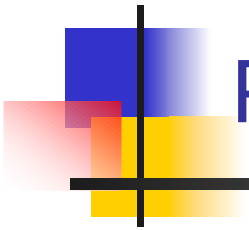

Research horizons

Lecture 10 of a course on Schumpeterian Economics at the
Graduate School of Economics, Kyoto University
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Retrospect and prospect

- Prospect (looking forwards)
  - Develop an agenda for our modern research on economic evolution
- Retrospect (looking backwards)
  - Learn from the immediate past
    - The emergence of evolutionary-economic modelling with formal models, simulation, evometrics, history-friendly models, …
  - Learn from the distant past
    - Exploit Schumpeter's rich but verbal evolutionary economics with modern tools
    - Use the results to exploit the ideas of others, like Marshall, Menger, Marx, …

Slogans for evolutionary economics

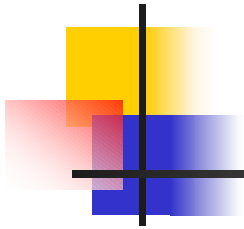
- Economic evolution is a unique process in historical time!
- Dynamics first!
- Theories should be explicitly micro-founded!
- Use bounded rationality in a radical sense!
- Use heterogeneity of agents and population thinking!
  - No "types" or "representative agents"
- Recognise persistent appearance of novelty!
- Make firms nested in environments of collective interaction!
- Study aggregate regularities as emergent properties of out-of-equilibrium interactions!
  - A preference for bottom-up modelling
  - But feed-back from the macro level
- Include nano-evolution, micro-evolution and macro-evolution!

History, statistics and theory –
according to Schumpeter in Kobe, February 1931

- The problem:
  - "In our science … the data [i.e. parameters] themselves are changed and the thing to be measured changes."
- The new tools:
  - "We only see the first steps, but future generations will have to try their best, perhaps by a different mathematics to those evolved in physical science, where time series plays so small a part. Our case is different; we want a different mathematical technique and it is possible for us at present to see here and there the beginning of it."
- The prophecy
  - "There is a dropping of the barriers between history and statistics and theory. They are melting into one."

Elements of scientific work

- Marshall in *Principles* (1890/1920):
  - "The economist needs the three great intellectual facilities, perception, imagination and reason : and most of all he needs imagination" (Marshall, 1920)
- Thus we need
  - (1) data
  - (2) **vision**
  - (3) analysis
- Fables are often sketches of visions
  - Mandeville's **Fable of the Bees** started the classical study of self-organising market forces
  - Marshall had a "**fable of the trees**" for evolutionary analysis



Evolutionary vision and tools

- **Sketching the evolutionary vision**
  - Marshall used his **fable of the trees of a virgin forest** as a *pointer to* a huge set of evolutionary problems
  - An **extended version of the fable** gives intuitive meaning to the different forms evolutionary population analysis
- **Finding the tools**
  - Marshall lacked analytical tools for implementing population thinking (he tried in vain to find them!)
  - We have today many of the necessary tools!
  - The tools deal with the statistical analysis of evolutionary change
  - Here we need the help of theoretical biologists

Marshall's basic fable of the trees

- **Selection**
  - "[W]e may read a lesson from the young trees of the forest as they struggle upwards through the benumbing shade of their older rivals. Many succumb on the way, and a few only survive;"
- **Monopolistic dominance?**
  - "those few become stronger with every year, they get a larger share of light and air with every increase of their height, and at last in their turn they tower above their neighbours, and seem as though they would grow on for ever, and for ever become stronger as they grow."
- **Countervailing forces**
  - "But they do not. One tree will last longer in full vigour and attain a greater size than another; but sooner or later age tells on them all. Though the taller ones have a better access to light and air than their rivals, they gradually lose vitality; and one after another they give place to others, which, though of less material strength, have on their side the vigour of youth." (Marshall, 1920)

The fable and the representative firm

- Marshall used the representative firm as a placeholder for the evolutionary process!
- Naive assumptions of others
  - "Of course we might assume that in our stationary state every business remained always of the same size, and with the same trade connection.
- Realistic assumptions
  - But we need not go so far as that; it will suffice to suppose that firms rise and fall, but that the 'representative' firm remains always of about the same size, as does the representative tree of a virgin forest, and that therefore the economies resulting from its own resources are constant[.]"

