Lecture 10
Unemployment, Inequality in Macro

Macroeconomics EC2B1

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London School of Economics, Lent 2023

Plan

1. Measuring the labor market and unemployment
2. Unemployment: Diamond-Mortensen-Pissarides model
3. Inequality and heterogeneity in macro

A Nobel Prize for work on unemployment (and LSE!)

The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2010

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Peter A. Diamond

Prize share: 1/3

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Dale T. Mortensen

Prize share: 1/3

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Christopher A. Pissarides

Prize share: 1/3

The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2010 was awarded jointly to Peter A. Diamond, Dale T. Mortensen and Christopher A. Pissarides "for their analysis of markets with search frictions"

Source: https://www.nobelprize.org/prizes/economic-sciences/2010/summary/

Readings

Unemployment

- Supplement with derivations on moodle
- Kurlat, chapters 7.1 and 7.5 (the part on "search")
- Wikipedia https://en.wikipedia.org/wiki/Search_and_matching_theory_(economics)
- PhD-level treatment: Pissarides book "Equilibrium Unemployment Theory", Shimer book "Labor Markets and Business Cycles"

Inequality in macro

- Kaplan, Moll and Violante IMF Finance & Development magazine piece on HANK models https://www.imf.org/en/Publications/fandd/issues/2023/03/modern-monetary-policy-kaplan-moll-violante
- Chapter 18 "Heterogeneous agent macroeconomics: origins, progress & challenges" in Carlin and Soskice (2023) "Macroeconomics: Institutions, Instability & Inequality"
- Cherrier, Garcia-Duarte and Saïdi (2022) "Household Heterogeneity in Macroeconomic Models: A Historical Perspective" https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4250570
- Reis (2018) "Is something really wrong with macroeconomics?" https://personal.lse.ac.uk/reisr/papers/18-wrong.pdf
- Yellen speech https://www.federalreserve.gov/newsevents/speech/yellen20161014a.htm
- BoJ Governor Kuroda speech boj.or.jp/en/about/press/koen_2017/ko170524a.htm

Measuring the labor market and unemployment

Definitions: unemployed is not the same as not employed

Three groups:

1. Employed, E
2. Unemployed, U: not employed, but actively searched for work at some time during the last four week
3. Not in labor force, NL: neither employed nor unemployed

