Rational Expectations, Risk, Uncertainty, and Market Responses

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The incorporation of rational expectations into economic models is widely recognized as one of the more significant advances in economic theory during the past decade. The advances are methodological—improvements in the methods economists use to derive the implications of dynamic models and the treatment of unanticipated changes. Many of the substantive benefits of the methods remain in the future, however. The reason is that the models used to illustrate rational expectations typically endow people with more information than they usually have.

With few exceptions, current models that incorporate rational expectations use Edmund Phelps’s (1970) island paradigm. The principal problem that people solve arises because no one can distinguish between aggregate and relative prices changes at the time changes occur. Publication of aggregate data provides the relevant information after one period, and this removes the difference between anticipated and actual events.

An older tradition in economics is associated with the classic work of Frank Knight, *Risk, Uncertainty, and Profit* (1921), but is prominent also in John Maynard Keynes (1921, 1936). These authors distinguish between risk and uncertainty. In the terminology of Knight, the island paradigm is a model of insurable risk because the unforeseen changes that occur are drawn from a distribution with fixed mean and variance. There is no reason for opinions to differ about the outcomes anticipated for tomorrow or for the more distant future. Hence there are no opportunities for profit—economic profit—and no force driving entrepreneurs to excel at their specialized task—interpreting current events, divining their implications for the future, and profiting from their specialized ability.

The Knight-Keynes tradition is an alternative model that can be combined with the method known as rational expectations. John Muth, who developed the method, applied the principle of economic efficiency to the use of information. Muth (1960, 1961) reasoned that accurate information...
about the future is scarce. Not only are we uncertain about events that have not occurred, but we are uncertain about the correct interpretation of events that have occurred and about their implications for the future. The best we can do, according to Muth, is to use the best confirmed hypothesis to separate the essential facts from the inessential, to interpret observations (or facts), and to draw their implications.

Muth's work eventually produced an important change in the way economists introduce expectations into hypotheses. The old method, and its fruitful application is well illustrated by the work of Milton Friedman (1957) that stimulated Muth's contribution and numerous other applications. There, expectations are formed without regard for efficiency in the use of information or optimality of forecasts.

Robert E. Lucas, Jr. made the second major change in method by joining rational expectations to general equilibrium theory. In a series of pathbreaking papers, beginning with Lucas (1972), he recognized that the information available in all markets must be consistent. Bringing expectations into general equilibrium theory requires people to act on the same beliefs when they are buying goods and bonds, selling services, and increasing or decreasing real cash balances. As Lucas (1980) later wrote, it is no longer acceptable modeling practice to introduce free parameters, representing expectations, into the equations of an econometric model to reproduce the past and forecast the future of the economy. Expectations must be consistent with the implications of a general equilibrium model and must either use available information or explain why it is not used.

The importance of Lucas's contributions can be judged both by the dominant role of his methods, models, and insights for the current generation of economists and by the negative reaction of an impressive list of general equilibrium theorists. The achievements of general equilibrium rational-expectations models are surveyed in several places, most recently—and insightfully—by McCallum (1980) and from a very different perspective by Brian Kantor (1979). The principal objections of some general equilibrium theorists are familiar also. Kenneth Arrow (1978) and James Tobin (1980) discuss a number of assumptions used in rational-expectations models that are inconsistent with observations. Everyone does not have the same information or access to information at the same costs. Tastes and opportunities differ. Aggregation is neglected. Forward markets do not exist for all contingent claims.

Many of the criticisms are too sweeping. One or more applies to all general equilibrium theory—indeed all economic theory, micro as well as macro. The particular reason for citing these standard assumptions in criticism of rational expectations appears to be that Arrow and Tobin claim that they are principal causes of disequilibrium in product and labor markets. If people learn at different rates or have different opportunities or
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information, some can be fooled. There is nothing in the method known as rational expectations that makes these standard assumptions more objectionable when applied to information than to markets for other goods or services. The fault lies in the model not in the method that requires expectations to be consistent with the best confirmed model.

My criticism of rational-expectations models is not a criticism of the method of bringing information into general equilibrium theory. By emphasizing the role of information, rational expectations has forced everyone to model some aspects of the process by which new information reaches the markets and to be clear about what is known and unknown, by whom and when. This is a step forward—I would say a long step—from the earlier tradition of deterministic models that relied on errors in the equation to rationalize our dependence on econometric estimates of parameters.

The gain from using the method is limited, however, by the quality of the models with which it is used. In the following section, I discuss the information people have available and, following Knight (1921) and Keynes (1921 and 1936), distinguish between risk and uncertainty. I relate uncertainty to stationarity and propose an alternative to Phelps's (1970) island paradigm. The nonstationary model seems consistent with price-setting behavior in many markets and, I suggest, offers an explanation for this behavior and other commonly observed institutions and practices.

