Johannes-Gutenberg University Mainz
Bachelor of Science in Wirtschaftswissenschaften

Macroeconomics II: Behavioural Macro

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Klaus Wälde (lecture) and Jean Roch Donsimoni (tutorials)

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Part IV
Wealth distributions and redistribution

14 Origins of wealth distributions

14.1 Some facts

- See a video on the wealth distribution in the USA
- See the evolution of the wealth distribution of a cohort in the USA
  - National Longitudinal Survey of Youth (born between 1957-64)
  - Cohort originally included 12,686 respondents ages 14-22 when first interviewed in 1979
  - https://www.nlsinfo.org/content/cohorts/nlsy79

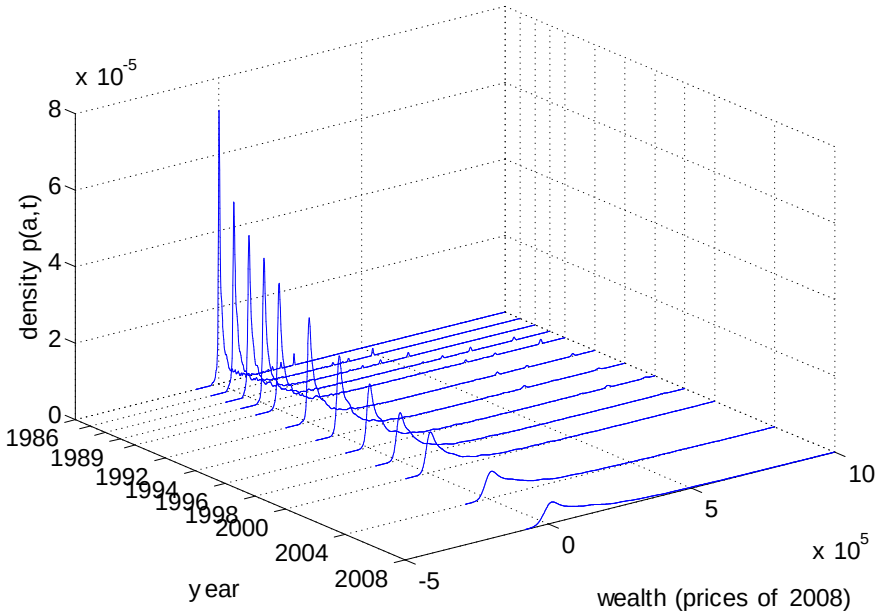

Figure 28 *Empirical wealth distribution of the 1979 cohort in the NLSY from 1986 to 2008*

14.2 Determinants of wealth distributions

Questions and (some) answers

- How can we understand wealth distributions theoretically and empirically?
- What are *theoretical mechanisms* that allow us to understand that some have more wealth than others?
  - born rich (inheritance)?
  - saved a lot over time (preference)?
  - high labour income (intelligent and income-oriented)?
  - luck on the labour market (always had good paying jobs, never lost the job)?
  - wealthy because old (life-cycle considerations)?
- Can we construct economic models that explain wealth distributions (and their dynamics) in a *quantitatively satisfactory* way?

15 A simple model

15.1 The setup

- The idea (see Bossmann, Kleiber and Wälde, 2007)
  - Individuals live in a 2-period OLG general equilibrium world
  - The economy evolves in a deterministic way at the aggregate level (as in 'Makro I')
  - There are no aggregate shocks (*no* TFP shocks as in section 13.1.3)
  - Two novel features
    - Idiosyncratic shocks: Labour income is uncertain (ability when born and skills when entering the labour market are random)
    - Bequests: Individuals inherit wealth when born and leave bequests

- The formal structure for an individual i
  - First-period budget constraint

$$w_t l_{it} + b_{it} + g_t = c_{it}^y + s_{it} \tag{51}$$

    * b_{it} denotes after tax inheritance received from the parent
    * $w_t l_{it}$ stochastic income depending on (deterministic)
    * wage w_t per efficiency unit and the
    * random ability of the individual l_{it}
    * g_t is the uniform lump-sum transfer received from the government in case that it levies a tax on bequests
    * s_{it} savings
  - The distribution for individual ability

$$E(l_{it}) = \bar{l} \equiv 1, \quad \text{var}(l_{it}) = \sigma^2, \quad \text{cov}(l_{ir}, l_{is}) = 0 \text{ for } r \neq s. \tag{52}$$