$$\text{unemployment rate} = \frac{U}{E+U}$$

$$\text{participation rate} = \frac{E+U}{E+U+NL}$$

$$\text{employment-population ratio} = \frac{E}{E+U+NL}$$

Importantly, population is not just E and U but also NL and hence

$$\text{unemployment rate} \neq 1 - \text{employment-population ratio}$$

Smooth labor force participation, volatile unemployment rate

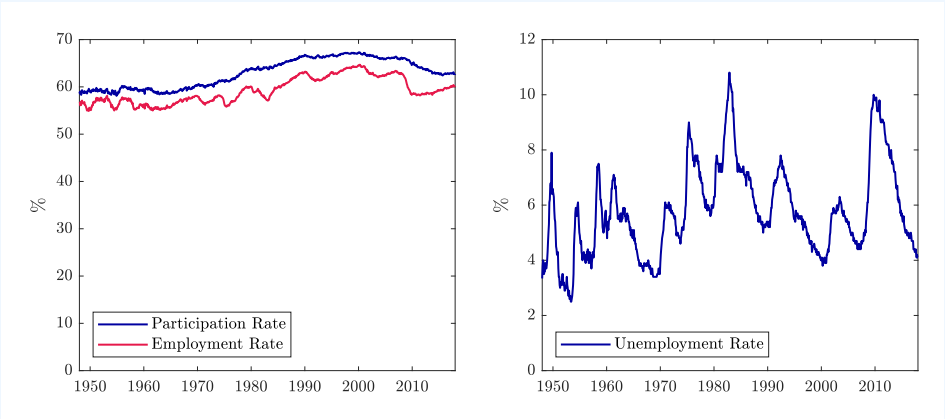


Fig. 7.1.1: *Labor market indicators in the United States. Source: CPS.*

Labor market stocks and flows

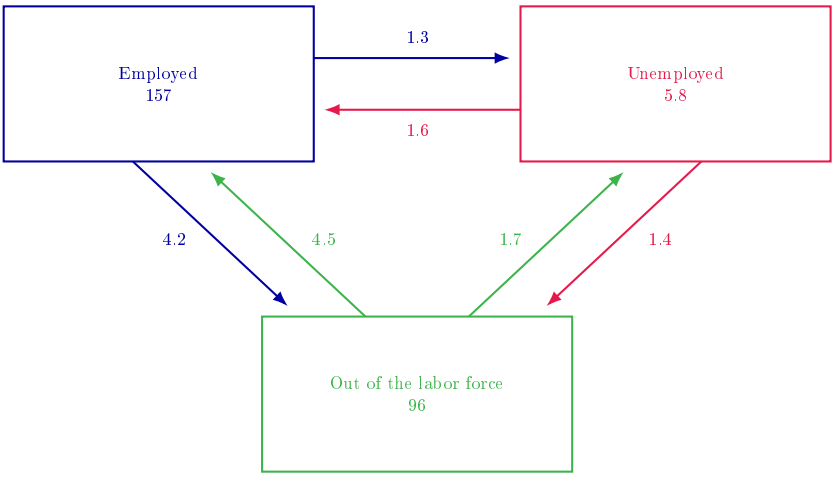


Fig. 7.1.2: *Stocks and flows of workers across labor market status in October, 2018. Figures in millions of workers. Source: CPS.*

Labor market flows: job finding and job loss rates

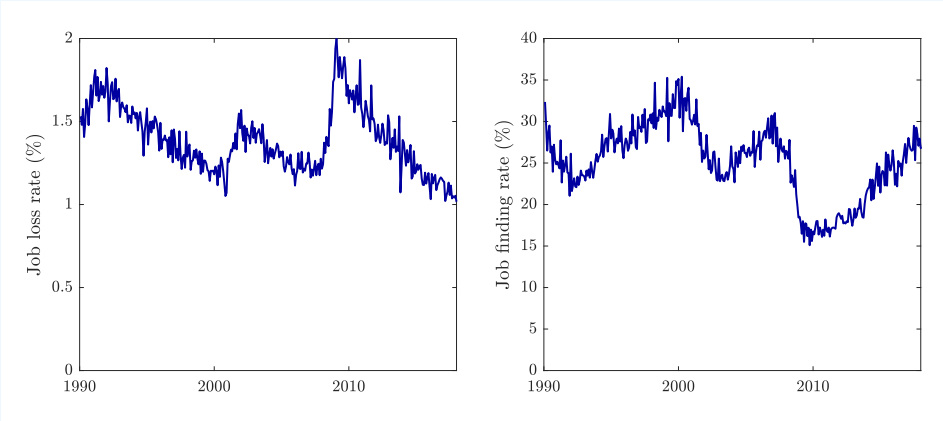


Fig. 7.1.3: *Monthly job loss rate and job finding rate. Source: CPS.*

Beveridge curve: vacancies are high when unemployment is low

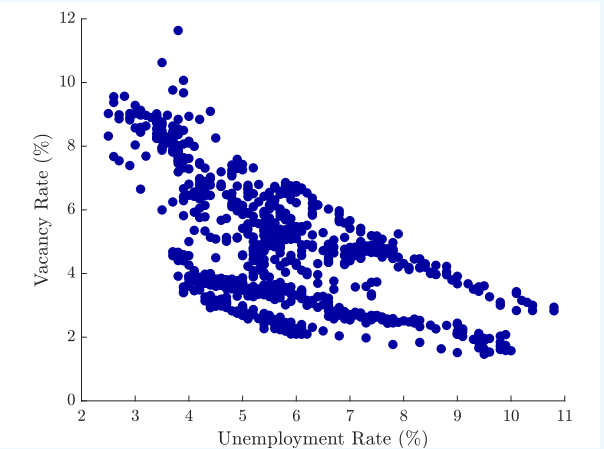


Fig. 7.1.4: *The US Beveridge Curve, 1948-2018. Each dot is one month. Sources: Unemployment from CPS. Vacancies from NBER Macrohistory Database, Barnichon (2010) and JOLTS.*

When vacancy/unemployment ratio is high, labor market is said to be “tight”

Unemployment:
Diamond-Mortensen-Pissarides Model

Brief recap of standard labor market model (lectures 1 & 2)

(Note change of notation: need u, v for unemployment, vacancies)

A competitive equilibrium are quantities (c, y, n, h) and a wage w such that

1. Utility maximization: taking as given w, the representative household chooses (c, h) to solve

$$\max_{c,h} \; U(c) - V(h) \quad \text{s.t.} \quad c = wh + \Pi$$

2. Profit maximization: taking as given w, the representative firm chooses n and $y = f(n)$ to solve

$$\Pi = \max_{n} \; f(n) - wn$$

3. Market clearing: demand = supply for both goods and labor

$$\text{goods market:} \qquad c = y$$

$$\text{labor market:} \qquad n = h$$

Brief recap of standard labor market model (lectures 1 & 2)

