An Evolutionary Interpretation of Technical Change

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Summary I

Introduction I

What does it mean evolutionary?

- Since last 40 years, economists have started observing technical progress as an evolutionary process, closely linked to industrial dynamics and economic growth
- Not a new idea:

  "What a Noble as well as Beautiful, what a glorious Machine is a First-Rate Man of War... We often ascribe to the Excellency of Man's Genius, and the Depth of his Penetration, what is in reality owing to the length of Time, and the Experience of many Generations, all of them very little differing from one another in natural Parts of Scarcity"(Mandeville, 1714, pp. 141-142)

Introduction II

"Many improvements have been made by the ingenuity of the makers of the machine... and some by that of those who are called philosophers or men of speculation, whose trade it is, not to do anything by to observe everything; and who, upon that account are often capable of combining together the powers of the most distant and dissimilar objects" (Smith, 1776, p. 21)

- Authors like Mandeville reject the assumption of strong rationality, i.e. economic agents have neither perfect information nor perfect foresight
- Emphasis on disequilibrium dynamics: capitalism as a restless process in which innovation is associated with trails and errors, mistakes and unexpected successes

Introduction III

- Identification of the regularities in the process of technological and industrial change:
  - → any invariant pattern in the innovation process?
  - → how are innovations selected?
  - → how does history affect technical change?
  - → what is the role of institutions and policies?
- Dosi and Nelson (2010, p. 54): "An evolutionary perspective focuses upon the processes by which firms persistently search for and adopt new technologies as well as new organizational forms and new behavioral patterns as means of gaining advantages over their competitors, and upon the features of the competitive process driving the growth, the decline and possibly the disappearance of various firms"

Introduction IV

- The literature has developed across three main streams of research:
  - → theory of the firm;
  - → nature of competition in such industries;
  - → innovation-led economic growth

What is technology? I

- Definition: technology is a human designed means for achieving a particular end.
- Means require *knowledge*, *procedures* and *artifacts*
- Ex: Pythagoras' Theorem: *The area of the square whose side is the hypotenuse is equal to the sum of the areas of the squares on the other two sides*

Technology as Information I

1. Non-rivalry in use: two agents can use the Theorem at the same time
2. Indivisibility: half of the Theorem is not very useful
3. High up-generation cost but low cost of re-utilisation:
   - → Pythagoras did not conceive it in a day;
   - → once there is, anybody can use it;
   - → *scale-free* property, but at a first approximation only
4. Increasing returns: non-depreciation in use (technically)
   - → you can use the Theorem as much as you want at no cost, once developed

Deepening of the above:

- Non-rivalry implies *non-depletablity by reproduction*.

Technology as Information II

- Different from costless replication
- Tacitness: we know more than we can tell

  Most technology is specific, complex... [and] cumulative in its development... It is specific to firms where most technological activity is carried out, and it is specific to products and processes, since most of the expenditures is not on research, but on development and production engineering, after which knowledge is also accumulated through experience in production and use on what has come to be known as 'learning by doing' and 'learning by using' (*Pavitt 1987, p. 9*)

- Pragmatic nature of technological knowledge
- Technological knowledge is different from public goods

Technology as Information III

- Scaling-up is a challenge
- Additivity may stand
- Inability to explicity articulate the sequences of procedure by which "things are done"
- No clear distinction between "exogenous" and "endogenous" technical progress

Technology as Recipe I

- The production of any artifact requires *sequences of cognitive and physical acts*
- Technology as recipe: design of the product + set of procedures, e.g., Mandeville's warship
- Recipes specify the sequence of procedures that are technically feasible and apt to get the desired outcome: recipes as coded programs, e.g., make a cake
- No good artifact or service comes out of codified recipe alone: tacitness again
- When dealing with sophisticated technologies, skills and knowledge are distributed across many individuals

Technology as Recipe II

- Social technologies: intrinsic social elements nested in particular organisations that capture the ways of doing things

Technology as Routine

- The multi-person nature of the way organizations make or do things
- An executable *capability* for repeated performance in some *context* that has been *learned* by an organisation:
  - → memory of problem-solving repertoires
  - → mechanisms of governance
  - → meta-routines
- Routines involve multiple organisational members
- Difference between capability and competence:
  - → capability: high-level tasks, e.g., building an automobile
  - → competence: master a specific knowledge, e.g., organic chemistry

Technology as Artifact

- Recipes usually involve the *design* of an *artifact*
- *Design space*: properties of the components that make up the final output
- By the way, we can study innovation in terms of modifications and improvements of the system
- Identification of techno-economic characteristics of outputs and inputs

Technology and Input-output Relations I

- The *procedural* view of technology concerns where the action is
- The production function (change in input-output relations) is an ex-post description and involves just *quantities*:
  - → ex: "90% eggs and 10% flour" does not give you a cake;
  - → this holds *irrespectively of relative prices*
- Substitution of inputs requires changes in production procedures
- Mapping between *procedures*-centered and *input/output*-centered representations: simular procedures that are far in the input-output space, and viceversa

Technology and Input-output Relations II

- Focussing on procedures allows to account for very different performances across firms:
  - → partial understanding of complex procedure;
  - → an organisation masters at most few of them;
  - → organisations master the same technique at different degree;
  - → firms are highly heterogeneous