PAUL SAMUELSON AND VISUAL REPRESENTATION IN ECONOMICS

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The place of visual representation in economics – obvious, yet unstudied (1)

- You do not have to think much to find how central some visuals are in economics
  - Supply and demand curves
  - Edgeworth diagrams
  - The Phillips-curve
  - Samuelson 45° diagram, etc.

- Yet this is still a relatively unstudied subject.
The place of visual representation in economics – obvious, yet unstudied (2)

- Economists tend to either:
  - Dismiss the importance of visuals as active players
  - Or fetishize them.

- What is important to understand is:
  - How visual representation “works” in practice.
  - How diagrams and other visuals are active tools of dissemination of economic knowledge.
Most practicing scientists tend to rely to a “diffusion model” (Latour 1987).
- Dichotomy between knowledge creation and dissemination
- The former is “serious science”, the latter is just instrumental.
- Visual representation, seen through this framework, appears as auxiliary.

Sociologists of science, on the contrary, offer the “translation model”.
- Science, all in all, is an act of dissemination.
- Objects that circulate among scientific communities are the only observable “tools” of science – as opposed to “ideas” or “theories”.
- Seen through this framework, visual representation appear as crucial.
Why visuals matter (in a nutshell) to historians

- They help focus more on “objects”, and less on “ideas”.
  - Looking at one controversy like the Laffer curve through the successive transformations of the diagram, for instance.
  - See Thomas Stapleford (2017)

- Studying them helps us qualify the history of 20th century as that of “the mathematization” of the field.
  - The ‘maths’ did not just replace “verbal economics” but a more complex mixture of verbal and visual arguments.
  - There were intermediary stages between, say, Adam Smith and Samuelson.

- They make us interrogate the question of how economists try to address/convince various audiences (same as textbooks).

- They help us locate a few ‘hidden’ methodological issues.
An example: graphs (Klein, 1995)

- To make it simple, graphs are a particular kind of diagram.
  - These are two-dimensional diagrams that help us represent the relation between two properties, expressed quantitatively.
  - While an organizational chart, for instance, represent “things”, a graph can just represent the “properties” of these things.
- But in fact, in spite of their commonality, graphs can be used in a great number of ways.
Klein’s dual distinction

- Law curve vs. fact curve
  - A law curve represents a theoretical relation.
  - A fact curve represents actual data.

- Historical time (1) vs. logical time (2) (borrowed from J. Robinson)
  - (1) The relation is ordered historically. You read it (for instance) from left to right. You just can’t go back (as you can’t go back in time).
  - (2) The relation is ordered logically. You can move freely in all directions in the diagram → in economics, it is often meant as representing a “bargain”: possibilities as opposed to realizations.
A relation in historical time

Household consumption in Brazil (% of GDP), 1960-2015.
Source: World Bank
A relation in logical time

The 45° diagram, Source: The Journal of Keynesian Economics
## A few examples

<table>
<thead>
<tr>
<th>Logical time</th>
<th>Law curve</th>
<th>Fact curve</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Supply and demand curves</td>
<td>Phillips curve (Phillips’ version)</td>
</tr>
<tr>
<td></td>
<td>Phillips curve (Samuelson and Solow version)</td>
<td></td>
</tr>
<tr>
<td>Historical time</td>
<td>Kuznets curve</td>
<td>Stock charts, GDP charts</td>
</tr>
</tbody>
</table>

Note: clearly, we are more used to graphs emphasized in the blue areas than to others.
Things are not so simple, though.

- People can infer law curves from fact curves.
  - Samuelson and Solow’s transformation of the original Phillips curve → it was an empirical relation transformed into a theoretical one (and then a policy menu).

- At the pedagogical level, we often present logical decisions as historical decisions (not always consciously).

- Transforming historical into logical time is pretty much the point of econometrics (identification).
Things that are important to consider when looking at visuals (1)

- There is not one “true” version of a diagram. There are different instantiations disseminated in various articles, books, textbooks, etc.
  - See Kaiser (2005) on Feynman Diagrams in physics
    Sometimes by studying diagrams, we can see several different perceptions of science at stake.
  - Then, generally, there is one “canonical” version of the diagram that sticks when other versions disappear.
  - Diagrams can also travel from one discipline to another.
Things that are important to consider when looking at visuals (2)

- There is a variety of ways in which people can use similar diagrams
  - As a heuristics – it does not demonstrate anything “scientifically” speaking but it helps make a point
  - As means of demonstration (substitute for algebra)
  - As means of simplification (use for pedagogical purposes)

- But generally visuals have a very hybrid methodological status in economics
  - They are seen as useful but rarely as “scientifically” compelling.
  - Yet in past economics, they were considered so.

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Marshall’s view of diagrams


- Today, we see diagrams as substitutes for algebra (without the accuracy of the latter) but not Marshall, in his Theory of Foreign Trade.