- Household utility maximization:

$$\frac{V'(h)}{U'(c)} = w$$

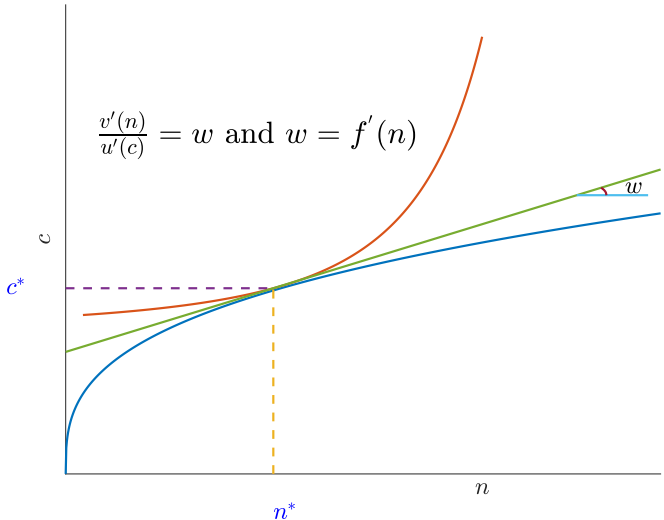
- Firm profit maximization:

$$f'(n) = w$$

- Market clearing:

$$\frac{V'(n)}{U'(c)} = f'(n)$$

Recall graphical representation



In standard model there is no involuntary unemployment

$$\frac{V'(n)}{U'(c)} = f'(n)$$

Important feature of standard model: **no involuntary unemployment!**

- worker's always set $MRS = w$
- only reason $n \downarrow$ at given w is change in preferences, e.g. disutility of work $\uparrow$

Modeling involuntary unemployment: search and matching

- This part of lecture notes: model with involuntary unemployment
- Will feature workers who "actively searched for work but could not find it"
- Key idea = search process is frictional: workers looking for jobs and firms who need them might fail to find each other
- Diamond-Mortensen-Pissarides search model
  - fully-fledged version = complicated multiperiod model
  - here: simplified static (one-period) version of Shimer's book

The matching function

Standard model: recruiting is costless, can find as many workers as you want

New assumptions:

- to hire a worker, have to post vacancy at cost $\kappa > 0$
- posting vacancy does not guarantee hiring, instead search frictions
- when unemployment rate $= u$ and firms post total vacancies $= v$

$$\text{number of new jobs or ``matches''} = m = M(u, v)$$

- $\Rightarrow$ employment is

$$n = n_0 + M(u, v)$$

  where $n_0 =$ workers employed (matched) before start of period
- labor force fixed at 1 so that $u = 1 - n$ (no participation decision)

The matching function

- Function $M(u, v)$ is called "matching function"
- Production function: inputs = unemployed, vacancies; output = matches
- Reduced-form representation of search and matching process in reality
  - reduced-form like all production functions
  - Pissarides' key simplifying assumption
- Common assumption: Cobb-Douglas matching function

$$m = M(u, v) = \bar{\mu} v^{\eta} u^{1-\eta}, \quad 0 < \eta < 1 \qquad (*)$$

- Will make this assumption going forward
- Useful momentarily: can write $(*)$ as

$$m = \bar{\mu} \theta^{\eta - 1} v \quad \text{where} \quad \theta = \frac{v}{u} = \frac{v}{1 - n}$$

is "vacancy-unemployment ratio" or "labor market tightness"

Vacancy filling rate for individual firm

- Individual firm that considers posting vacancy needs to know "vacancy filling rate" = probability of filling given vacancy
- Claim: vacancy filling rate equals $m/v = \bar{\mu}\theta^{\eta-1}$
  - see supplement for explanation
- $\Rightarrow$ employment n of individual firm determined by

$$n = n_0 + \mu(\theta)v \quad \text{where} \quad \mu(\theta) = \bar{\mu}\theta^{\eta-1}$$

  and v = vacancies posted by this firm
- Note:
  - firms choose v taking θ as given
  - $\mu'(\theta) < 0$: higher $\theta \Rightarrow$ harder to recruit workers
  - reason why θ is called "labor market tightness"

Firms

- Production: $y = An$, i.e. labor is only factor of production
- Profits of a firm with existing workers n_0 are

$$\Pi = \max_{v} \; An - wn - \kappa v, \quad n = \mu(\theta)v + n_0$$

- Assumption: cost of posting vacancies κv paid to households (next slide)
- Optimality condition for vacancies v:

$$A = w + \frac{\kappa}{\mu(\theta)}$$

- Marginal product A = wage w + recruiting cost per new worker $\kappa/\mu(\theta)$
- Note: when recruiting is costless $\kappa = 0$ recover standard frictionless model $A = w$

