Hayek and Intertemporal Equilibrium

I am starting to write a paper on Hayek and intertemporal equilibrium, and as I write it over the next couple of weeks, I am going to post sections of it on this blog. Comments from readers will be even more welcome than usual, and I will do my utmost to reply to comments, a goal that, I am sorry to say, I have not been living up to in my recent posts.

The idea of equilibrium is an essential concept in economics. It is an essential concept in other sciences as well, its meaning in economics is not the same as in other disciplines. The concept having originally been borrowed from physics, the meaning originally attached to it by economists corresponded to the notion of a system at rest, and it took a long time for economists to see that viewing an economy as a system at rest was not the only, or even the most useful, way of applying the equilibrium concept to economic phenomena.

What would it mean for an economic system to be at rest? The obvious answer was to say that prices and quantities would not change. If supply equals demand in every market, and if there no exogenous change introduced into the system, e.g., in population, technology, tastes, etc., it would seem that would be no reason for the prices paid and quantities produced to change in that system. But that view of an economic system was a very restrictive one, because such a large share of economic activity – savings and investment — is predicated on the assumption and expectation of change.

The model of a stationary economy at rest in which all economic activity simply repeats what has already happened before did not seem very satisfying or informative, but that was the view of equilibrium that originally took hold in economics. The idea of a stationary timeless equilibrium can be traced back to the classical economists, especially Ricardo and Mill who wrote about the long-run tendency of an economic system toward a stationary state. But it was the introduction by Jevons, Menger, Walras and their followers of the idea of optimizing decisions by rational consumers and producers that provided the key insight for a more robust and fruitful version of the equilibrium concept.

If each economic agent (household or business firm) is viewed as making optimal choices based on some scale of preferences subject to limitations or constraints imposed by their capacities, endowments, technology and the legal system, then the equilibrium of an economy must describe a state in which each agent, given his own subjective ranking of the feasible alternatives, is making a optimal decision, and those optimal decisions are consistent with those of all other agents. The optimal decisions of each agent must simultaneously be optimal from the point of view of that agent while also being consistent, or compatible, with the optimal decisions of every other agent. In other words, the decisions of all buyers of how much to purchase must be consistent with the decisions of all sellers of how much to sell.

The idea of an equilibrium as a set of independently conceived, mutually consistent optimal plans was latent in the earlier notions of equilibrium, but it could not be articulated until a concept of

optimality had been defined. That concept was utility maximization and it was further extended to include the ideas of cost minimization and profit maximization. Once the idea of an optimal plan was worked out, the necessary conditions for the mutual consistency of optimal plans could be articulated as the necessary conditions for a general economic equilibrium. Once equilibrium was defined as the consistency of optimal plans, the path was clear to define an intertemporal equilibrium as the consistency of optimal plans extending over time. Because current goods and services and otherwise identical goods and services in the future could be treated as economically distinct goods and services, defining the conditions for an intertemporal equilibrium was formally almost equivalent to defining the conditions for a static, stationary equilibrium. Just as the conditions for a static equilibrium could be stated in terms of equalities between marginal rates of substitution of goods in consumption and in production to their corresponding price ratios, an intertemporal equilibrium could be stated in terms of equalities between the marginal rates of intertemporal substitution in consumption and in production and their corresponding intertemporal price ratios.

The only formal adjustment required in the necessary conditions for static equilibrium to be extended to intertemporal equilibrium was to recognize that, inasmuch as future prices (typically) are unobservable, and hence unknown to economic agents, the intertemporal price ratios cannot be ratios between actual current prices and actual future prices, but, instead, ratios between current prices and *expected* future prices. From this it followed that for optimal plans to be mutually consistent, all economic agents must have the same expectations of the future prices in terms of which their plans were optimized.

The concept of an intertemporal equilibrium was first presented in English by F. A. Hayek in his 1937 article "Economics and Knowledge." But it was through J. R. Hicks's *Value and Capital* published two years later in 1939 that the concept became more widely known and understood. In explaining and applying the concept of intertemporal equilibrium and introducing the derivative concept of a temporary equilibrium in which current markets clear, but individual expectations of future prices are not the same, Hicks did not claim originality, but instead of crediting Hayek for the concept, or even mentioning Hayek's 1937 paper, Hicks credited the Swedish economist Erik Lindahl, who had published articles in the early 1930s in which he had articulated the concept. But although Lindahl had published his important work on intertemporal equilibrium before Hayek's 1937 article, Hayek had already explained the concept in a 1928 article "Das intertemporale Gleichgewichtasystem der Priese und die Bewegungen des 'Geltwertes.'" (English translation: "Intertemporal price equilibrium and movements in the value of money.")