Risk and Uncertainty

The framework used most often to derive or test propositions from models in which expectations are rational follows Lucas (1972). Lucas combined Samuelson's (1958) intertemporal model with a key insight of Phelps's (1970) island paradigm to show that neutrality is temporarily disturbed if people cannot distinguish, on impact, between real impulses or shocks that change relative prices and monetary impulses or shocks that change only the absolute price level.

The innovative feature in recent work is not the discovery that money is neutral. Rigid wages and incorrect beliefs or misperception of future prices have long been used to explain why monetary changes have real effects and why the real effects persist at times. Recent models differ from their predecessors by incorporating the source of misperceptions within the model explicitly. In the island paradigm, spatial separation on islands raises the cost of acquiring accurate information about relative and absolute price changes to a level that is high when new information enters the system, then falls rapidly.

Discussion of rational expectations models often criticizes the assumption of islands or, more usefully, the posited cause of lags in the receipt of
information. Usually, the criticism runs, people can have more information than the model allows. My criticism of current, rational-expectations models is that they endow people with too much information, not too little. Information is drawn from distributions with fixed means and constant variances. Everyone believes that the expected values of real variables (or their rates of change) are constant. Further, people know the rules governing the behavior of the money stock (and other policy variables).

Frank Knight was a pioneer in the analysis of information and the role of information in economic decisions. Knight (1921) believed that the search for economic profit drives the economy. Profits occur because changes are predicted imperfectly. For Knight imperfect knowledge is a consequence of change: “Changes in conditions give rise to profit by upsetting anticipations and producing a divergence between costs and selling price, which would otherwise be equalized by competition” (1921, p. 198).

Knight classifies probabilities into three groups (1921, chapter 7, especially pp. 224-225). A priori probabilities are derived mathematically. The probability that a die or a coin toss will produce a particular value is an example. Knight thought that this type of probability is least important for economics and business. Empirical probabilities rest on classification of instances and are not derivable from mathematical laws or principles. A main reason for distinguishing empirical from a priori probability is that Knight wanted to emphasize the greater amount of judgment involved in classifying events or instances to form distributions where the laws governing the classification are not as well known as the laws governing (say) the probabilities of heads or tails in a coin toss. The distinguishing characteristic of the third class is that “there is no valid basis of any kind for classifying instances” (1921, p. 225, italics in the original).

Knight recognized that the three types of probability differed in degree. In practice, classification is neither certain or impossible. But, Knight wanted to distinguish sharply two types of errors. One is the error made when assigning events to classes. The other is the error made in basing decisions on the ability of particular individuals to classify events correctly. Business decisions are made by managers or entrepreneurs, and the success or failure of a business depends on the correspondence between actual outcomes and the outcomes anticipated by managers or entrepreneurs.

Knight assigned the term risk to uncertain events for which the distribution of outcomes is known either a priori or by classification. He restricted uncertainty to events for which the distribution of outcomes is unknown and the basis for classification is tenuous. The classification of events as risky or uncertain is not immutable. People learn to group (classify) events, and they identify people with the ability to make correct decisions about uncertain events. In these, and other (1921, p. 239) ways, uncertainty can be reduced. But it remains as a source of profits, or Marshallian quasi-rents, to
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decision makers who forecast correctly the direction of change in the mean value.

J.M. Keynes discussed very similar issues at about the same time. In his *Treatise on Probability* (1921), Keynes described the weight of a probability as a relation between evidence and the confidence or degree of belief in the probability assigned to a particular outcome. Probabilities are subjective. The lowest weight is placed on *a priori* probabilities and the weight rises as evidence accumulates. Whenever people gain confidence in their beliefs but believe that an event is less probable, the weight increases as the probability of an event declines (1921, p. 72). In Keynes's terminology, a person who becomes almost certain that an event will not occur places a high weight on a very low probability.

Years later, in his *General Theory*, Keynes distinguished between very uncertain and very improbable (1936, p. 148) by referring to the discussion of weight in his *Treatise on Probability*. He used the distinction to explain the difference between a risk premium and a liquidity premium. The former produces more income; the latter may yield greater utility, a sense of security or confidence, but less income. A well-known example is the nonpecuniary yield that French or Indian peasants receive from the (alleged) practice of holding wealth in gold or silver during periods of stable or falling prices. The peasants are uncertain about the durability of noninflationary or deflationary policies, so they pay to reduce uncertainty. Keynes (1979, pp. 293–294) gives a similar example.