Households

- Representative household with large number of members
  - fraction n are employed, fraction $u = 1 - n$ are unemployed
- Households do not get to choose how much they work
  - instead search for jobs, if matched: take job unless wage is too low
- Household utility is (note: no $\max_n$ and κv = income)

$$E(n) = U(c) - V(n) \quad \text{where} \quad c = wn + \kappa v + \Pi$$

- Marginal value of extra employed member $E'(n) = U'(c)w - V'(n)$
- Household members happy to employed whenever $E'(n) \geq 0$ or

$$w \geq \frac{V'(n)}{U'(c)}$$

- Intuition: $V'(n)/U'(c)$ = value of leisure, wage needs to exceed that

Wage determination

- If worker and firm match, need to decide what wage worker will be paid
  - assumption: they bargain over wage ("Nash bargaining" due to same John Nash as "Nash equilibrium")
  - for details, see supplement and Kurlat, chapter 7.5
- Outcome of Nash bargaining

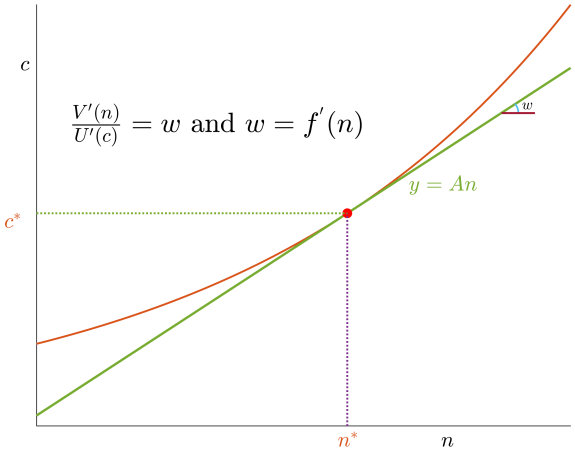
$$w = \phi A + (1 - \phi)\frac{V'(n)}{U'(c)}$$

where $0 \leq \phi \leq 1$ = worker's bargaining power

- Assumption: $U(c) - V(n) = \log c - \gamma n$

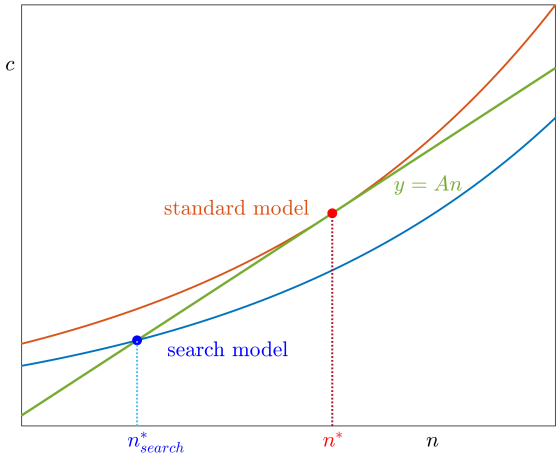
$$\Rightarrow \quad w = \phi A + (1 - \phi)\gamma c$$

Graphical representation of wage determination: standard model



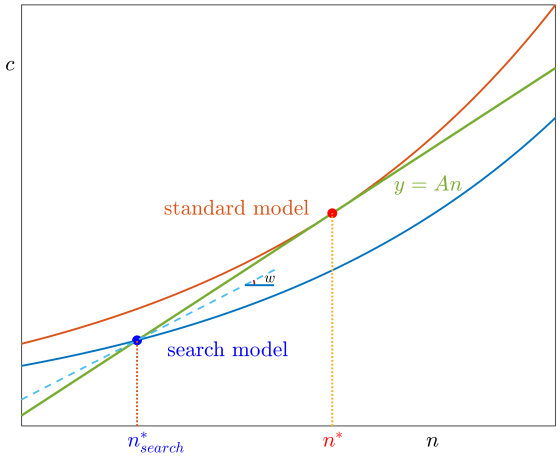
Graphical representation for standard model with linear production $f(n) = An$

Graphical representation of wage determination: search model



Search frictions ⇒ lower n and wedge between MPL & MRS, $A > V'(n)/U'(c)$

Graphical representation of wage determination: search model



Wage w is in between $V'(n)/U'(c)$ and A depending on bargaining power ϕ

Equilibrium in static Diamond-Mortensen-Pissarides model

Definition: An equilibrium are quantities (c, y, n, u, v, θ), and a wage w such that

