, 2008)
  - People in rich countries tend to live longer and healthier.

But obviously, in the short run, there are situations where per capita real GDP and welfare do not go together. (For example, real GDP was very high during the WWII in the U.S.) Thus, direct welfare measures are important in particular when evaluating the short-run policies. Also, GDP is silent about distributional consequences and (therefore) the political feasibility of a policy change.

# Welfare measurement in modern macroeconomic models

In modern macroeconomic models, which are based on explicit optimization and market equilibrium, it is not very difficult to measure the welfare effects of various macroeconomic policies—just compare the utility levels of consumers.

- One question that has to be raised in a heterogeneous-agent world:
  - Whose utility?

In this presentation, I will talk about the issues of evaluating the welfare effects of economic policies in the heterogeneous agent environment.

# The welfare measure

We will use $\mu$ that satisfies the following equation as the welfare measure. For consumer $i$,

$$E\left[\sum_{t=0}^{\infty}\beta^t U((1+\mu)c_{it}^o, h_{it}^o)\right] = E\left[\sum_{t=0}^{\infty}\beta^t U(c_{it}^n, h_{it}^n)\right], \qquad (1)$$

where period 0 is the period that the policy changes, $c_{it}$ is the individual $i$'s consumption, and $h_{it}$ is hours worked. The superscript $o$ denotes "old policy" and $n$ denotes "new policy." In a life cycle model, the terminal date is the time of death.

- This measure is usually attributed to Lucas (1987) in measuring the welfare cost of business cycles.
- If $\mu > 0$, the consumer likes the "new policy," and if $\mu < 0$, the consumer likes "old policy." $\mu$ can be thought of the Hicksian "equivalent variation" measured in percentage consumption terms.
- It is important (although many papers violate this) that we are comparing the utilities from the same starting point. I will discuss this issue later.

# Some remarks

- We can compute $\mu$ for the representative agent when agents are homogeneous, and we can also compute $\mu$ for each individual when agents are heterogeneous.
- With heterogeneous agents, $\mu$ can be positive for some agents and can be negative for other agents at the same time—a political disagreement.
- $\mu$ is the % of consumption goods that is required to make this agent indifferent between $o$ and $n$. This can give some guidance for the necessary compensations for "losers" of the policy, in order to make them agree on the policy reform. (A caveat: when the economy does not aggregate, it is harder to think of the exact compensation that is necessary, because the equilibrium can change with the compensation.)
- There are many variations of computing "aggregate $\mu$." One has to take a stand on a social welfare function in order to do this.

# Is $\mu$ difficult to compute?

No!

- If the utility function permits balanced growth, $\mu$ is a closed-form function of the value functions.
  - If $U(c_t, h_t) = \log(c_t) + \nu(1 - h_t)$ where $\nu(1 - h_t)$ is utility from leisure,

$$\mu = \exp((1 - \beta)(V^n - V^o)) - 1,$$

    where $V^n$ and $V^o$ are value functions under $n$ and $o$.
  - If $U(c_t, h_t) = c_t^{1-\sigma}\nu(1 - h_t)/(1 - \sigma)$,

$$\mu = \left(\frac{V^n}{V^o}\right)^{\frac{1}{1-\sigma}} - 1.$$

- It may be a bit harder for the other class of utility functions, but since you know the policy functions, it is not difficult to calculate the LHS of (1) for a given $\mu$. Then (1) can be solved as an equation for $\mu$.

# Some results when the economy aggregates (Mukoyama, 2010)

- Suppose that the utility function of consumer $i$ is of the form

$$\mathbf{U} = E\left[\sum_{t=0}^{\infty} \beta^t \frac{c_{it}(s^t)^{1-\sigma}}{1-\sigma}\right]$$

(the results will be similar in the log utility case—see the paper) and the present value budget constraint is

$$\sum_{t=0}^{\infty} \int p_t(s^t) c_{it}(s^t) ds^t \leq W_{i0},$$

where $W_{i0}$ is the present-value wealth and $p_t(s^t)$ is the state price.