    * l_{it} are identically and independently distributed (iid)
    * Hence, mean and variance are the same for all t (identically distributed) and ...
    * Covariance is zero (independently distributed)
    * Without loss of generality, we set $\bar{l} = 1$

– Second-period constraint

$$s_{it}\left[1+r_{t+1}\right]=c_{it+1}^{o}+\left(1+\tau\right)b_{it+1}, \tag{53}$$

  * r_{t+1} is the second period certain (!) interest rate
  * c_{it+1}^{o} is second period consumption
  * τ is the proportional tax rate on
  * bequests b_{it+1}

– Preferences

  * Individuals enjoy consumption and bequests ("warm-glow" motive)

$$U_{it}=U\left(c_{it}^{y},c_{it+1}^{o},b_{it+1}\right) \tag{54}$$

  * They choose consumption c_{it}^{y} when young, c_{it+1}^{o} when old, and the bequest b_{it+1} passed on to the child
  * Utility depends on the amount b_{it+1} the child receives after tax
  * Joy-of-giving idea: "consumers leave bequests simply because they obtain utility directly from the bequest"
  * Next generation also has index i such that i is the "name" of a family/ dynasty

15.2 Equilibrium

- Optimal behaviour
  - After some (not complicated but time-consuming) steps,
  - employing a Cobb-Douglas utility function

$$U_{it} = \alpha \ln c_{it}^{y} + (1-\alpha)\left[\beta \ln c_{it+1}^{o} + (1-\beta)\ln b_{it+1}\right]$$

  - and defining wealth as $a_{it+1} \equiv s_{it}$, we get

$$a_{it+1} = (1-\alpha)w_t l_{it} + \frac{(1-\alpha)(1-\beta)(1+r_t)}{1+\tau} a_{it} + \frac{\tau(1-\alpha)(1-\beta)(1+r_t)}{1+\tau} k_t \quad (55)$$

    which shows that wealth of dynasty i in period $t+1$ depends on
    - wealth a_{it} of previous generation (via bequests b_{it})
    - aggregate capital stock k_t per worker (via government transfers g_t) and
    - individual skills l_{it} (via labour income)

- Macroeconomic equilibrium and microeconomic dynamics
  - Employ a simplifying assumption which is common to very many macroeconomic models
  - At the aggregate level, the economy is in a steady state, i.e.

$$k_t = \bar{k},\ r_t = \bar{r},\ w_t = \bar{w} \tag{56}$$

    are constant over time
  - At the microeconomic level, there is still idiosyncratic risk via ability l_{it} of individual/ dynasty i
  - Some family i becomes richer over time, some family becomes poorer, some remain at more or less the same level

- The evolution of wealth
  - Fundamental wealth equation for family i

$$a_{it+1} = c_3 l_{it} + c_4 a_{it} + c_5 \tag{57}$$

  - c_3 to c_5 are abbreviations for parameters and constant variables (w, r, k) as shown in (55)
  - (c_1 and c_2 were used earlier in paper)
  - This is the reduced form of the model – no further simplification possible

15.3 The distribution of wealth

- What does this model tell us about the evolution of wealth of one family i?
  - Not very much
  - As individual skills are uncertain, so is individual wealth
  - wealth evolves over time, it can rise, it can fall, almost anything can happen
  - Model makes hardly any prediction about the *realization* of wealth at some future point in time t
  - But we do know something about the *probability* that wealth is within a certain range – and we can compute *expected* wealth
- Simple but powerful principle
  - A very simple example which has the same properties: playing dice (Würfel)
  - Before someone throws one die, one cannot say a lot about the *realization* (apart from numbers between 1 and 6)
  - But one can say something about the *probability* to throw between 3 and 5, or to throw 1 (or other)
  - This is the case with all models containing some source of uncertainty – they make predictions about probabilities or - more generally - distributional properties