1. Households: taking as given w, v, Π and the level of employment n, the representative household's utility is

$$E(n) = U(c) - V(n) \quad \text{s.t.} \quad c = wn + \kappa v + \Pi$$

2. Firms: taking as given w and θ, the representative firm chooses v, n to solve

$$\Pi = \max_{v} \; An - wn - \kappa v, \quad n = \mu(\theta)v + n_0$$

3. Goods market clearing:

$$c = An$$

4. Labor market with search frictions:
   - employment is $n = \mu(\theta)v + n_0$ where $\theta = v/u$ is labor market tightness
   - unemployment is $u = 1 - n$
   - the wage w is determined by Nash bargaining

$$w = \phi A + (1 - \phi)\frac{V'(n)}{U'(c)}, \quad 0 \leq \phi \leq 1$$

Characterizing the equilibrium

- Goal: characterize equilibrium, comparative statics
- Closed-form solution not feasible but can still characterize solution tightly
- Going forward, assume $U(c) - V(n) = \log c - \gamma n$
- Recall the following three equations:

$$\text{Optimality for } v\text{:} \quad A - w = \frac{\kappa}{\mu(\theta)}$$

$$\text{Wage determination:} \quad w = \phi A + (1 - \phi)\gamma c$$

$$\text{Employment:} \quad n = \mu(\theta)v + n_0$$

Characterizing the equilibrium

Using that $c = An$ and $v = \theta u = \theta(1 - n)$ we have

$$\text{Optimality for } v: \quad A - w = \frac{\kappa}{\mu(\theta)}$$

$$\text{Wage determination:} \quad w = \phi A + (1 - \phi)\gamma An$$

$$\text{Employment:} \quad n = \mu(\theta)\theta(1 - n) + n_0$$

These are three equations in three unknowns (w, n, θ)

Characterizing the equilibrium

- With some more algebra (see supplement), boil things down to one equation in one unknown n:

$$\underbrace{A - W(n)}_{\text{profit per filled vacancy}} = \frac{\kappa}{\underbrace{\mu(\Theta(n))}_{\text{recruiting cost}}} \qquad (*)$$

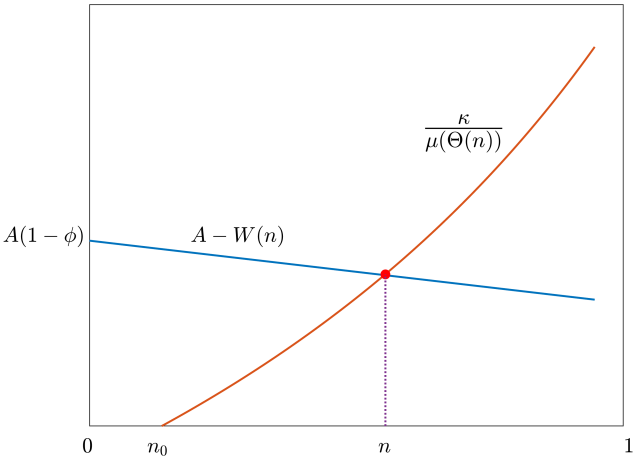
  where

$$W(n) = \phi A + (1 - \phi)\gamma A n$$

$$\Theta(n) = \left(\frac{n - n_0}{\bar{\mu}(1 - n)} \right)^{1/\eta}$$

- No closed-form solution for equilibrium n
- But can characterize solution graphically

Graphical representation of equilibrium condition $(*)$



Can show: exactly one intersection, i.e. equilibrium exists and is unique

Key feature of DMP model: actively looking for work but cannot find it

- Equilibrium wage exceeds value of leisure

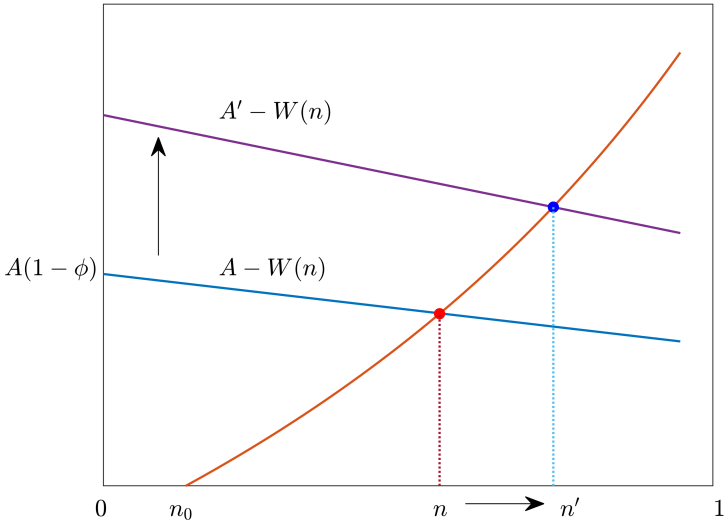
$$w > \frac{V'(n)}{U'(c)}$$

- $\Rightarrow$ households want to work more $E'(n) = U'(c)w - V'(n) > 0$
- But even though they are actively looking for more work, they cannot find it due to search frictions
- Typical survey question to measure unemployment:
  "Have you been actively looking for a job over the past four weeks?"
  - e.g. see `https://www.bls.gov/cps/cps_htgm.htm` for questions asked in U.S. Bureau of Labor Statistics (BLS) Current Population Survey (CPS)
- If ask this question to unemployed living in this model, they will say "yes"!