- Here, we only consider the heterogeneity in terms of the wealth $W_{i0}$.

# Some results when the economy aggregates (cont'd)

- Then

$$\mu_i = \Omega(\mathbf{p}, \tilde{\mathbf{p}}) \frac{\tilde{W}_{i0}}{W_{i0}} - 1,$$

  where $\mathbf{p}$ is the vector of prices and $\Omega$ is a function. ("~" indicates "after the policy change.")
- This means that there are two channels that a policy affect each consumer's welfare:
  1. Change in prices (common to everyone).
  2. Change in wealth (different across people). Note that the wealth can potentially be a function of prices.

# Some results when the economy aggregates (cont'd)

- With this utility function and complete markets, the economy aggregates and the representative agent exists.
- For the representative agent,

$$\mu_R = \Omega(\mathbf{p}, \tilde{\mathbf{p}}) \frac{\int \tilde{W}_{i0} di}{\int W_{i0} di} - 1.$$

- When a policy reform raises the utility of the representative agent, it is possible to come up with a lump-sum transfer scheme in order to achieve a Pareto-improving policy reform.

# Some results when the economy aggregates (cont'd)

- How can we do it?
  Just set the new (after transfer) level of wealth as

$$\hat{W}_{i0} = \frac{\int \tilde{W}_{i0} di}{\int W_{i0} di} W_{i0}.$$

  Then for all $i$,

$$\mu_i = \Omega(\mathbf{p}, \tilde{\mathbf{p}}) \frac{\hat{W}_{i0}}{W_{i0}} - 1 = \Omega(\mathbf{p}, \tilde{\mathbf{p}}) \frac{\int \tilde{W}_{i0} di}{\int W_{i0} di} - 1 = \mu_R.$$

  Since

$$\int \hat{W}_{i0} di = \int \tilde{W}_{i0} di,$$

  this transfer is feasible.

# How should we aggregate different people's opinions?

When a lump-sum transfer is not available, we can face different opinions of people for one policy.

- If a lump-sum transfer or something close to it is feasible, as I just showed, the most reasonable thing is to look at $\mu_R$ in deciding the most desirable policy.
- Otherwise, it depends on who we care about—we need some kind of a social welfare function.
  - Macroeconomists tend to avoid this issue—but they often (implicitly) assume some social welfare function.
    - See the next slide for examples.
    - Many papers that employ overlapping generation models use the expected utility of a newborn at each steady state as the criterion.
  - In the real world, here is the place where politics steps in. Political economy considerations are quite essential in analyzing the policy determination in this type of environment.

# Some results when the economy aggregates (cont'd)

A bit more about aggregation of opinions:

- Many papers use $\int \mu_i di$ as the "average welfare gain."
  - This is different from $\mu_R$. This criterion favors an "equalizing policy." This criterion has some undesirable characteristics.
- Often the following $\bar{\mu}$ is often used as the "average welfare gain."

$$\int E\left[\sum_{t=0}^{\infty} \beta^t U((1+\bar{\mu})c_{it}^o, h_{it}^o)\right] di = \int E\left[\sum_{t=0}^{\infty} \beta^t U(c_{it}^n, h_{it}^n)\right] di.$$

  - This can be viewed as the criterion over "the expected utility behind the Rawlsian veil of ignorance," since $\bar{\mu} > 0$ if and only if $\int E\left[\sum_{t=0}^{\infty} \beta^t U(c_{it}^o, h_{it}^o)\right] di > \int E\left[\sum_{t=0}^{\infty} \beta^t U(c_{it}^n, h_{it}^n)\right] di$.
  - This is also different from $\mu_R$. This criterion also favor an equalizing policy.

# The case of incomplete market model (Mukoyama, 2011)

Many economists believe that the assumption of the complete markets is too extreme. Models with incomplete markets are gradually gaining popularity:

- The assumption of complete asset market looks unrealistic.
- They can describe the mobility of consumption.
- They can address the policies related to insurance.
- Some policy conclusions can be dramatically different (e.g. capital income taxation).
- Some versions of the model are closer to what microeconomists study (permanent income hypothesis, life cycle hypothesis).