- What does this model tell us about inequality?
  - This depends on how we define inequality
  - Various measures are available: variance, standard deviation, coefficient of variation, wealth held by richest x%, ratios of percentiles and so on
  - We start with a simple measure: variance
  - [The coefficient of variation (standard deviation divided by the mean) would have the advantage of being scale-independent]

- From individual probabilities to cross-sectional distributions
  - So far, we only discussed, for some future point in time t,
    - probability of an individual to have wealth within a certain range
    - expected wealth of a person
    - variance of wealth of a person
  - We also want to know what the expected wealth level is for a *group* of people
  - Imagine we look at many individuals that all start with the same initial wealth level $a_{i0} = a_{\text{low}}$ (we look at "the poor") or $a_{i0} = a^{\text{high}}$ (we look at "the rich")
  - Employing a law of large numbers, one can show that
    - the *probability of an individual* to have wealth within a certain range also gives the *share of individuals of this group* within this certain range
    - *expected wealth of a person* also gives *average wealth of this group*
    - *variance of wealth of a person* also gives *variance of wealth of this group*
    - we obtain a distribution of wealth for a cross-section of individuals for any point in time
  - To illustrate, think about playing dice

15.4 The mean and variance of the wealth distribution

- Let us now compute the variance and coefficient of variation (for which we need the mean) for the wealth distribution for one dynasty i
- We compute the wealth level a_{it} of an individual i at $t > 0$ by solving the difference equation (57)
- We obtain (Wälde, 2012, ch. 2.5.3) wealth a_{it} as a function of parameters, time t, the initial wealth level a_{i0} and luck, i.e. the realization of skills l_{is} for family i at each point in time between 0 and $t-1$,

$$a_{it} = c_5 \Sigma_{s=0}^{t-1} c_4^s + c_4^t a_{i0} + c_3 \Sigma_{s=0}^{t-1} c_4^{t-1-s} l_{is} \tag{58}$$

- What does this tell us?
  - If we knew l_{is} already in 0, we could perfectly predict (no uncertainty) what the wealth level a_{it} is in t
  - As we do not know the l_{is}, a_{it} is unknown
  - Initial wealth a_{i0} matters and c_4 is a measure of social mobility: the lower c_4, the less social background ("wealth of parents") matters (see Charles and Hurst, 2003)
  - Apart from a_{i0}, why are some people rich and some are poor? The rich were lucky, the poor were not: a_{it} is basically the sum of past luck l_{is}

- Is there "equality of chances"?
  - Same equation as (58) above

$$a_{it} = c_5 \Sigma_{s=0}^{t-1} c_4^s + c_4^t a_{i0} + c_3 \Sigma_{s=0}^{t-1} c_4^{t-1-s} l_{is} \tag{59}$$

  - If uncertain skills l_{is} come from the same distribution for all individuals, there is an "equality of chances" in this economy
  - If social background also affects luck, there is no equality of chances
  - Examples for absence of equality of chances
    - the share of students at university coming from parents with a university degree is larger than the share of parents with a university degree in society
    - the share of ethnic group A in government is larger than the share of this group in society

- Computing the mean
  - Define expected wealth as $\mu_{it} = E_0 a_{it}$ (compare the definition in (50))
  - In words, μ_{it} is the expected wealth of dynasty i for some future point in time t when we form expectations at 0
  - Apply this to (58) and get

$$\mu_{it} = c_5 \Sigma_{s=0}^{t-1} c_4^s + c_4^t a_{i0} + c_3 \Sigma_{s=0}^{t-1} c_4^{t-1-s}$$

    where we use $E(l_{it}) = \bar{l} \equiv 1$ from (52)
  - Why does the expected wealth level still depend on the dynasty, i.e. why is there an index i in μ_{it}? Because of initial wealth a_{i0} of dynasty i
  - After some steps (see web appendix of the paper - which is not part of the contents of this lecture), we get a very intuitive result

$$\mu_{it} = \left(a_{i_0} - \bar{k}\right) c_4^t + \bar{k}$$

  - Expected wealth in t depends on initial wealth a_{i_0}, wealth per capita, $\bar{k}$, in the economy and the social mobility paramter c_4