Having been a junior colleague of Hayek's in the early 1930s when Hayek arrived at the London School of Economics, and having come very much under Hayek's influence for a few years before moving in a different theoretical direction in the mid-1930s, Hicks was certainly aware of Hayek's work on intertemporal equilibrium, so it has long been a puzzle to me why Hicks did not credit Hayek along with Lindahl for having developed the concept of intertemporal equilibrium. It might be worth pursuing that question, but I mention it now only as an aside, in the hope that someone else might find it interesting and worthwhile to try to find a solution to that puzzle. As a further aside, I will mention that Murray Milgate in a 1979 article "On the Origin of the Notion of 'Intertemporal Equilibrium'" has previously tried to redress the failure to credit Hayek's role in

introducing the concept of intertemporal equilibrium into economic theory.

What I am going to discuss in here and in future posts are three distinct ways in which the concept of intertemporal equilibrium has been developed since Hayek's early work – his 1928 and 1937 articles but also his 1941 discussion of intertemporal equilibrium in *The Pure Theory of Capital*. Of course, the best known development of the concept of intertemporal equilibrium is the Arrow-Debreu-McKenzie (ADM) general-equilibrium model. But although it can be thought of as a model of intertemporal equilibrium, the ADM model is set up in such a way that all economic decisions are taken before the clock even starts ticking; the transactions that are executed once the clock does start simply follow a pre-determined script. In the ADM model, the passage of time is a triviality, merely a way of recording the sequential order of the predetermined production and consumption activities. This feat is accomplished by assuming that *all* agents are present at time zero with their property endowments in hand and capable of transacting – but conditional on the determination of an equilibrium price vector that allows all optimal plans to be simultaneously executed over the entire duration of the model — in a complete set of markets (including state-contingent markets covering the entire range of contingent events that will unfold in the course of time whose outcomes could affect the wealth or well-being of any agent with the probabilities associated with every contingent event known in advance).

Just as identical goods in different physical locations or different time periods can be distinguished as different commodities that cn be purchased at different prices for delivery at specific times and places, identical goods can be distinguished under different states of the world (ice cream on July 4, 2017 in Washington DC at 2pm only if the temperature is greater than 90 degrees). Given the complete set of state-contingent markets and the known probabilities of the contingent events, an equilibrium price vector for the complete set of markets would give rise to optimal trades reallocating the risks associated with future contingent events and to an optimal allocation of resources over time. Although the ADM model is an intertemporal model only in a limited sense, it does provide an ideal benchmark describing the characteristics of a set of mutually consistent optimal plans.

The seminal work of Roy Radner in relaxing some of the extreme assumptions of the ADM model puts Hayek's contribution to the understanding of the necessary conditions for an intertemporal equilibrium into proper perspective. At an informal level, Hayek was addressing the same kinds of problems that Radner analyzed with far more powerful analytical tools than were available to Hayek. But the were both concerned with a common problem: under what conditions could an economy with an incomplete set of markets be said to be in a state of intertemporal equilibrium? In an economy lacking the full set of forward and state contingent markets describing the ADM model, intertemporal equilibrium cannot predetermined *before* trading even begins, but must, if such an equilibrium obtains, unfold through the passage of time. Outcomes might be expected, but they would not be predetermined in advance. Echoing Hayek, though to my knowledge he does not refer to Hayek in his work, Radner describes his intertemporal equilibrium under uncertainty as an equilibrium of plans, prices, and price expectations. Even if it exists, the Radner equilibrium is not the same as the ADM equilibrium, because without a full set of markets, agents can't fully hedge against, or insure, all the risks to which they are exposed. The distinction between ex ante and ex post is not eliminated in the Radner equilibrium, though it is eliminated in the ADM equilibrium.