Keynes never refers to Knight, but there is no doubt that he made the same distinction between risk and uncertainty. At one point, he uses reasoning very similar to Knight's to explain the difference between uncertain and improbable. Keynes (1973, pp. 113–114) wrote:

> By “uncertain” knowledge, let me explain, I do not mean to distinguish what is known for certain from what is only probable. The game of roulette is not subject, in this sense to uncertainty; nor is the prospect of a Victory Bond being drawn. . . . The sense in which I use the term is that in which the prospect of a European war is uncertain, . . . or the position of wealth-owners in the social system in 1970. About these matters there is no scientific basis on which to form any capable probability whatever. We simply do not know (italics added).

Keynes argued that in practice, people ignore uncertainty. They act as if the distribution of expected returns is fixed. Expected values are computed on the assumption that future outcomes are drawn from a stable distribution of returns. People know that distributions are not fixed, but they have no better choice than to act as if they are. In Keynes's words, (1973, p. 114) "[T]he necessity for action and decision compels us . . . to behave exactly as we should if we had behind us a good Benthamite calculation of prospect-
tive advantages and disadvantages, each multiplied by its appropriate prob-
ability, waiting to be summed."

Neither Knight nor Keynes appears to reject the key assumption of
Muth's rational expectations—that individuals act as if their subjective
probabilities are identical to the distribution of outcomes required for a
general market equilibrium. Knight stresses that the probabilities that people
use to evaluate risk are obtained from observations and adjust as informa-
tion changes. Keynes's emphasis on weight, and his observation that the
assigned weights change as information changes, have a similar
implication.

The critical difference between these earlier works and current models
is that Knight's and Keynes's discussions of uncertainty recognize nonsta-
tionarity. Their world is subject to change in ways that cannot be foreseen
or predicted from the distribution of past outcomes. These changes are the
cause of profit (and loss) for Knight, and the attempt to minimize cost and
maximize profit in a world of uncertainty is a principal reason for organizing
business firms, delegating power of decision, centralizing decisions, and
compensating executives. Keynes, too, linked uncertainty to the form of
economic organization but drew very different conclusions about business
decisions.

Stationarity and Uncertainty

At a purely formal level, we can assign prior probabilities to any event or to
the timing of any event that we can imagine. The expected value of any
occurrence can be computed, in this formal sense, and decisions can be
described as a choice between expected values.

An alternative, and possibly more useful, way to think about economic
decisions is to distinguish between risk and uncertainty and to treat uncer-
tain events as (unforeseen) changes in the mean of a distribution of out-
comes. The mean of the distribution becomes nonstationary in a sense to be
made more precise in this section. People make decisions by assigning (sub-
jective) probabilities to outcomes, but the only outcomes they consider are
drawn from stationary distributions. As in Keynes and Knight, there is no
basis for assigning probabilities to some occurrences or, if one prefers, for
placing much weight on the assigned probability.

A simple model illustrates the point. Suppose that the process govern-
ning a variable $X_t$ is

$$X_t = A_t e^{\alpha (i) t} u_t$$

where $t$ is time, $A$ and $\alpha$ and $u$ are random walks with, using $ln u$ for illus-
ration:
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\[ \ln u_t \sim N(0, \sigma_u^2). \]

If \( A_t \) and \( \alpha(t) \) are constants, \( \ln X_t \) is expected to change at a constant rate through time. If \( X \) is real income, for example, real income deviates randomly from a constant, stationary trend. In any period, there is risk of departure from trend, but the risk is constrained by the knowledge that the trend is constant. A diversified portfolio of investments can be made in period \( t \) with full knowledge of the return expected to accrue to the owner in period \( t + j \).

The expected value of the logarithm of \( X \) looking forward to \( t \) at \( t + j \) is not a simple random walk around a trend, however:

\[ E \ln X_{t+j} = E \ln A_{t+j} + E \alpha_{t+j}(j - t). \]  

(1.2)

By assumption, \( A \) and \( \alpha \) are random walks, but from equation 1.2:

\[ E \Delta \ln X_{t+n} = E \Delta \ln A_{t+n} + E(\Delta \alpha_{t+n}(n - t) + \alpha_{t+n}) \]  

(1.3)

Changes in \( A \) augment or reduce the level of \( X \) but do not change the system's trend. They appear as one-time or permanent changes in the level of \( X \). Changes in \( \alpha \) alter the trend rate of change. As people look forward in time, the difference between actual and expected \( X \) increases (or decreases) continuously following a change in \( \alpha \). It is no longer true that a diversified portfolio of investments will yield a predictable return if held long enough. Nonstationarity introduces the kind of uncertainty discussed by Knight and Keynes.

