What Should Computational Financial Economists Do?

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Economics as an independent field of study is very young, and likewise the field has changed tremendously over time developing many sub-fields and specializations. Each sub-discipline pushes the bounds on how economics is studied and the tools used to approach economics questions. However, studying economics as a science is very difficult because there is no ethical way to run controlled experiments on individuals and their interactions. Therefore, elaborate mathematical models have been developed to test and control for economic variables.

All of these characteristics of economics have created many diverging schools of thinking and therefore many diverse opinions on role of economists play in the world.
Is economics purely an academic field only to be discussed in peer-reviewed journals? Should economics be used as an approach to influence government policy? Is economics an art form to create models which serve no purpose but to display their own innate beauty? Is economics an attempt to describe the world as it is or rather, how it should be? In order to answer the question of what "should" be done in the study of economics it is imperative to layout what has been done and what is being done by modern economists.

Economics Over Time

The field of economics developed almost simultaneously with the spread of the market system for trade during the early industrialization of Europe. Adam Smith is often cited as the "father of economics" however the field is less of a creation as it is a reaction to the expansion of market based interactions and drive to understand a technologically developing world. Smiths fundamental explanation of economics and capitalism in "The Wealth of Nations"

focuses less on how markets work and more on how they "should" work. Over the next century the study of the political economy was more or less a philosophical prose on the interactions of consumers and producers. This abstract approach to economic thought changed when Leon Walras published "Elements of Pure Economics," which expressed concepts statistically and mathematically, planting the seed for modern mathematical based modeling. Much of economics today has developed into a more convoluted mathematical undertaking in an attempt to explain how and why market outcomes occur and as such, many sub fields of economics have developed to study particular facets of the market.

Financial Economics

This examination is meant to specifically focus on the sub-field of financial economics. Like much of economics the lines between financial economics and other disciplines are often blurred, however financial economics tends to focus on the modeling and data regarding decisions of exchange; often when exchanges can be interpreted as money now for money later. This execution is often done through the use of financial assets which implicitly deal with problems of time and uncertainty, often referred to as risk.

History

Clearly the distinction between financial economics and other sub fields of economics is blurry as financial economics pulls many fundamental concepts from microeconomic theory. However, some notable achievements in financial economics can help set the tone for what is labeled as modern financial economics. One of the most influential models in financial economics was introduced by Harry Markowitz in his 1952 essay, "Portfolio Selection," in which he lays out mean-variances analysis which has come to be known as modern portfolio theory.

Markowitz was later award the 1990 Nobel prize for his work in developing the field of financial economics.

Sharing the 1990 Nobel prize with Markowitz were two other individuals, William Sharpe, and Merton Miller. Sharpe, while working with Markowitz at the RAND corporation, developed early work describing the capital asset pricing model (CAPM). Simultaneously, Miller worked on many models the made use of the "no arbitrage" argument, claiming that states allowing for trading arbitrage will immediately be taken advantage of, and therefore, disappear.

Using Miller's ideas of no arbitrage, Fischer Black, Myron Scholes, and Robert Merton, later developed a method of pricing derivative options, using the idea of delta hedging, or buying and selling the underlying asset to eliminate risk. The Black-Scholes-Merton model has become one of the most widely implemented models in practical trading. Likewise, Merton and Markowitz, alongside Paul Samuelson, were among the first to implement computerized arbitrage trading further bridging the gap between economic theory and financial market application.

Modern expansions in financial economics have included dynamic portfolio theory and applications of probability theory. Naturally, an overlap occurs between the fields of economics, finance, and financial economics and the distinction is becoming more blurred as the fields develop. The greatest distinction can be specified as the perspective each field takes. Where finance tends to focus on the particular assets and institutions, financial economics tends to focus on the decision making by market participants underlying these assets and institutions. However, a common underlying tone inseparably ties the two fields: risk.

The introduction of probability and risk into the standard neoclassical models used by economists greatly increases the complexity of models and data collection. Therefore, computational methods play a pivotal role in the further understanding of a world of risk.

Role of Computational Methods

The real world is an extremely dynamic, intertwined series of variables and stochastic processes therefore, models with high external validity become very complex very quickly. The use of computational tools and programming allows for iteration of numerical methods that cannot be done by hand. Financial applications specifically require models to account for risk which often is solved by repetitions over pseudo-random variables, such as Monte Carlo methods. In addition, regression based models in n-dimensions become exponentially more difficult to compute by hand but only require a small increase in computation type when done with a computer.

