The Evolving Fable of the Trees

Population Thinking and Evolutionary Economic Analysis

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Evolutionary visions and tools

- Marshall (1920): ‘The economist needs the three great intellectual facilities, perception, imagination and reason: and most of all he needs imagination’
- Marshall used his fable of the trees of a virgin forest as a pointer to a huge set of evolutionary problems
- The fable gives an intuitive meaning to evolutionary populating thinking and emphasises its different forms
- Marshall lacked analytical tools for implementing population thinking
- We have today many of the necessary tools!
Basic population thinking

- What evolves in economic evolution?
  - The *average* characteristics of a population of economic agents!

- How does evolution take place?
  - By *selection* among agents with different characteristics!
  - By emergence of *new* characteristics of agents!

- Conclusions?
  - Study statistics – not representative agents!
  - Selection destroys variance, so innovation is crucial for long-term evolution!
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)
  - But Marshall lacks analytical tools!
The statistics of evolution

Task: study the evolution of an average characteristic
- Fisher’s theorem of selection (1930)
  - Population variance determines speed of evolution
- Price’s equation (1972) to decompose evolution
  - Total evolutionary change = Selection effect + Innovation effect
  - Selection effect = Variance × selection efficiency
  - Innovation effect = Expected effect of individual innovations

Metcalfe (2002): ‘For some years now evolutionary economists have been using the Price equation without realising it.’
A simple example

- Basic information for two points of time
  - Initial capacity share of each firm $s_i$
  - Expansion coefficient of each firm—‘absolute fitness’—$\rho_i$
  - Productivity of each firm and its change ($A_i$, $\Delta A_i$)

- Simple statistics
  - Average expansion coefficient $\overline{\rho}$
  - Change of average productivity $\Delta \overline{A}$
  - Variance of productivities $\text{Var}(A)$
  - Covariance of expansion coefficients and productivities $\text{Cov}(r, A)$
Price’s equation for the example

Decomposition of productivity change:

Total change = Selection effect + Innovation effect

Formally:

\[ \Delta \overline{A} = \frac{\text{Cov}(\rho, A)}{\overline{\rho}} + \frac{\text{E}(\rho \Delta A)}{\overline{\rho}} \]

where

\[ \text{Cov}(\rho, A) = \beta_{\rho A} \text{Var}(A) \]

\[ \text{E}(\rho \Delta A) = \sum s_i \rho_i \Delta A_i \]
Expanding the area of analysis

- The simple forest: Intra-population thinking à la Price
- The clustered forest: Multi-level-population thinking
- The diversified forest: Inter-population thinking
- The diversifying forest: Intra-to-inter-population thinking
Multi-level-population thinking

- Marshall’s industrial districts are local populations
  - Both a national and a local selection environment
  - Locally there are inter-firm economies and a related fitness function
  - This can be studied by expanding Price’s equation

- Total change =
  National selection + Local selection + Innovation

- Formally:
  \[
  \rho \Delta A = \text{Cov}(\rho_g, A_g) + E[\text{Cov}(\rho_{gi}, A_{gi}) + E(\rho_{gi} \Delta A_{gi})],
  \]
  where \(g\) is district and \(i\) is firm
Inter-population thinking

- Removing Marshall’s *ceteris paribus* clause
  - Co-evolution of industries
  - Simplest with two industries
  - Use the tools of evolutionary ecology

- Evolutionising the logistic equation and the Lotka–Volterra equations
  - Basic expansion coefficient of population $g$ is $r_g$
  - Intrinsic carrying capacity of population $g$ is $K_g$
  - $r$-selection in pioneering situations
  - $K$-selection in crowded situations
Intra-to-inter-population thinking

- The emergence of new populations
  - Basic mechanism: partitioning of resources
  - Some members of an old population specialises in a limited niche
  - Other members focus on residual resources

- Limits of endogenous growth theory
  - Paul Romer (1993) wants to supply clear models to sloppy evolutionary researchers. But, ...
  - New growth models has no population thinking
  - Their new sectors consists of a single firm
  - No interesting inheritance from old sectors
Analysing macroevolution?

- Marshall studied a best gradualistic evolution
- Schumpeter’s dramatic capitalist evolution is still beyond our analytical toolbox
- But catastrophic events are part of both biological and economic evolution
Conclusions

- Population thinking is at the very core of evolutionary economics!
- There are many interrelated forms of population thinking!
- We have good tools for simple analyses: Try out Price’s equation!
- We can now analyse a much extended version of Marshall’s fable of the trees!
- We have still problems with Schumpeter’s fable of capitalism!
  Complex evolution is, of course, analytically complex!