To summarize, \( X_t \) changes in three ways. There are transitory, random deviations around the trend line, given by \( u_t \). There are, also, permanent changes in level, \( \Delta \ln A_t \), and permanent changes in growth rate, \( \Delta \alpha \). People cannot observe \( A, \alpha, \) or \( u \) directly. All they know is the history of \( X \) and the information they extract from the best available estimates of \( A \) and \( \alpha \). Muth (1960) used a model with permanent and transitory changes in level to show that the optimal forecast of a variable like \( X_t \) is a distributed lag of current and past values of observables. A model incorporating unanticipated permanent and transitory changes in level and growth rate adds another source of error and incorporates many of the standard issues that economists discuss. Permanent changes in growth differ from permanent changes in level. Transitory changes in growth are persistent (or permanent) changes in level; transitory changes in level are treated as random changes.

Suppose we compute the optimal forecast of \( \ln X_t, E \ln X_t \), and find, later, that the forecast is low. Call the observed error, \( \ln X_t - E \ln X_t, \ln \epsilon_t \). A single observation of \( \epsilon_t \) is not sufficient to distinguish permanent from transitory changes or changes in level from changes in growth rate. Ob-
viously, it is a mistake to equate \( \ln \epsilon_t \) with \( \ln u_t \). Even a series of observations, \( \epsilon_t < 0 \), stretching over several periods can be insufficient to determine with precision the type of change that has occurred. Knowledge that the conditional forecast of \( X_t \) is unbiased and efficient assures that we do not waste information but does not assure that we avoid persistent errors. Until we decompose \( \ln \epsilon_t \) into \( \ln u_t \), \( \Delta \ln A_t \), and \( \Delta \alpha \), we must be prepared for errors that, with hindsight, appear to be correlated.

Every economist who uses market data discovers the substantial difference between dating past and current turning points. On the charts, accelerations and decelerations of money, income, prices, and other variables—or changes in their direction of change—often have sharpness and clarity that is absent at the time the changes occur. Even if every observation is drawn from a distribution with constant mean, large random deviations create opportunities for profit and loss.

The variance of the distribution of \( \ln u_t \) is a measure of risk. The larger is the variance, \( \sigma^2 \ln u_t \), the greater is the risk that at time \( t \) the actual observation will differ from the expected value by a given amount. The difference \( \sigma^2 \ln \epsilon - \sigma^2 \ln u \) is a measure of uncertainty. On the usual assumptions, \( \sigma^2 \ln u \) is constant. Inspection of equation 1.2 suggests that \( \sigma^2 \ln \epsilon \) is an increasing function of time; the variance increases as we look farther into the future. In period \( t + j \), for large \( j \), the risk element is insignificant; \( \sigma^2 \ln \epsilon_t + j \) is dominated by uncertainty.

Figure 1-1 shows the effect of a reduction in \( \alpha \) at period \( t_0 \) and an increase in \( A \) at \( t + j \). The solid line is the actual path of \( X \). If there is no uncertainty, and the mean is constant, the expected value is fixed permanently; \( X \) follows the broken line. Repeated sampling produces estimates that remain within sampling error of previous estimates, and the variance of the estimates is constant.

Permanent changes in level or growth rate produce nonstationary means.\(^8\) When large changes in the mean are relatively frequent, people have difficulty identifying the mean. The critical ability is, as in Knight, an ability to classify events into drawings from a fixed distribution or changes in expected value. In my example, this involves making a correct inference about the expected value of the outcome or, more specifically, classifying an observation as a drawing from the distribution of \( \ln u \), \( E \ln X \) unchanged, or as a change in \( E \ln X \). Further, changes in \( E \ln X \) must be appportioned into permanent or transitory changes in the rate of change of \( X \). The farther one looks into the future, the larger is the potential error of confusing \( \Delta \ln A \) and \( \Delta \alpha \).

Keynes's examples of uncertainty about wars or the future of capitalism are extreme examples but fit the distinction between shifts in expected value and drawings from a distribution with a stationary mean. Prior probabilities can be assigned to these events, and the frequency distribution of wars per decade can be drawn. As the event approaches, typically more informa-
tion becomes available. As Knight suggested, our ability to classify events may improve; in Keynes's terms, the weight on the probability may increase as the time between present and future shrinks.

There is, of course, no reason why every event becomes more certain as it approaches. Contemporary history offers many examples of wars, revolutions, earthquakes, and other shocks that are neither more nor less probable just before they occur. The model implies, however, that there is less uncertainty about near-term than about more distant events.