Furthermore, models solved by hand often include assumptions about continuity and differentiability in order to apply the tools of calculus. Yet, with the use of computational methods discrete and circular models can be solved. This allows for an expansion of theory and application beyond the bounds of individual mathematical ability.

The Goal of Economics

The fundamental question of what economics is can be boiled down to an initial distinction: whether economics is a normative science or a positive science. Declaring this distinction implicitly changes what could be considered an “appropriate” approach to economic questions. If the goal of economics is purely positive, then perhaps equilibrium models of utility maximization are an overly abstracted approach to describing the real world and can be

deemed useless. However, if economics is purely normative, then these same models may create some simplifications that make the real world interpretable and therefore, help determine appropriate market decisions.

Within either distinction, economics can most plainly be described as the study of decision making regarding exchange. In his paper "What Should Economists Do?", James Buchanan describes the market as the revelation of these observed exchanges:

> *The market or market organization is not a means toward the accomplishment of anything. It is, instead, the institutional embodiment of the voluntary exchange processes that are entered into by individuals in their several capacities. This is all that there is to it. Individuals are observed to cooperate with on another, to reach agreements, to trade. The network of relationships that emerges or evolves out of this trading process, the institutional framework, is called "the market".*

The market as defined by Adam Smith was merely a process to obtain optimal outputs driven by individual's decision making based off self interest. Hayek furthered this market concept by claiming that the price system provides the mechanism to implicitly translate information to each individual decision maker. The work of Leon Walras, and later, John Maynard Keynes helped develop the ideas of general equilibrium and micro aggregation to describe a market as a whole rather than individuals. Yet, this set the scene for the largest deviation in economic philosophy, that of equilibrium.

Equilibrium is the fundamental driving force of model outputs and determines the conclusions found by most major economic schools of thought. Great economic thinkers have claimed that equilibrium models do not represent the world which is a series of disequilibrium processes. These arguments are countered by claiming that the normative implications of equilibrium can help determine proper action to take in the market. Buchanan offers that this is

"the most sophisticated fallacy in economic theory, the notion that because certain relationships hold in equilibrium the forced interferences designed to implement these relationships will, in fact, be desirable."

The strongest counterargument is that of Paul Samuelson who writes in support of these mathematical models because, "it is surprising how rare pure mistakes in logic are." Samuelson points out that "Where the really big mistakes are made is in the formulation of a premises." Likewise, he considers this accuracy "one of the advantages of the mathematical medium." Mathematical models create a method to reduce the impact of human error on theory and the results can be reasonably trusted within the specification of the model.

Conclusion

Much like Samuelson, I believe that the use of pure mathematical models is extremely useful in the production of accurate results and they can eliminate many behavioral mistakes. However, the use of mathematical models models in economics often requires a high level of abstraction and in doing so the external validity of the model is jeopardized. This is not to say that intuition and philosophy are powerful enough to replace neoclassical models used today, but rather a skeptical approach to "pure theory" is essential for advancing the field.

The real comparative advantage of financial economics over other fields is the access large amounts of data, both historic and in real time. This allows for financial economics to truly behave as a positive science, collecting quantitative values, before trying to take a speculative normative approach to the world. The financial system allows for a highly efficient transfer of information across time and space and creates high levels of coordination among individuals in

the market. Under Hayek's assumption of knowledge aggregation through the price system financial economists have unprecedented access to information on preferences and behavior.

This prods the question, "what should computational financial economists do?" I believe that the answer lies in the ability to process huge amounts of data. Financial economists, in their study of monetary institutions and exchanges can encapsulate information to create accurate positive models of regional and global economic interactions. Through financial assets and trading, predictive models can be applied and tested without the ethical limitations usually faced by economic experimentation. Likewise, financial institutions create a facility to test for market efficiency through arbitrage opportunities. This means that financial economists can either find support for the efficient market hypothesis or exploit the inefficient markets to push prices toward equilibrium.

Financial economists have at their fingertips the purest fruition of the market system. A money for money, or value system of exchange. A market that quickly aggregates and dispenses information and can be entered and exited to test economic models. Therefore, computational financial economists should create systems that allow the massive amounts of information passed through financial markets each day to be compiled and interpreted to advance the understanding of how our modern economic systems operate.

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