# The case of incomplete market model (cont'd)

Here, I will use my own paper to illustrate the welfare evaluation of policies under incomplete markets.

- Evaluation of unemployment insurance policy.
- How does an (unexpected) increase in unemployment affect each person's welfare?
- In the paper, I talk about three different models. Here, I will only talk about the easiest model (Model 1). In the other two models, I highlight the effect of the labor supply (Model 2) and demand (Model 3) response.
- The model is the standard Bewley-Huggett-Aiyagari model. In the model, a consumer can have a job or be unemployed by exogenous shock. The job finding probability is $\lambda_w$ and the separation probability is $\sigma$. A consumer can self-insure by saving (in capital stock).

# The case of incomplete market model (cont'd)

- Employed consumer:

$$W_t(a_t) = \max_{c_t, a_{t+1}} \log(c_t) + \beta[(1-\sigma)W_{t+1}(a_{t+1}) + \sigma U_{t+1}(a_{t+1})]$$

subject to

$$c_t + a_{t+1} = (1 + r_t - \delta)a_t + w_t\bar{h} - T_t$$

and

$$a_{t+1} \geq \underline{a},$$

- Unemployed consumer:

$$U_t(a_t) = \max_{c_t, a_{t+1}} \log(c_t) + \beta[\lambda_w W_{t+1}(a_{t+1}) + (1-\lambda_w)U_{t+1}(a_{t+1})]$$

subject to

$$c_t + a_{t+1} = (1 + r_t - \delta)a_t + b - T_t$$

and

$$a_{t+1} \geq \underline{a}.$$

# The case of incomplete market model (cont'd)

- I only look at the constant unemployment rate situation:

$$\bar{u} = \frac{\sigma}{\sigma + \lambda_w}.$$

- The balanced budget tax is

$$T_t = \bar{u} b.$$

- The representative firm's production function:

$$Y_t = K_t^{\alpha} L_t^{1-\alpha}.$$

# The case of incomplete market model (cont'd)

- The firm's first-order conditions:

$$r_t = \alpha \left( \frac{K_t}{L_t} \right)^{\alpha - 1}$$

and

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

$r_t$ is decreasing in $K_t/L_t$ and $w_t$ is increasing in $K_t/L_t$.

- Equilibrium conditions:

$$K_t = \int a_t^i di$$

and

$$L_t = (1 - \bar{u})\bar{h}.$$

# The case of incomplete market model (cont'd)

Experiment:

- Unexpected increase in $b$ (and therefore $T_t$) at time 0.
- The welfare effect is heterogeneous.
  - High initial asset ($a_0$) or low initial asset at the time of policy change.
  - Employed or unemployed at the time of policy change.