The forecasting problem does not end when an event occurs. The duration of most shocks is uncorrelated with time of occurrence. To paraphrase Keynes, we simply did not know how long the hostages would remain in Iran, how long the Shah would retain power, when the anchovies would return to the coast of Peru, when rainfall would end the California drought of the midseventies, or how long the Federal Reserve will continue any particular episode of inflationary or disinflationary policy.

Applications and Evidence

The standard model of rational expectations, described for example in McCallum's (1980) survey, ignores uncertainty and nonstationarity. Emphasis
is on the confusion between changes in relative prices and changes in the price level. No student of economics has to be reminded that confusion between relative and absolute prices is important for economic theory and for its application to actual economies. But, a considerable amount of sophisticated, analytical work of very high quality should convince us that a model in which people know the correct expected values one period after an event occurs, and know the policy rules followed by governments, is difficult to reconcile with prewar economic contractions that lasted about two years and postwar economic contractions that last about a year.

Stanley Fischer (1977), Edmund Phelps, and John Taylor (1977), and others have proposed the existence of wage contracts to explain the persistence of recessions. Prices fixed by contracts are sticky, so all prices do not adjust to shocks at once. If wages adjust to new information more slowly than prices, real wages move countercyclically, and profit maximizing firms expand and contract procyclically. Cargill's work (1969) for Britain and the United States suggests, however, that this pattern is not clearly stamped on the real wage changes for the past century. Earlier work by John Dunlop (1938) and Lorie Tarshis (1939) and tests of the wage-lag hypothesis by Reuben Kessel and Armen Alchian (1950) reach similar conclusions. These studies suggest that wage contracts cannot explain the persistence of business contractions.

Two additional features of business cycles provide evidence about persistence. One is the length of cycles whether measured from peak-to-peak or from trough-to-trough. The other is the length of expansions and contractions. The National Bureau of Economic Research chronology provides estimates of these data for all the business cycles since 1854.

One of the most regular features of peacetime cycles is that on average there are four years between peaks and four years between troughs. The averages for twenty-four peacetime cycles—ten peacetime cycles under the gold standard (1879–1919) and five peacetime cycles between 1945 and 1980—differ very little. In contrast, there is a notable difference in the lengths of expansion and contractions. Under the gold standard, cycles are evenly divided between months of contraction and months of expansion. Since 1945, peacetime expansions are one-third longer and peacetime contractions are less than one-half their average length under the gold standard. The average peacetime expansion has lasted four times as long as the average peacetime contraction in the five most recent peacetime cycles.

Under the gold standard, the government had a smaller role in the economy. Tariffs were the principal source of revenue. The monetary "rule" was widely known—gold movements determined the quantity of money. Prior to 1914 there was not central bank, and monetary intervention by the Treasury was limited, as Phillip Cagan (1965) has shown. Tenure rules for employees, wage contracts, severance payments, and firing costs
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were almost certainly less important, since more of the labor force was unskilled and there were few unions to negotiate contracts. In contrast, the years 1945 to 1980 cover a period in which the monetary standard changed from Bretton Woods to fluctuating rates. Many currencies shifted from inconvertible to convertible and back again. The roles of government and labor unions expanded.

Were the rules clearer and the contracts less restrictive in the later period? This seems implausible. If so, the standard rational expectations model—with or without fixed nominal wage contracts—cannot now be reconciled with these facts about the comparative length of expansions and contractions. Fixed nominal wages are not a necessary condition for fluctuations of the type observed in the United States and other market economies.

Friedman's (1957) model of a wealth maximizing consumer, who chooses to allocate consumption and leisure between present and future, is not a model of constant expected income. Muth's development of rational expectations was stimulated, in part, by his interest in finding an optimal method of forecasting a variable like Friedman's permanent, or expected, income that is subject to shocks. He developed a model in which permanent changes occur but cannot be identified immediately. I suggest that this model, with rational expectations, captures part of the distinction between risk and uncertainty and is a more relevant model of the business cycle. Lucas's (1977) discussion of business cycles, unlike his formal models, takes a similar view of cycles.