- In the presence of equality of chances
  - "family background" does not matter, $E(l_{it}) = \bar{l} \equiv 1$
  - wealth regresses to the mean $\bar{k}$ from (56)
  - initial wealth matters from generation to generation, but not in the long run
- This is a relatively "optimistic model" with respect to inequality
  - Race, gender, country of origin, family background do not play a role
  - Hard to believe?
  - Empirically hard to support?

- Computing the variance
  - We are interested in the variance of wealth a_{it} as given in (59)

$$a_{it} = c_5 \Sigma_{s=0}^{t-1} c_4^s + c_4^t a_{i0} + c_3 \Sigma_{s=0}^{t-1} c_4^{t-1-s} l_{is}$$

  - Note that we can look at a_{it} as a standard random variable
    - It is true that a_{it} changes from one point in time to the next
    - When we are interested in the variance (or any other moment), we hold time t fixed and use standard rules for standard random variables
  - We therefore need to understand the variance of a sum of parameters and random variables

- Computing the variance (cont'd)
  - Starting from (59)

$$a_{it} = c_5 \Sigma_{s=0}^{t-1} c_4^s + c_4^t a_{i0} + c_3 \Sigma_{s=0}^{t-1} c_4^{t-1-s} l_{is},$$

    we get (using knowledge from Statistik I and II)

$$\begin{aligned} \text{var}\left(a_{it}\right) &= \text{var}\left(c_5 \Sigma_{s=0}^{t-1} c_4^s + c_4^t a_{i0} + c_3 \Sigma_{s=0}^{t-1} c_4^{t-1-s} l_{is}\right) \\ &= 0 + 0 + c_3 \text{var}\left(\Sigma_{s=0}^{t-1} c_4^{t-1-s} l_{is}\right) \\ &= c_3 \Sigma_{s=0}^{t-1} \left(c_4^{t-1-s}\right)^2 \text{var}\left(l_{is}\right) \end{aligned}$$

    where the second equality employed that the variance of a constant is zero and the second equality used (52), especially the covariance of zero
  - Using (52) further and Wälde (2012, ch. 2.5.1), we find

$$\text{var}\left(a_{it}\right) = c_3 \sigma^2 \Sigma_{s=0}^{t-1} \left(c_4^{t-1-s}\right)^2 = c_3 \sigma^2 \frac{1 - c_4^{2t}}{1 - c_4^2}$$

    which tells us that the variance increases over time (but approaches a constant)

15.5 What do we learn from this?

- Imagine we have a real world distribution (reminder)

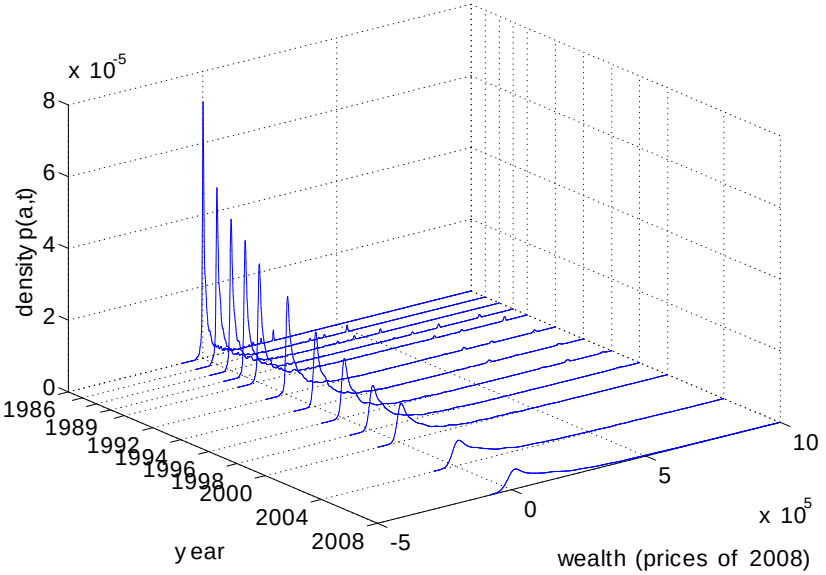

Figure 29 *Empirical wealth distribution of the 1979 cohort in the NLSY (1986 to 2008)*