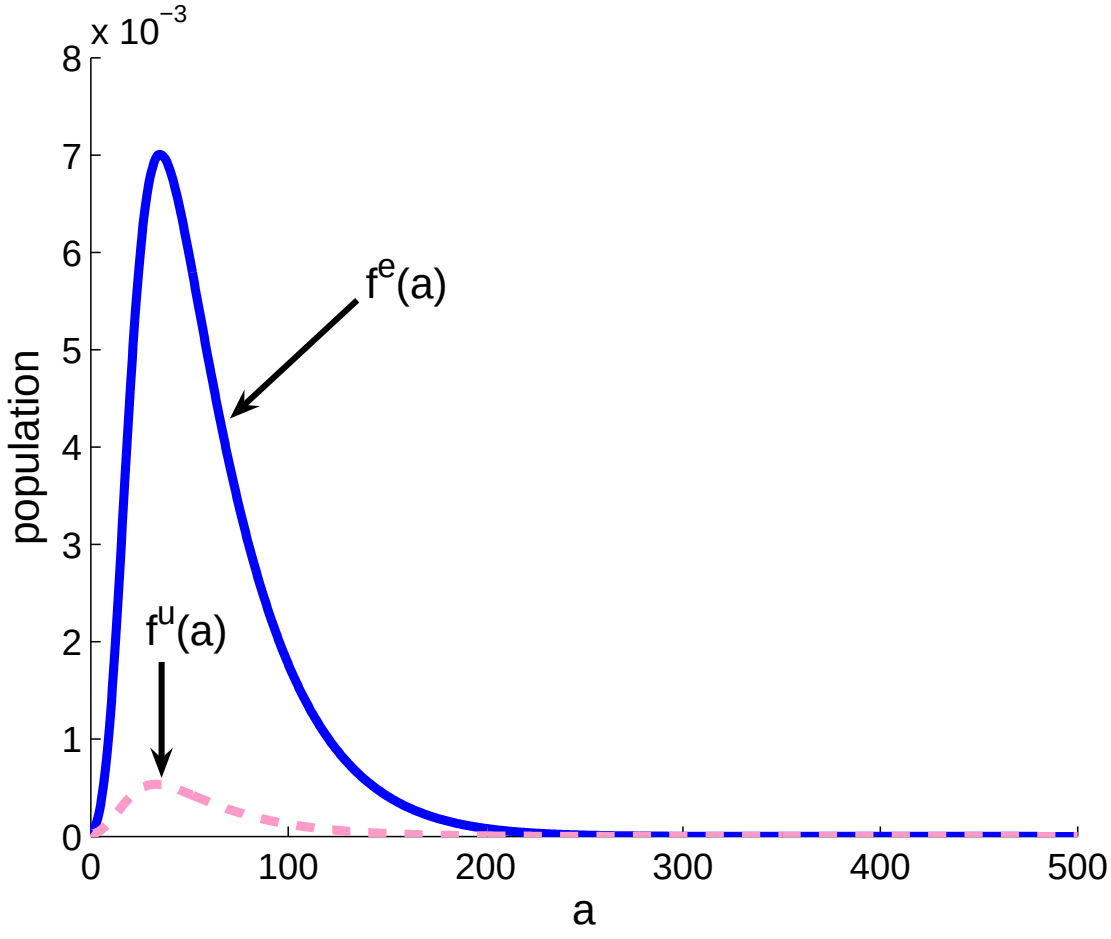
# The case of incomplete market model (cont'd)

Calibration:

- Monthly model.
- $\beta = 0.9967$, $\alpha = 1/3$, $\bar{h} = 1/3$, $\delta = 0.0067$.
- $\lambda_w = 0.26$ and $\sigma = 0.02$
  $\Rightarrow \bar{u} = 0.071$.
- Original benefit level: $b = 0.27$ (U.S.)
  $\Rightarrow$ net replacement rate is about 20%.
- New benefit level: $\tilde{b} = 0.90$ (Europe)
  $\Rightarrow$ net replacement rate is about 69%.