The model with risk and uncertainty views wage and other contracts not as a cause, but as a consequence of fluctuations in the level and growth rate of economic activity. Workers do not enter implicit agreements or sign contracts that measure (or create) periods of unemployment without receiving some benefit in exchange. The benefit from entering contracts is not very large where there is no uncertainty about the possible outcome. The comparative benefit from fixing wages or hours is not very large if all drawings are made from a distribution with fixed, known mean and constant variance. The benefit of an employment contract is reduced when everyone knows the expected value of lifetime earnings. For example, if real income, \( X_t \), is drawn from equation 1.1 with constant \( A \) and \( \alpha \):

\[
X_t = Ae^{\alpha u_t}
\]

Let \( A \) and \( \alpha \) vary, as above. There is now uncertainty in addition to risk. Contracts and agreements can be analyzed as arrangements for reducing costs of acquiring information, of sharing the costs of variability, and as efficient (or inefficient) arrangements for reducing the costs of variability to the minimum inherent in nature and in social arrangements.
Contracts and agreements are not the only reason for suggesting that the model with risk and uncertainty directs attention to issues that cannot be addressed in a model in which there is only risk. Some of the following questions suggest topics that can only be addressed where \( A \) and \( \alpha \) are permitted to change.

Do Japanese consumers and producers believe that the observed growth rates of real income for the past twenty years have all come from the extreme right tail of the distribution they sampled in the previous hundred years? Do Europeans, Brazilians, or Koreans believe a similar story? Do the citizens of these countries believe that their growth rates can remain permanently above the rates in developed economies? Does anyone believe that the relative size of government or the expected future tax rate is constant, or that the growth rates of real tax burdens in Organization for Economic Cooperation and Development (OECD) countries are constant? If these, and other expected values are not constants, the stochastic process used in standard rational expectations models misses some of the principal uncertainties that most of us face as consumers and producers. These choices include decisions to change saving and consumption in response to changes in permanent income or to shift the allocation of portfolios between financial and real assets when there are permanent changes in the perceived rate of inflation.

**Market Responses**

Some goods and services are sold in fixed price markets, some in auction markets. Labor markets are commonly cited examples of fixed price markets, but retail grocers also post a price and allow purchasers to choose the quantity. Indeed, retail transactions in developed economies are typically made at prices posted by the seller.

An economic rationale for the widespread use of price-setting markets, looks to the comparative advantage of buyers and sellers in acquiring or processing information relevant for announcing (or posting) prices. In the absence of the auctioneer, who calls prices at random, some pricing mechanism is required. The method or approach emphasized in rational-expectations models suggests that the choice of an institution or person to set prices would result from optimizing behavior. The problem is that the island paradigm provides no basis for making a choice of this kind. Everyone has the same information about the mean, and everyone knows that the mean is stationary. If we all draw the same balls from the same urn, there is no room for specialized information.

Frank Knight was an early expositor of what might have been called the economics of information. In Knight (1921, pp. 237–263), he argued that
discussions about what is to be produced, how much, and when, require a pooling of information about the many individual decisions that, when aggregated, constitute a demand curve. Pooling gives rise to firms (productive units) as an efficient arrangement even in the absence of economies of scale in the production process.

A critical point of Knight's argument is that firms reduce uncertainty for consumers. In principle, people can contract in advance for the goods and services they want, but this happens rarely. Individuals are less certain about the magnitude and timing of their own future purchases than firms are about market demand. Knight appeals to the law of large numbers to explain the firms' advantage (1921, p. 241).

A single firm's ability to reduce uncertainty by pooling differs from insurance. Both depend on grouping, but insurable risks must be measurable and susceptible to prior classification. Firms' (noninsurable) decisions possess a greater degree of uniqueness, according to Knight, so decisions require more use of judgment by the businessman when assigning subjective probabilities and computing expected outcomes. Errors of judgment tend to cancel, but only after the fact. The tendency for errors to cancel is weaker for business decisions than for insurance because groups are less clearly defined and decision makers are active for only a short period. Knight mentions moral hazard (1921, p. 251) as one reason why outsiders have difficulty classifying the risks in individual decisions before decisions are taken.

Instead of classifying risks, the market system relies on specialization to reduce uncertainty by concentrating information. Knight discusses several types of specialists, including speculators, entrepreneurs, and managers who centralize information in different ways. Each specialist relies on subjective evaluation of events that are not easily classified into risk distributions.

Knight's discussion lends itself to a view of the business firm as a unit producing or purchasing inventories today for future sale. Or, to put the point in a more contemporary way, production for inventory is a social arrangement that shifts uncertainty from individuals to collective units and, by pooling, reduces the social cost of bearing uncertainty.

Knight's argument for firms is consistent with several different methods of pricing. Consider the pricing of consumer goods. In Oriental bazaars and supermarkets, sellers hold inventories that they resell to final consumers. Prices in the bazaar are negotiated; in the supermarket, prices are posted by the seller. Price setting is not ubiquitous. The problem is to explain which prices are set in advance and which are set in auction markets or in bilateral negotiation. Knight's distinction between risk and uncertainty is useful.