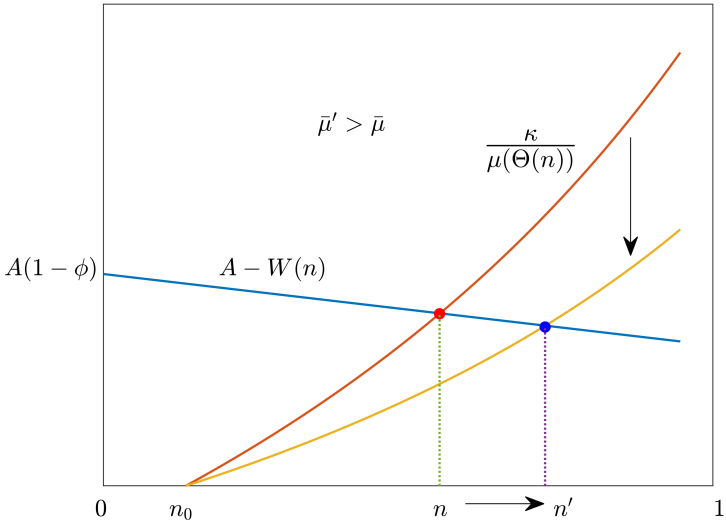
Comparative statics

- Having solved the model, let's do some comparative statics
- What happens to employment and unemployment when
  - productivity $A \uparrow$?
  - matching efficieny $\bar{\mu} \uparrow$ (recall $M(u, v) = \bar{\mu} v^{\eta} u^{1-\eta}$)?
  - vacancy posting cost $\kappa \uparrow$?
  - ...
- See graphical analysis on next slides as well as supplement

An increase in productivity *A* raises employment



An increase in matching efficiency $\bar{\mu}$ raises employment



Unemployment insurance (UI)

- See supplement
- Introduce unemployment benefits b so that household consumption is

$$c = wn + (1 - n)b$$

- Key results: UI
  - increases household consumption and welfare
  - but also increases equilibrium unemployment rate u
- Key mechanisms: UI increases workers' outside option

$$w = \phi A + (1 - \phi)\left(\frac{V'(n)}{U'(c)} + b\right)$$

Inequality in Macroeconomics

Do macroeconomists ignore heterogeneity and inequality?

- So far in this course: mostly representative agent models
  - only exception = models with two types of households (TANK etc)
- Seemingly consistent with popular criticisms of macroeconomics: "macroeconomists ignore heterogeneity and inequality"
- Example: excerpt from a 2017 newspaper article

> The preference for high theory and abstruse mathematical modeling meant that mainstream economics had come to rest on a number of gloriously improbable assumptions. In their models, millions of households were reduced to a single "representative agent," a God-like being, omniscient and immortal. This unreal creature inhabited a world where peace – or equilibrium – ruled. Crises were impossible in such an Eden, unless a mischievous serpent entered from abroad. But such an outcome was naturally impossible to predict.

Source: https://www.reuters.com/article/us-review-crisis-breakingviews-idUSKBN1811XP

Modern macro $\neq$ representative agent models

- Is all of moden macro just representative agent models?
- No, not all: macroeconomics research of the last 20 or 30 years is all about heterogeneity and inequality
  - "heterogeneous agent models"
  - if someone tells you otherwise, they simply don't know what they are talking about
- Two reasons for teaching you representative agent models
  1. they often capture key mechanisms in transparent fashion
  2. properly modeling heterogeneity is hard (PhD-level material)

Ricardo Reis (2018) on criticisms of macro

After summarizing current work by a number of young macroeconomists, Ricardo writes:

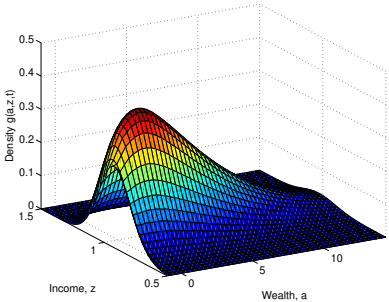
> In my reading, this is all exciting work, connected to relevant applied questions, and that takes data and models seriously. In contrast, in the caricatures of the state of macroeconomics, there are only models with representative agents, perfect foresight, no role or care for inequality, and a cavalier disregard for financial markets, mortgage contracts, housing, or banks. Supposedly, macroeconomic research ignores identification and does not take advantage of plentiful microeconomic data to test its models, which anyway are too divorced from reality to be useful for any real world question. Compare this caricature with the research that I just described: the contrast is striking. Not a single one of these bright young minds that are the future of macroeconomics writes the papers that the critics claim are what all of macroeconomic research is like today. Instead, what they actually do is to mix theory and evidence, time-series aggregate data and micro data, methodological innovations and applied policy questions, with no clear patterns of ideology driven by geography.