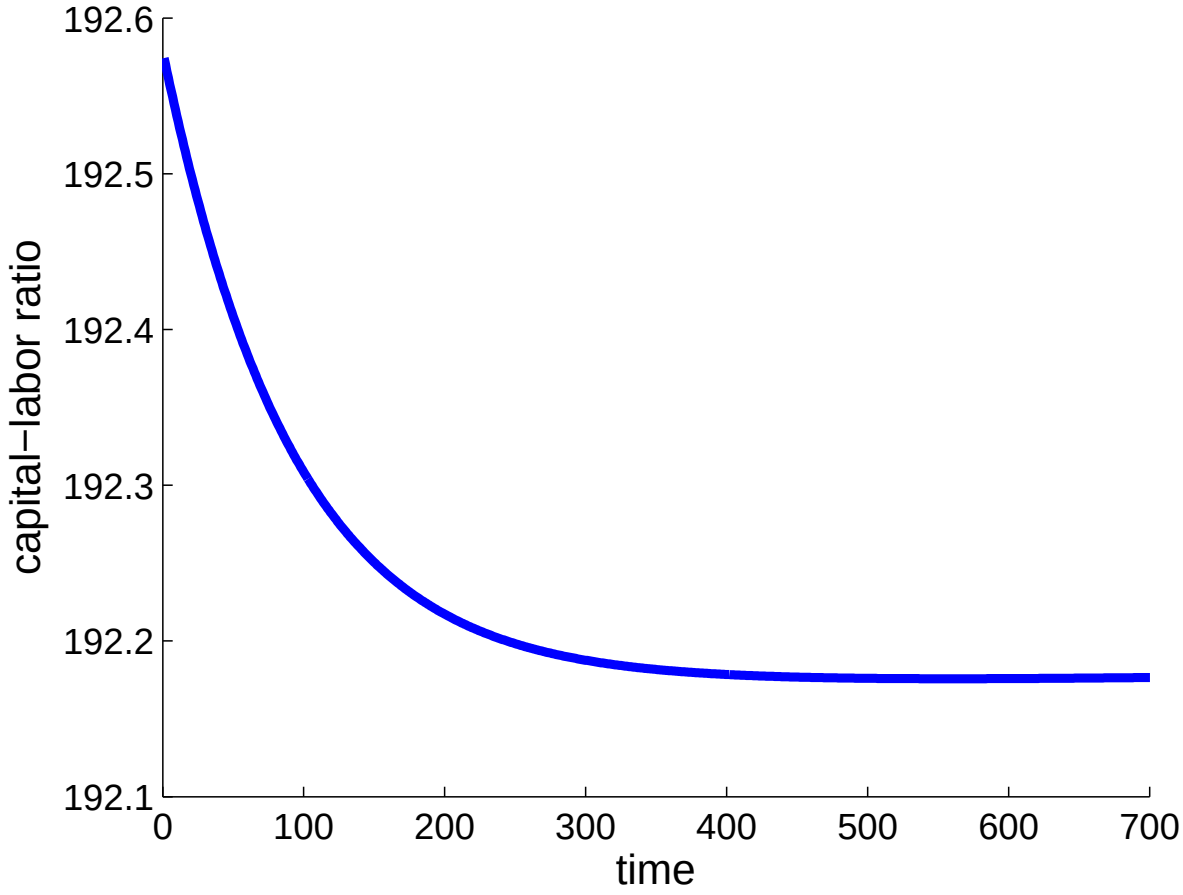
# The case of incomplete market model (cont'd)