- We can then ask the following question
  - Can we understand this increase in inequality to be consistent with 'equality of chances'?
  - [Let us imagine we consider 'equality of chances' to be important – think of "all men are created equal" or "All human beings are born free and equal in dignity and rights"]
  - More precisely speaking: if each generation has iid ability l_{it}
    - (a) can we replicate this empirical evolution of wealth in our model?
    - (b) can we do so with realistic parameter values?
  - If not, what is the source of large inequality and why is 'equality of chances' being violated?
- We can ask further questions
  - What would happen to the wealth distribution if we had a social security system or if we had a (progressive) tax system? Would the wealth distribution become more equal?
  - Is there a trade-off between average wealth (imagine society wants to become richer) and inequality? (Think about the Kuznets curve in economic development.)
  - ... and much more ...

16 Conclusion

- Basic questions
  - Why are some people rich and some people poor? Why do some people even die with debt, i.e. with negative wealth?
  - What is the role of personality, family background, social background, education and work life?
  - Which role does the tax and redistribution system play?
- Framework of analysis
  - We got to know a simple but powerful analytical framework that allows to think about these questions
  - With its two-period structure, it allows for many analytical findings
  - It seems a useful framework to answer questions *in principle*
  - For a *careful explanation of data*, a many-period structure (probably with life-cycle features) would be more promising

- Real world relevance?
  - Hard to deny
  - Think about discussions about rising inequality of all sorts in many OECD and G7 countries
  - Think about the outcome of (pre-) elections and a referendum in the US and the UK
  - For more background and a starting point, see OECD (2015, 2008) or Wälde (2016)

Part V
Summary

17 General idea of the lecture

- This was a lecture on behavioural macroeconomics
- The lecture had the following structure
  - Emotional economics
  - Behavioural economics
  - How behavioural macroeconomics could look like
  - Wealth distributions and redistribution

- Structure was chosen as the field of behavioural macro is developing
  - We first look at behavioural foundations
  - Then we look at macroeconomic models (unemployment, growth, business cycles) and discuss their extension to allow for behaviour features
  - Wealth distribution chapter is pure macro (so far) – empirical economists (Dynan, Skinner and Zeldes, 2004) argue that behavioural features are required
- Good example of "research-based teaching", a concept favoured by JGU

18 Big messages

- What are the messages that should survive from this lecture?
  - Every detail of the course for the rest of everybody's life ;-)
  - Strong belief that psychological research is extremely useful for understanding economic questions
  - Strong(er) belief that economic methods are even more useful to further develop psychological thinking
  - Example of interdisciplinary research where every discipline learns something from the other discipline
- The most striking insight from emotional and behavioural economics
  - Models of time inconsistency
  - Individuals make plans – and they do not stick to them
  - This is because individuals keep being surprised by their changes in preferences (the present-bias parameter β)

- What is THE issue in macroeconomics?
  - Inequality in GDP per capita and in its average growth rates over decades around the world
  - Yes, there is inequality in wealth distributions within a country
  - Yes, there is unemployment
  - But none of this is as strong as inequality in GDP per capita

- Do we need economics to solve these problems?
  - Yes and no – where the no is stronger
  - Yes as we need methods to meaningfully run a country, to manage a market economy, to internalize externalities, to control competition by reducing market power of firms that are too large
  - But – in most cases – reasonable methods are known
  - So: no, we need rethinking of human beings
  - We need more sharing, more compassion, more thinking in terms of groups than thinking in individual terms – so keep in mind $u = u\left(c^{\text{me}}, c^{\text{the others}}\right)$
  - How this works: Know Thyself

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