Marshall's population thinking

- The central fable of the trees (i.e. firms):
  - Selection takes place among the young trees
  - Surviving trees undergo a life cycle with respect to productivity
  - New variance is introduced by new young trees
- The many uses of the fable
  - Explain why a single tree is not a monopoly – by its life cycle or by new innovations
  - Open up for broader evolutionary analyses (e.g. of industrial districts)
  - Study the strength and weaknesses of neoclassical equilibrium analysis

Critique of Marshall's analysis

- Automatic economies of scale
  - This assumption does not emphasise the idiosyncrasies of firm behaviour that Marshall used to uphold variance
  - Introduction of Schumpeterian innovators helps to avoid this problem
- Firm life cycle
  - This assumption is related to owner-managed firms
  - Better to introduce e.g. the lock-in of firms to initial routines
- The stationary "representative firm"
  - Marshall himself emphasises that mean behaviour evolves!
- Partial equilibrium analysis
  - This emphasis postpones the study of coevolution

Short and long run evolutionary analysis

- Short run: Given population data for two periods, find the evolutionary transformation
  - Environmental effects are parameters

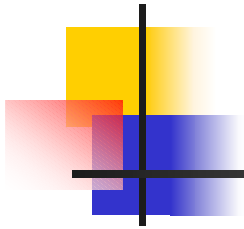
$$(\boldsymbol{P};\boldsymbol{E}) \xrightarrow{T} (\boldsymbol{P}';\boldsymbol{E})$$

- Very long run: Everything changes
  - We have endogenous and exogeneous environment change
  - Change in the transformation mechanism
  - Analytically hopeless
  - But slowly changing variables can be treated as parameters

$$(\boldsymbol{P},\boldsymbol{E};\mathrm{E}) \xrightarrow{T} (\boldsymbol{P}',\boldsymbol{E}';\mathrm{E}') \xrightarrow{T'} (\boldsymbol{P}'',\boldsymbol{E}'';\mathrm{E}'') \xrightarrow{T''} \ldots$$

Broadening Marshall's fable of the trees

- The simple forest
  - Intra-population thinking which includes the monopoly problem – Price's equation
- The clustered forest
  - Multi-level-population thinking – Price on groups
- The diversified forest
  - Inter-population thinking about the coevolution of different populations – Lotka-Volterra
- The diversifying forest
  - Intra-to-inter-population thinking of the emergence of new populations in competition with old ones – emerging multisectoral *AL* model



Price's definitions of evolutionary change

- **Total evolutionary change** with respect to a particular characteristic of a population is the change in the **mean** of the individual values of that characteristic
- **Selection effect** is the **covariance** between the relative reproduction coefficients and the values of that characteristic
- **Innovation effect** is the **mean** of the product of the change of the values of that characteristic and the relative reproduction coefficients
- **Total change ≡ Selection + Innovation**

Rethinking Marshall's simple forest

- The selection effect is simple
- The innovation effect ($\mathbf{E}(w_i \Delta z_i)$) is very complex
  - Automatic increasing returns to scale
    - The reproduction coefficient is related to innovation effect!
    - Non-evolutionary
  - Decreasing returns to firm age after a point
    - Also a non-evolutionary and automatic effect
  - Firm-specific events create variance – evolutionary effect
    - E.g. due to non-automatic learning
  - Innovation creates variance – evolutionary effect
    - But Marshall thinks it is too complex to analyse!

Modern productivity analysis

$$\Delta z = \sum \Delta s_i (z_i - z) + \sum s_i \Delta z_i + \sum \Delta s_i \Delta z_i$$
$$= \sum \Delta s_i z_i + \sum s_i' \Delta z_i$$
$$= \mathbf{Cov}(f_i, z_i) + \mathbf{E}(f_i \Delta z_i)$$

$$\Delta z = \underbrace{\sum \Delta s_I (z_I - z)}_{\text{selection}} + \underbrace{\sum s_I \Delta z_I + \sum \Delta s_I \Delta z_I}_{\text{innovation}}$$
$$+ \underbrace{\sum s_J (z_J' - z)}_{\text{entry}} - \underbrace{\sum s_K (z_K - z)}_{\text{exit}}$$

Bartelsman and Doms (2000), *Journal of Economic Literature*, **38**: 569–594.