Wealth distribution: stationary measures



# The case of incomplete market model (cont'd)

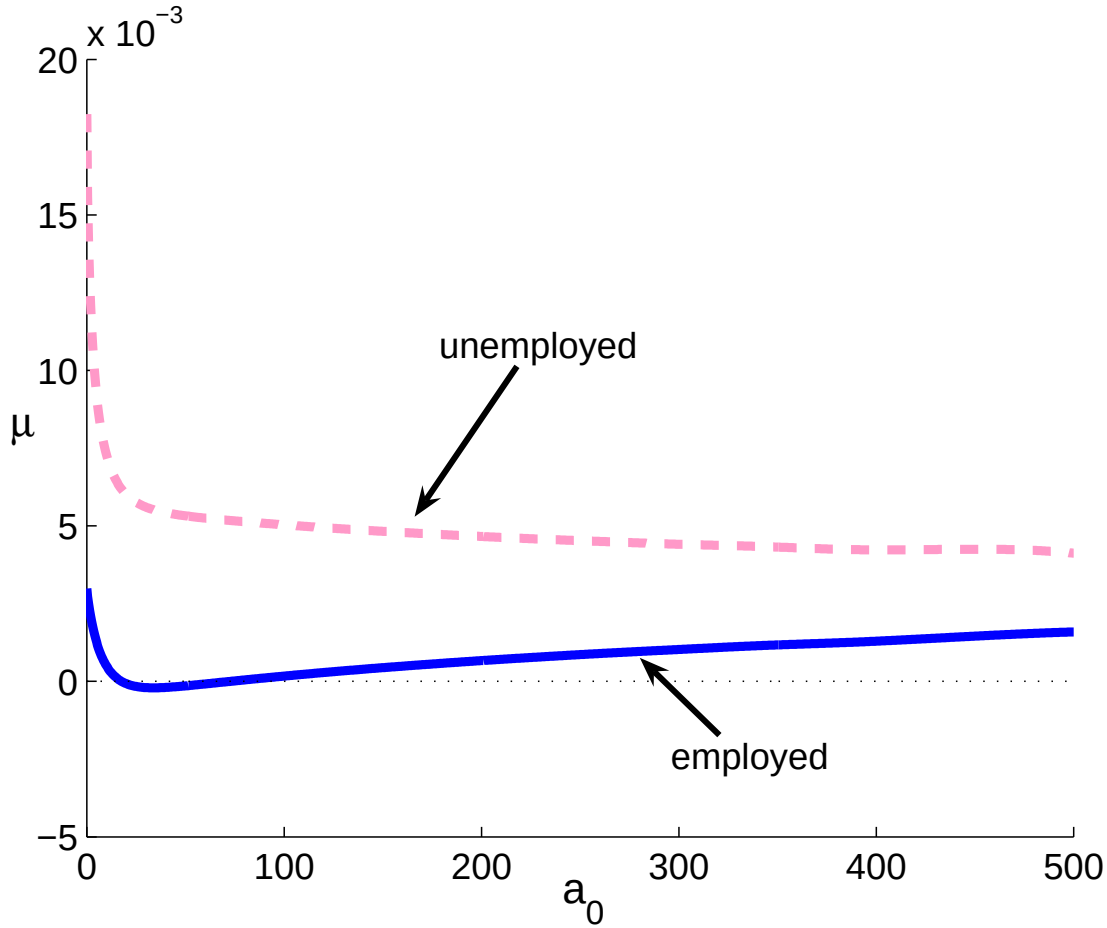
Transition path of aggregate capital-labor ratio:




- $K_t$ falls due to the decline in precautionary saving. $L_t$ is constant.

# The case of incomplete market model (cont'd)

Welfare effects of the policy change:




- Average $\mu = 0.00037$.
- Heterogeneity: 33% of the employed workers gain, and all the unemployed workers gain.

# The case of incomplete market model (cont'd)

- In the paper, I decompose the welfare effect into several components. I emphasize that there is non-trivial welfare effect from price change. Also, there is an implicit transfer across different agents.
- It is important to analyze the transition dynamics. In the paper, I illustrate the case that the short-run price effect is the opposite of the long-run price effect. Steady-state comparisons can be misleading.
- One big addition in this framework is the welfare effect of insurance. (People close to the borrowing constraint gain a lot from policy.)
- In the incomplete market case, a Pareto-improving reform (combined with lump-sum) transfers may or may not be possible even if an "average gain" (with whichever aggregation method) is positive. (The opposite is also true: a Pareto-improving reform may be possible even if the average gain is negative.)

# In the context of Japanese economy,

the perspectives from heterogeneous agent models are important.

- For example, the problem of government debt:
  - There is a classical argument that a government borrowing using an internal debt has no effect: it is like "borrowing from yourself."
  - Diamond (1965) criticizes this by developing an overlapping-generations model. The heterogeneity in age can change the result dramatically.
  - Further, in reality, there is more heterogeneity: differences among the people in the same generation. The people who hold the government debt and the people who bear tax burden can be different.
  - Who loses and who gains from alternative debt-repaying methods (different methods of taxation, "inflating away" the debt, or default)?

# Finally,

- Finally, I should talk about other people's work.
  - There has been an explosion of literature in many contexts in recent years.
    - One good starting point is the survey by Heathcote, Storesletten, and Violante (2009).
    - A good book for computation is Heer and Maußner (2009).
  - Many contributions are made by young Japanese macroeconomists.
- So far, a large part of contributions is about fiscal policy. There are many Japan-specific research agendas in this aspect (taxation, social security, transfers to parents with small kids, cross-regional transfers). In future, there should be more research related to monetary policy and stabilization policies in general. For this type of research, the availability of micro-level data is essential. I hope that the situation will get better for Japanese researchers.

# References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