# Lecture 0

# Econo*metrics*: Quantification in Economics

Ananya Iyengar

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St. Stephen's College

## 1 The Starting Point of Econometrics

As the Roaring Twenties skidded to a painful halt and stock markets plummeted to all-time lows, the main problem concerning Alfred Cowles, owner of an investment company in Colorado Springs, was the failure of stock market forecasting in predicting the crisis. Dismayed, Cowles set out on a project to measure how existing forecasts performed against actual stock market performance — the variables were many and computations (and computational power) involved non-trivial. Just about this time, in 1930, a group of economists, including Frisch, Roos, and Schumpeter, had instituted the Econometric Society to inculcate the application of quantitative methods in economics. Cowles contacted the Society's first president, Irving Fisher, who in turn was glad to receive the funding that Cowles brought along with his project. Initially based in Colorado Springs, the Cowles Commission found its first home at the University of Chicago, where the methodological foundations of "modern" economics would develop; forming the epistemological soul of the Econometric Society.

The work of the Cowles Commission in developing these quantitative techniques was given great fillip by the work of Norwegian economist Trygve Haavelmo, who later himself joined the commission. Most seminal today is Haavelmo's 1944 essay in Econometrica, *The Probability Approach to Econometrics* — salient not just in providing meaning to the economic model but also "comfort" (Hoover, 2007) against the long-standing belief that the social (and hence, moral) sciences could not be conceived of statistically. Before Haavelmo, it was well-fretted about that to study cause-and-effect in the social sciences was entirely unlike the project in the natural sciences. In his 1836 essay *On the Definition and Method of Political Economy*, J.S. Mill contrasts the study of Euclid's *Elements*, where the idea of a line is built axiomatically into a prefixed definition and there can be no two ways about it, with the definition of man, on which there can certainly be no uniform understanding. In absence of this uniformity, the Bacon-ian *experimentum crucis*, the basis for proof in the natural sciences, is rendered unusable. Mill writes:

*"There is a property common to almost all the moral sciences, and by which they are distinguished from many of the physical; that is, that it is seldom in our power to make experiments in them. [...] We cannot try forms of government and systems of national policy on a diminutive scale in our laboratories, shaping our experiments as we think they may most conduce to the advancement of knowledge".*

Nonetheless, Haavelmo persisted; and modern econometrics stems from and continues to grow on the exact intellectual foundations set by Haavelmo and polished by the work of Cowles economists — and today the impossibility highlighted by Mill is circumvented (in ways elegant, precise, popular, augmented by technology; and not uncritiqued) by quasi-experimental methods and the credibility revolution.

The starting point of Haavelmo (1944) is to identify what makes a model economic, and from there does the method of econometrics arise. Haavelmo makes a distinction between a theoretical model, with premise and conclusions consistent within its structure, and real-world observation, which he calls "facts". For example, within the premises of the model of a monopoly firm, a decrease in demand elasticity implies an increase in monopoly profit when cost structures are unchanged. This is theory. Facts, here, are real-world observations of monopoly behaviour, which in the purview of the economic are, for Haavelmo, something measurable.

In line with the positivist tradition of knowledge-generation (later immortalised by Friedman), the main concern is relating fact to theory. Can one conclude that theory is supported by fact only if fact perfectly follows theory? Consequently, if one observes facts that do not align exactly with theory, is that basis for discarding the theory entirely? Economic variables are, as Mill has highlighted, ambiguous to define and even more so to measure. A lot of contemporaneous research still centres on trying to measure and understand correctly economic variables that are so entrenched in common parlance that one may think them trivial. Furthermore, "fact", as used by Haavelmo, is observation — implying that most measures are observational and the economist has little to no control over the way these measures are perceived. Even today, concerns about the cost and enumeration of observational measures dictate how we interpret fundamental economic concepts. For instance, Merfeld and Morduch (2024)'s Poverty at Higher Frequency highlights how the seemingly innocuous choices made by India's National Sample Survey Organisation prevent the colloquial interpretation of annual expenditure poverty estimates as the number of expenditure-poor people in the country in a year (i.e. the head-count ratio).

Even when one may have a complete grasp of the variable and its measurement, fact may support not the exact theory. It may, however, support a version of the theory the implications of which are broader — an "almost-true" theory. Haavelmo writes:

*"We shall then find that it is practically impossible to maintain any theory that implies a nontrivial statement about certain facts, because sooner or later the facts will, usually, contradict any such statement".*

To escape this quandary, Haavelmo considers that observed fact not corresponding to the implications of some theory A is equivalent to observed fact corresponding to the implications of some other theory B, where B studies the same phenomena and dynamics as A but in ways where it claims less in its information content than A. The inexact correspondence of fact and theory is reconciled with the idea that the implications of models need not be true always but rather must have a chance of being true. Haavelmo proposes a probabilistic (as formalised by the Kolmogorov axioms) structure of theory.

However, it is not yet clear what is economic about this whole enterprise. Clearly, any mathematical framework with a domain, premise and implication will satisfy the definition of a model. Probability can be integrated. This does not ensure that implications of this model are meaningful in its economic content. A model and its implications are given economic meaning by the (imperfect) fact that it (imperfectly) explains. In the observation of fact,

*"... in most cases we are not even able to give an unambiguous description of the method of measurement to be used, nor are we able to give precise rules for the choice of things to be measurement in connection with a certain theory".*

The project, at the risk of vacuous repetition, involves the mathematical analysis of economic variables. The economic is a product of observation itself. Haavelmo divides the economic into three types of models: definitional identities (revenue is price times quantity), technical relations (the production function) and relations describing interdependent actions of agents (utility maximisation). It must be noted that what is the variable and what is the mode parameter is entirely endogenous to the context surrounding the construction of the model — there is nothing sacrosanct about it.

The model is made mathematical not by the use of symbols or algebra (both a relief and threat to students!) but by conceiving mentally an experiment that holds in itself some true value of economic variables (what is now called the data generating process). Observed facts are the outcomes of that experiment, plus some impreciseness/error/noise. Conceptualising the theoretical model as an experiment relating to true economic variables facilitates a probabilistic interpretation. An economic hypothesis, then, is a joint implication of both theory and experiment and therefore can be tested by using statistical methods.

It is in this core insight that Frisch and the Econometric Society's vision of unifying statistics, economic theory and mathematics comes alive. In the very first edition of Econometrica, published January 1933, Schumpeter wrote:

*"We do not impose any credo — scientific or otherwise — and we have no common credo beyond holding: first, that economics is a science, and secondly, that this science has one very important quantitative aspect. [...] Theoretical and 'factual' research will of themselves find their right proportions, and we may not unreasonably expect to agree in the end on the right kind of theory and the right kind of fact and the methods of treating them, not postulating anything about them by program, but evolving them, let us hope, by* ***positive achievement*** [emphasis added]*".*

Haavelmo's work had major implications for the adoption of statistical practice — econometrics — in empirical research. As identified by Hoover (2007), statistical controls began to be used as experimental controls in econometric models. Moreover, Haavelmo's structure of theory and experiment constituting the economic model led to the separation of the economic process into a deterministic component and a stochastic component, the latter described by a probability distribution which allows characterising the difference between true fact and observation, and testing hypotheses generated from the model. Modern econometric textbooks start with this premise.

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