I conjecture that prices are set where costs of acquiring information dif-
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fer for buyers and sellers. One party to the sale internalizes the cost of gathering and processing information. Reasoning similar to Knight's argument about the advantages firms have in setting future production suggests that it is less costly for firms to acquire the specialized information relevant for pricing products. Once prices are posted, the least cost method for the buyer to acquire information about prices is, periodically, to shop at more than one store.\(^\text{13}\)

Compare pricing information at the Oriental bazaar and the supermarket. A trip to two or three supermarkets provides a considerable amount of information about the prices of each of the goods in the buyer's market basket and, simultaneously, comparative information about the relative cost of the buyer's basket if purchased from different sellers. A trip to the Oriental bazaar provides none of this information. Buyer and seller negotiate each price, and there is no way to extract reliable information about prices at other locations or prices of other goods without purchase. Further, the buyer cannot know whether the price he pays is the minimum price at that location. Even after the trade is made, the buyer remains uncertain about the seller's reservation price and must incur relatively large costs to determine whether he is a victim of price discrimination. Moving to the next stall does not give the purchaser an array of prices or comparative costs and provides no information about the reservation price of other suppliers.

Price setting reduces the marginal cost of acquiring information for both buyers and sellers. The supermarket hires purchasing agents who acquire information about prices, thereby converting the cost into a fixed cost and spreading the fixed cost over a large number of units. In a competitive market, this lowers the marginal cost to the buyer of the product.

If the mean of the distribution of prices is invariant, everyone learns the mean value, so the expected price is a common reference point. When there are permanent and transitory changes affecting the level and growth of demand and supply, price setting is a low cost—and perhaps an optimal—method of disseminating information about market conditions. Firms have an economic incentive to set (or announce) prices where they have a comparative advantage in acquiring information relevant for pricing. Posted prices reduce buyers' uncertainty. Where the frequency of price changes is relatively large, and some changes are permanent, demand shifts from sellers that negotiate price to price setters.

We should find price setting as a dominant solution where opportunities for reducing marginal cost differ for buyers and sellers. In markets dominated by professional traders, buyers and sellers have similar costs of acquiring information, so prices are not set in advance. The purchasing agent for the supermarket, in the example, buys some goods in auction markets but sells all goods at preset prices. Retailers of diamond rings buy diamonds in markets where prices are negotiated and sell rings in a set price
market. In the market for existing houses, neither buyer nor seller has, uniformly, a lower cost of acquiring information or an opportunity to internalize the cost.  

These examples suggest that mechanisms for minimizing the cost of Knightean (or Keynesian) uncertainty become important when we want to predict price and output changes in individual markets. The stochastic structure of current rational-expectations models does not distinguish between risk and uncertainty, and the economic structure does not distinguish price-setting firms from firms that negotiate prices or buy in auction markets. Where these distinctions influence the magnitude and timing of price and output changes, the current generation of rational-expectations models will make larger errors than market analysts who use less explicit models or economists who distinguish transitory and permanent changes.

This conclusion about firms is little more than a restatement of Knight’s argument about managers, entrepreneurs, and other people with specialized knowledge or the ability to make better than average decisions under conditions of uncertainty. It is not a general conclusion, however.

Defining rational expectations as the expectations consistent with, or generated from, the best available model sidesteps an important issue. Economists do not use the same structural model for all events. The usual economic model tries to capture the aspects that are considered most relevant to a particular problem. There is a reason to believe that managers and speculators do not differ in this respect from economists.

The less explicit, often idiosyncratic, models that managers or speculators use to classify events and analyze their effects are unlikely to be comprehensive general equilibrium models. When the mean of some distribution changes permanently, their models, like ours, are apt to ignore the information that is outside the (changing) set of events deemed relevant in the past. Generally, this set expands and contracts. Events that are uncertain at one period become more predictable, more readily classified, and more subject to systematic analysis and prediction. For example, at the beginning of an inflation, firms may ignore inflation. Later, many internalize the monitoring cost and learn to predict (or buy forecasts of) inflation.

When large, permanent changes in the mean occur, economists’ models have no clearcut advantage over the speculators, managers, or entrepreneurs because the models do not distinguish permanent changes in mean values and deviations around a fixed mean. The disadvantage can be reduced without abandoning rational expectations. However, it is not clear why, whether, or perhaps when economists can be expected to learn faster than entrepreneurs and managers about the proper classification of uncertain events.
Economists may have no particular advantage in treating uncertainty in individual markets, where they compete with specialists and yet have an advantage with respect to aggregates. To realize this advantage more fully requires, at a minimum, the use of rational expectations models that incorporate uncertainty and gradual learning.\(^{14}\)

**Conclusion**

I have been asked to write about the role of shocks in relation to economic models, particularly rational expectations models. I have argued that there should be no issue about the use of rational-expectations models in economics. As is often true, the issue is the type of model that is most appropriate.