Additionally, because all trades in the ADM model have been executed before "time" begins, it seems impossible to rationalize holding any asset whose only use is to serve as a medium of exchange. In his early writings on business cycles, e.g., *Monetary Theory and the Trade Cycle*, Hayek questioned whether it would be possible to rationalize the holding of money in the context of a model of full equilibrium, suggesting that monetary exchange, by severing the link between aggregate supply and aggregate demand characteristic of a barter economy as described by Say's Law, was the source of systematic deviations from the intertemporal equilibrium corresponding to the solution of a system of Walrasian equations. Hayek suggested that progress in analyzing economic fluctuations would be possible only if the Walrasian equilibrium method could be somehow be extended to accommodate the existence of money, uncertainty, and other characteristics of the real world while maintaining the analytical discipline imposed by the equilibrium method and the optimization principle. It proved to be a task requiring resources that were beyond those at Hayek's, or probably anyone else's, disposal at the time. But it would be wrong to fault Hayek for having had to insight to perceive and frame a problem that was beyond his capacity to solve. What he may be criticized for is mistakenly believing that he he had in fact grasped the general outlines of a solution when in fact he had only perceived some aspects of the solution and offering seriously inappropriate policy recommendations based on that seriously incomplete understanding.

In *Value and Capital*, Hicks also expressed doubts whether it would be possible to analyze the economic fluctuations characterizing the business cycle using a model of pure intertemporal equilibrium. He proposed an alternative approach for analyzing fluctuations which he called the method of temporary equilibrium. The essence of the temporary-equilibrium method is to analyze the behavior of an economy under the assumption that all markets for current delivery clear (in some not entirely clear sense of the term "clear") while understanding that demand and supply in current markets depend not only on current prices but also upon expected future prices, and that the failure of current prices to equal what they had been expected to be is a potential cause for the plans that economic agents are trying to execute to be modified and possibly abandoned. In the *Pure Theory of Capital*, Hayek discussed Hicks's temporary-equilibrium method a possible method of achieving the modification in the Walrasian method that he himself had proposed in *Monetary Theory and the Trade Cycle.* But after a brief critical discussion of the method, he dismissed it for reasons that remain obscure. Hayek's rejection of the temporary-equilibrium method seems in retrospect to have been one of Hayek's worst theoretical — or perhaps, meta-theoretical — blunders.

Decades later, C. J. Bliss developed the concept of temporary equilibrium to show that temporary equilibrium method can rationalize both holding an asset purely for its services as a medium of exchange and the existence of financial intermediaries (private banks) that supply financial assets held exclusively to serve as a medium of exchange. In such a temporary-equilibrium model with financial intermediaries, it seems possible to model not only the existence of private suppliers of a medium of exchange, but also the conditions – in a very general sense — under which the system of financial intermediaries breaks down. The key variable of course is vectors of expected prices subject to which the plans of individual households, business firms, and financial intermediaries are optimized. The critical point that emerges from Bliss's analysis is that there are sets of expected prices, which if held by agents, are inconsistent with the existence of even a temporary equilibrium.

Thus price flexibility in current market cannot, in principle, result in even a temporary equilibrium, because there is no price vector of current price in markets for present delivery that solves the temporary-equilibrium system. Even perfect price flexibility doesn't lead to equilibrium if the equilibrium does not exist. And the equilibrium cannot exist if price expectations are in some sense "too far out of whack."

Expected prices are thus, necessarily, equilibrating variables. But there is no economic mechanism that tends to cause the adjustment of expected prices so that they are consistent with the existence of even a temporary equilibrium, much less a full equilibrium.

Unfortunately, modern macroeconomics continues to neglect the temporary-equilibrium method; instead macroeconomists have for the most part insisted on the adoption of the rational-expectations hypothesis, a hypothesis that elevates question-begging to the status of a fundamental axiom of rationality. The crucial error in the rational-expectations hypothesis was to misunderstand the role of the comparative-statics method developed by Samuelson in *The Foundations of Economic Analysis*. The role of the comparative-statics method is to isolate the pure theoretical effect of a parameter change under a *ceteris-paribus* assumption. Such an effect could be derived only by comparing two equilibria under the assumption of a locally unique and stable equilibrium before and after the parameter change. But the method of comparative statics is completely inappropriate to most macroeconomic problems which are precisely concerned with the failure of the economy to achieve, or even to approximate, the unique and stable equilibrium state posited by the comparative-statics method.

Moreover, the original empirical application of the rational-expectations hypothesis by Muth was in the context of the behavior of a single market in which the market was dominated by well-informed specialists who could be presumed to have well-founded expectations of future prices conditional on a relatively stable economic environment. Under conditions of macroeconomic instability, there is good reason to doubt that the accumulated knowledge and experience of market participants would enable agents to form accurate expectations of the future course of prices even in those markets about which they expert knowledge. Insofar as the rational expectations hypothesis has any claim to empirical relevance it is only in the context of stable market situations that can be assumed to be already operating in the neighborhood of an equilibrium. For the kinds of problems that macroeconomists are really trying to answer that assumption is neither relevant nor appropriate.