  “Diagrams present simultaneously to the eye the chief forces which are at work, laid out, as it were in a map; and thereby suggest results to which attention has not been directed by the use of the methods of mathematical analysis ... The method of diagrams can be freely used by every one who is capable of exact reasoning, even though he have [sic] no knowledge of Mathematics.” (Marshall, 1930, p. 5)
Marshall on mathematics

- These views must be seen in relation to Marshall’s larger aversion for mathematics
  - “Burn the mathematics”, he wrote to Arthur Bowley.
  - By this, he meant that maths were just a tool, and that economics is not in essence ‘mathematical’ (contrary to Walras).
  - Both algebra and geometry are different means to express economic ideas, none surpasses the other.
- This view is quite common to the 19\textsuperscript{th} century. Rigor is not seen as an end. Science is judged not by its rigor but by its usefulness (today, we would call this ‘engineering’). See Weintraub (2002).
  - This is how mathematics was taught at Cambridge (tripos).
The importance of visual representation in the 19th century

- The 19th century (in Europe) represents a sort of golden area for visualization.
- Visuals travel from economics to mathematics to geography, from meteorology to astronomy ... and to economics.
- Let's borrow an example from Thomas Hankins' fascinating study of graphs.
Maurice d’Ocagne’s version of the table (late 19th century)

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Use of “Isocurves” in meteorology and geography

Von Humboldt (1817)  
Léon Lalanne (1846)
A “classic” diagram (C. Minard, 1869)
This occurs while something is happening to the very notion of “objectivity” (Lorraine Daston & Peter Galison, 2007)

- We move from a kind of “objectivity” where people try to locate ideal types (“truth to nature”) …
- To a kind of objectivity aiming at measuring things (“mechanical objectivity”).

And at this time a lot of instruments are invented that allow to do drawings and reproduction mechanically (the most important being the camera, of course).

This is the golden age of atlases, collections, science museums, etc.
Paul Samuelson (1915-2009)

- Undergrad student at the Univ. of Chicago (1932-35)
- Became a Professor at MIT (1940-2009)
Samuelson and visualization

- Samuelson is coming from a different tradition than European economists
  - He does not possess this “visual” culture
  - And he’s more interested in making economics more scientifically rigorous

- Then, remember that the very definition of “scientifically rigorous” is shifting in that period
  - It means: grounded in cogent mathematical axioms (as opposed to “conform to reality”)
  - There’s this idea that to be able to say something about the world, economics should not be less abstract but more abstract (this is discussed by Jacob Viner, Samuelson’s Prof at Chicago).
Samuelson’s intended scientific approach: operationalization

- Influence of his PhD advisor, Edwin B. Wilson (1879-1964)
  - A polymath and a former student of American physicist J. W. Gibbs

- Operationalization
  - It means that we should be able to reconstruct a relatively “fuzzy” concept through observation
  - For instance, “health” can be measured by a number of means (body-mass index, cigarette consumption, blood pressure, temperature, etc.)
  - In economics, the issue of measuring preference just by looking at the choices people do in real life.
Foundations of Economic Analysis (1947)

- Samuelson’s PhD dissertation, defended in 1941.
  - It does not treat one subject in particular.
  - But it tries to unveil the basic principles underlying all economic theories.
  - Samuelson sees two of them, which are the maximization of some objective quantity and the analysis of the dynamics of systems.
- All in all, Samuelson was interested in generalization, and being general was to him the criteria through which good science should be evaluated.
Samuelson’s relative disdain for visualization

- *Foundations* at the time was quite unique
  - Not so for its use of mathematics (algebra)
  - But for its scant use of visualization (six visuals)

- Visualization is purely illustrative for Samuelson and does not add much to his mathematical arguments

- Why are visuals so useless for him?
  - Samuelson think that visuals handle special case (as opposed to generalizations)
  - He is also under the impression that diagrams are mostly manipulative
A telling anecdote

- Jacob Viner (1892-1970)
  - Teaches at Chicago when Samuelson is there
- Also known for a famous mistake concerning cost curves
  - Tells Samuelson he sure can draw an LR average cost curve that goes through the minimum of all the SR curves.
  - Samuelson says: yes, with a “thick” pen, you surely can.
Samuelson criticized

- Samuelson’s use of mathematics is criticized by many
- But of particular interest is K. Boulding (1948)’s critique
  - Boulding is a British economist who emigrated to the US
  - He is very visually inclined in his reasoning
  - His review takes P.S. to task for not using the adequate kind of mathematics.
  - Economics should be interested in relations “in the large” (not infinitesimal variations) and visual representation is better to do so.
- Samuelson to Boulding: this is a matter of strategy, not principle.
- Yet in spite of these criticisms, Foundations sets the standards for postwar economics.
But then, there’s a new role for visual representation

- Samuelson’s *Economics* (1948)
  - More on its making in lecture II
  - A textbook made for undergraduate students
  - Using more visualization than other available textbooks

- Reasons for using diagrams
  - Students are former militaries (GI Bill of Rights), educated through visually rich war manuals
  - MIT students are future engineers and are also used to a specific visual culture
  - Visualization is invading popular culture
Samuelson’s visuals

- Samuelson feels it is important to make *Economics* a lively textbook
  - Hence it starts with a depiction of the US economy
  - A lot of statistical charts are used for this purpose
  - At a time when such information becomes more easily available (F. Delano’s National Planning Board)

- The second part makes a greater use of theoretical diagrams, meant as a way to tackle the issues emphasized in the beginning of the text.
  - Hence a kind of “faux” inductivism to the analysis.
  - Diagrams need to be simple and relatively self explanatory (not the kind of complicated diagrams used by A. Marshall, K. Boulding or other British economists)

- Sets the standard for all American introductory textbooks until today.
Conclusion: visualization stabilized

- As both *Foundations* and *Economics* set the standards, respectively, for research and education
  - We see that diagrams become old fashioned as research tools
  - Yet highly disseminated in textbooks and other pedagogical devices
- As a result, diagrams:
  - Have a relatively low scientific status in economics
  - Are nevertheless extremely important at the early stage of development of today’s economists
- Explains why they can be simultaneously fetishized and held in disdain.
- Is the relative lack of creativity in economic research hurtful?