Economists have not settled on one model with known parameter values. There is no agreement on the specific form of the utility function, or other functions, used in our analyses. Frequently, the professional skills of an economist are best displayed in choosing the model most useful for a particular problem. To speak of rational expectations as expectations consistent with the most reliable model is to ignore or neglect a significant part of an economist's professional role—structuring the problem.

The current generation of rational expectations macro-models ignores uncertainty in the sense of Knight and Keynes. I treat uncertainty as a shift in expected value following a shock to either aggregate demand or aggregate supply and claim that this usage is consistent with Knight’s and Keynes’s treatment of uncertainty. A simple model of trend distinguishes between risk and uncertainty and illustrates the point.

Most current rational-expectations models treat prices as if set in auction markets. I suggest that the incorporation of uncertainty, and the distinction between permanent and transitory changes, helps to explain the prevalence of types of pricing. Firms set prices under conditions of uncertainty where costs of acquiring information can be internalized, and reduced, by managers and entrepreneurs. Where information is diffuse, or buyers and sellers have similar costs of acquiring information, auction markets are more common.

Economics is not the science that makes highly accurate monthly or quarterly predictions of individual market responses or of aggregates. The distinction between risk and uncertainty, or between permanent and transitory changes in levels and in rates of change, helps to explain why short-term forecasts are subject to errors that often are large relative to the predicted changes. These distinctions seem highly relevant, also, to such frequently discussed issues as the meaning of unemployment, the relation of spot to forward prices, the term structure of interest rates,\(^{15}\) and the
measurement of the social costs of variable economic policies. I have tried, in this chapter to suggest that the distinction is relevant also to price setting, wage setting, and other institutional practices that remain puzzling if we assume that everyone has access to the same information on equal terms.

Notes

1. In Meltzer (1981), I discuss and interpret Keynes's views on expectations more fully.

2. Muth (1960, 1961) showed the conditions under which distributed lags used by Friedman and others gave optimal forecasts.

3. The stochastic process is described in Karl Brunner, Alex Cukierman, and Allan Meltzer (1980) as confusion between persistent and transitory changes. Lucas's (1977) less formal discussion of business cycles relies on this mechanism. A method of estimating the type of change that occurs is developed by Bomhoff (1982).

4. A very similar objection is made by Hirshliefer and Riley (1979), but these authors do not distinguish Knight's (1921) model from Lucas's (1972).

5. Knight also accepted the terms objective and subjective to refer to the two probabilities, but these terms are now used in different ways, so they are best avoided.

6. Keynes (1979, p. 288) refers to the process of using equivalent certainties to make decisions. A modern treatment might reformulate Keynes's weight in Bayesian terms and interpret low weight as a diffuse prior.

7. A recent application and extension of this framework by Brunner, Cukierman, and Meltzer (1980) provides a more formal analysis and application of some of the ideas in this section with $\alpha$ constant. Beveridge and Nelson (1981) show that this assumption of constant $\alpha$ cannot be rejected for the United States. It would be interesting to see their method applied elsewhere, for example, in Brazil or Japan.

8. The first difference of equation 1.1 is stationary for constant $\alpha$, but the level is nonstationary. Equation 1.3 shows that changes in $\alpha$ eventually dominate the forecast of $\Delta \ln X$.

9. The longest expansion during this period, 106 months, is excluded because it includes the Vietnam War.

10. During the Conference on Crises in the Economic and Financial Structure, at New York University, November 1981, I learned that James Ramsey (1980, pp. 17-18) uses a similar argument to explain why some items (oil leases, timber lots, antiques) are sold at auction.

11. Alchian (1969) uses a similar argument to explain the cost of changing prices.
12. If producers learn about new events more quickly than consumers, a Phillips curve relating the rate of inflation to output for given expected output and expected inflation is positively sloped. Producers increase the demand for labor in response to changes in demand before suppliers of labor (consumers) recognize that, at prevailing money wages, real wages will fall as employment increases.

13. The market for automobiles is another market in which prices of final sales are negotiated. The buyer, typically, trades a used car about which he has more information than the seller. Price, net of trade-in, is negotiated. Ramsey (1980, pp. 17-18) gives other examples.

14. Benjamin Friedman (1979) was one of the first to show that gradual learning is not inconsistent with rational expectations.

15. This point is made by Alex Cukierman (1981).

References


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