Point: there's plenty wrong with macroeconomics but please stop the lazy, off-target criticisms!

Source: https://personal.lse.ac.uk/reisr/papers/18-wrong.pdf

Why is modeling heterogeneity so hard?

- Mathematically need to carry around distributions of variables
- "Distribution" as in "density" or "cumulative distribution function (CDF)"



- Now: tell you a bit about this type of work
- End of slides: inequality in macro – a history of thought (not examinable)

Heterogeneous agent macroeconomics and HANK models

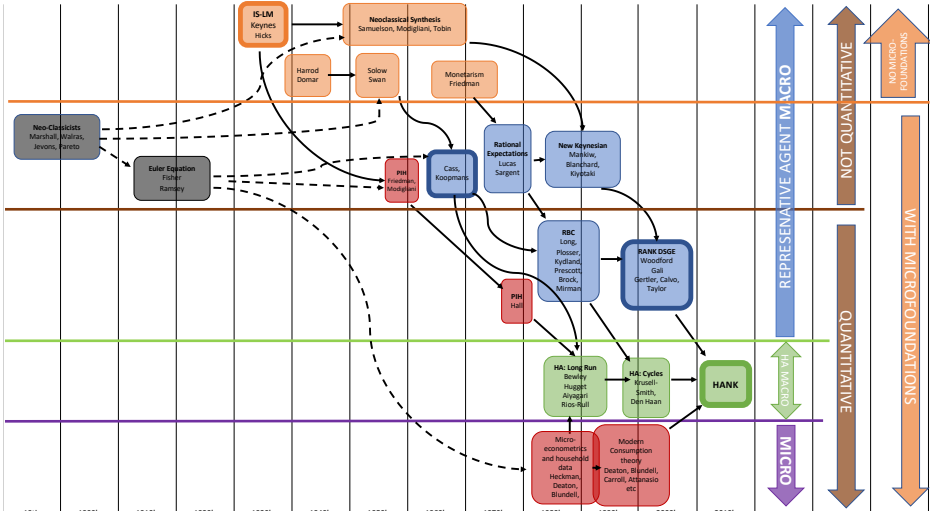
- Good overview in Chapter 18 “Heterogeneous agent macroeconomics: origins, progress & challenges” in Carlin and Soskice (2023) “Macroeconomics: Institutions, Instability & Inequality”

- As name suggests, Heterogeneous Agent New Keynesian (HANK) models = models with heterogeneity (HA) + nominal rigidities (NK)

- Four Lessons for monetary policy in Kaplan, Moll and Violante IMF Finance & Development magazine piece on HANK models
  https://www.imf.org/en/Publications/fandd/issues/2023/03/modern-monetary-policy-kaplan-moll-violante

- Note: this material is not examinable

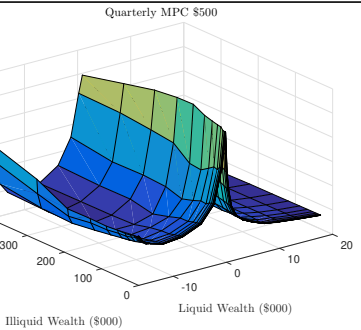
How does heterogeneous agent macro fit in with the rest of macro?



Source: Greg Kaplan's forthcoming book on heterogeneous agent macro

Note: timeline is incomplete (like all attempts to fit complex history into such narrative)

Recall from lecture 4: HANK models are NK models with large MPCs ⇒ model behaviour resembles Keynesian cross



- Interesting implication of empirically realistic MPCs: model behaviour resembles Keynesian cross again, in particular sizable multipliers
- But important difference: micro founded model, makes precise predictions about behavior as well as inequality, can use it to think about welfare

HANK models: four lessons for monetary policy

- **Lesson 1:** Predicting indirect policy impacts
  - High MPCs $\Rightarrow$ indirect effects $>>$ direct effects
- **Lesson 2:** Some ships are lifted higher, others are sunk
  - Traditional view of monetary policy: "a rising tide raises all ships." This is a fiction.
  - HANK models force us to let go of the fiction that we can cleanly separate stabilization from redistribution
- **Lesson 3:** Fiscal footprints matter
  - Another widespread misconception is the view that monetary policy can be divorced from fiscal policy
  - HANK models reestablish a strong link between the two, showing how monetary policy leaves consequential "fiscal footprints"
- **Lesson 4:** The right tool for redistribution
  - Monetary policy is a blunt tool for redistribution or insurance
  - HANK models tell us that fiscal policy is likely better suited for this task because it can be targeted more precisely to those in need of support

Thanks for 10 fun weeks!