The diversified forest: Inter-population analysis

- Removing the implicit *ceteris paribus* clause of intra-population thinking
  - Coevolution of industries
  - Simplest with two industries
  - Use the tools of evolutionary ecology
- Evolutionising the use of the logistic equation and the Lotka-Volterra equations
  - Basic expansion coefficient of population is ***r***
  - Intrinsic carrying capacity is ***K***

Equations of density-dependent change

Simple population dynamics

$$\frac{\mathrm{d}\,x_i}{\mathrm{d}\,t} = r_i x_i - b_i x_i x_i = r_i x_i \left(1 - \frac{x_i}{K_i}\right)$$

Simple multi-population dynamics

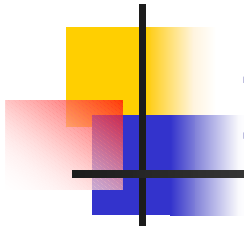
$$\frac{\mathrm{d}\,x_i}{\mathrm{d}\,t} = r_i x_i - b_i x_i x = r_i x_i \left(1 - \frac{x}{K_i}\right)$$

Complex two-population dynamics

$$\frac{\mathrm{d}\,x_1}{\mathrm{d}\,t} = r_1 x_1 \left(1 - \frac{\alpha_{11} x_1 + \alpha_{12} x_2}{K_1}\right); \quad \frac{\mathrm{d}\,x_2}{\mathrm{d}\,t} = r_2 x_2 \left(1 - \frac{\alpha_{22} x_2 + \alpha_{21} x_1}{K_2}\right)$$

Problem: No evolution in density-dependent change

- Ecology as the last stronghold of typological thinking
- The emergence of evolutionary ecology
  - MacArthur and Wilson's studies
  - Evolution is seen as change in the parameters
  - Two basic ecological situations
    - Non-crowded (far from *K*) and crowded (near *K*)
- Core concepts
  - *r*-selection for pioneering/entrepreneurial situations
  - *K*-selection for crowded situations
- Example: evolution in/of the Wild West of the USA
  - The moving Frontier area!



Intra-to-inter-population thinking

- The emergence of **new populations**
  - Basic mechanism: partitioning of **resources**
  - Some members of the old population specialises in a **niche**
  - Other members focus on **residual resources**
- Critique of endogenous growth theory
  - Paul Romer (JME, 1993) wants to supply clear models to sloppy evolutionary researchers, but …
  - New growth theory has no population thinking
  - Their new sectors consists of a single firm
  - No interesting inheritance from old sectors

Studying macroevolution?

- Marshall emphasised gradualistic microevolution
  - Related to his partial analysis!
- Schumpeter's dramatic vision of capitalist evolution is still beyond our analytical toolbox
- But catastrophic events are part of both biological and economic evolution!
- Start with an evolutionary analysis of long-term business cycles

Schumpeter in 1949

- The problem with econometricians:
  - "[N]obody seems to understand or even to care precisely how industries and individual firms raise and fall and how their raise and fall affects the aggregates"
- The provocation:
  - "To let the murder out and to start my final thesis, what is really required is a large collection of industrial and locational monographs all drawn up according to the same plan and giving proper attention on the one hand to the incessant change in production and consumption functions and on the other hand to the quality and behavior of the leading personnel."

Schumpeter as a Dr Jekyl and Mr Hyde?

- No, he had not given up "econometrics"
- He wanted to emphasise stylised facts for the modellers through historical studies
- He lacked tools for combining microscopic facts of economic evolution with aggregate change
  - Instead he, in vain, tried to combine the study of macrocycles with historical micro accounts
- A very powerful tool developed by Fisher and Price
  - This tool is a **general evometrics** that can be specialised into an **economic evometrics**

Joseph Schumpeter and George Price

- Business cycles
  - Upswing: innovation effect dominates and increases variance
  - Downswing: selection effect dominates and decreases variance
  - Innovation theory: Low variance makes innovation easier
- Creative destruction
  - Total evolutionary change ≡ Positive selection effect + Negative selection effect + Innovation effect
  - The negative selection effect is a problematic part of evolution
  - In Schumpeter Mark II innovation is used to avoid destruction
  - Evolution of capitalism means that the selection effect decreases while the innovation effect explains most change

Next session

- Session 1: Introduction
- A. Post-Schumpeterian evolutionary modelling
  - Sessions 2-5
- B. Schumpeter's theories in retrospect
  - Sessions 6-9
- **C. Research horizons**
  - Session 10: Andersen's contribution
  - **Session 11: Students' contributions**
    - **5 minutes presentations + short discussions**