Inequality in Macro: A History of Thought (not examinable)

I find it useful to categorize macroeconomic theories as follows:

- before modern macro: 1930 to 1970
- 1st generation modern macro: 1970 to 1990
- 2nd generation modern macro: 1990 to financial crisis
- 3rd generation modern macro: after the financial crisis

Main drivers of evolution in modern macro era

1. better data
2. better computers & algorithms
3. current events (rising inequality, financial crisis)

(Warning: narrative won't be perfect – will point out failures)

Before Modern Macro: 1930 to 1970

1. Keynesian IS/LM
   - about aggregates, no role for inequality/distribution by design
2. Distribution does play role in growth theory
   - mostly factor income distribution – capital vs labor
     Kaldor, Pasinetti, other Cambridge UK theorists
   - rarely personal income or wealth distribution
     exceptions: Tobin, Stiglitz, Blinder
3. Disconnected empirical work on inequality (Kuznets)

First Generation Macro Theories: 1970 to 1990

Representative agent models, e.g. RBC model

- again no role for inequality/distribution by design
- advertised as "microfounded" but rep agent assumption cuts 1st generation theories from much of micro research

What's wrong with that?

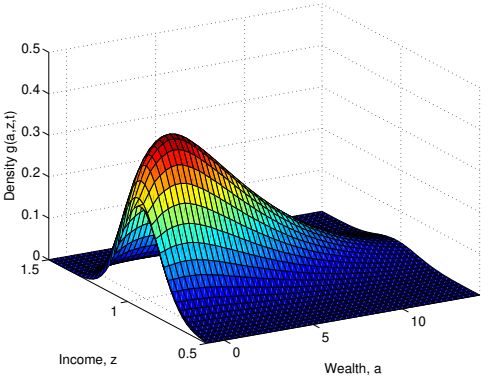
1. cannot speak to a number of important empirical facts, e.g.
    - unequally distributed growth
    - poorest hit hardest in recessions
2. cannot think coherently about welfare – "who gains, who loses?"

Second Generation Macro Theories: 1990 to 2008

Incorporate micro heterogeneity, particularly in income and wealth – early "heterogeneous agent models"

Aiyagari, Bewley, Huggett, Imrohoroğlu, Krusell-Smith, Den Haan,...

... represent economy with a distribution that moves over time, responding to macroeconomic shocks, policies



Second Generation Theories: Inequality $\not\Rightarrow$ Macro

- Typical finding: heterogeneity doesn't matter much for macro agg's
  Krusell-Smith (1998) "approximate aggregation"
- Reason: linearity – rich = scaled version of poor
  Hence "inequality $\not\Rightarrow$ macro", but also a knife-edge result
- Interestingly, some more nuanced, cautionary results in literature:
  - even in KS98, extension where heterogeneity does matter (§4)
  - but gets lost, economists' perception = "inequality $\not\Rightarrow$ macro"
- Either way: in data, rich $\neq$ scaled version of poor, e.g. rich have
  - e.g. lower MPCs out of transitory income changes
- Note: some important contributions from 90s don't fit my narrative
  - Banerjee-Newman, Benabou, Galor-Zeira, Persson-Tabellini, ...

Third Generation Theories: after the Crisis

- 3rd generation theories take micro data more seriously
- Leads them to emphasize things like
  - household balance sheets
  - credit constraints
  - MPCs that are high on average but heterogeneous
  - non-homotheticities, non-convexities

  $\Rightarrow$ move away from knife-edge case
- Typical finding: distribution matters for macro
- Momentarily: an application from my own work (HANK)

Distribution in Macro: Summary

- Before modern macro: 1930 to 1970
  - it's complicated
- 1st generation: 1970 to 1990
  - representative agent models (RBC, New Keynesian etc)
  - no role for inequality by design
- 2nd generation: 1990 to financial crisis
  - early heterogeneous agent models
  - "macro $\Rightarrow$ inequality" but "macro $\not\Leftarrow$ inequality" (perception)
- 3rd generation: after the financial crisis
  - current heterogeneous agent models
  - rich interaction: "inequality $\Longleftrightarrow$ macro"

Distribution in Modern Macro: Summary

Janet Yellen speech "Macroeconomic Research After the Crisis"

http://www.federalreserve.gov/newsevents/speech/yellen20161014a.htm

- "Prior to the financial crisis, representative-agent models were the dominant paradigm for analyzing many macroeconomic questions [= 1st generation]."
- "However, a disaggregated approach seems needed to understand some key aspects of the Great Recession..."
- "While the economics profession has long been aware that these issues matter, their effects had been incorporated into macro models only to a very limited extent prior to the financial crisis [= 2nd generation]."
- "I am glad to now see a greater emphasis on the possible macroeconomic consequences of heterogeneity [= 3rd generation]."