

to be based on a fiction and thus may cast doubt on the realism of even the very special case.

Some readers will undoubtedly think that *if* there is a methodological problem here, it is only because we are restricting our method of explanation to the use of calculus methods alone. But, in Chapter 5 we will see that the problems discussed here arise also when calculus is avoided in favor of set-theoretic analysis. For now we will continue to discuss the neoclassical method of explanation exclusively in terms of calculus – if for no other reason than that it is the method first presented to most beginning students in economics.

By narrowing, as we have been so far, on the special properties of a long-run equilibrium, and specifically on the individual's partial (short-run) equilibrium in that case, we are discussing a state of the economy where everything and everybody is accounted for and thus our explanation is logically complete. The next question to consider is, if the long-run situation is as precarious as we think it is when we worry about the empirical meaning of a partial derivative, can we ever expect to apply the same partial equilibrium method of explanation to disequilibrium situations?

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Methods of Explaining Disequilibrium States

> The theory of stable equilibrium of normal demand and supply helps indeed to give definiteness to our ideas; and in its elementary stages it does not diverge from the actual facts of life, so far as to prevent its giving a fairly trustworthy picture of the chief methods of action of the strongest and most persistent group of economic forces. But when pushed to its more remote and intricate logical consequences, it slips away from the conditions of real life.... [I]t is especially needful to remember that economic problems are imperfectly presented when they are treated as problems of statical equilibrium, and not of organic growth.
>
> Alfred Marshall [1926/64, p. 381–2]

> ... it is a mistake to ground disequilibrium theory in the *equilibrium* behavior of agents. Rather, the theory of the household and the firm must be reformulated and extended where necessary to allow agents to perceive that the economy is not in equilibrium and to act on that perception.... Agents in the standard theory react to given prices and take no account either of the fact that prices may change or of the possibility that they may not be able to complete their own transactions. So long as the plans which agents make are compatible, this presents no difficulty; in equilibrium the equilibrium assumptions of agents are fulfilled. If we are to deal with disequilibrium, however, this will not be the case, and we must start at the level of individual agents.
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> Franklin M. Fisher [1983, p. 11]

> ... Models of what is usually called disequilibrium behavior do not make sense and cannot serve as reliable guides to further theorizing or to policy unless they are consistent and coherent. No single equilibrium concept is valid for all situations.
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> Michael Rothschild [1973, p. 1283]

So far we have seen that we can have a complete explanation of prices and quantities if we restrict our understanding to that of an optimizing individual in a special short-run equilibrium where the endogenous givens (i.e. prices, income, capital stocks, etc.) are all the long-run optimum values. What does this mean for our explanation of prices or quantities whenever we examine something other than the long-run equilibrium?

This is not necessarily the methodological problem Arrow [1959] presented when he argued that we must have a different theory to explain prices or the adjustment of prices whenever we are examining individuals outside a market equilibrium. It is the same problem only when we are discussing a non-equilibrium long-run situation – that is, one where at least one person is not maximizing with respect to at least one choice variable, even though every endogenous variable is potentially adjustable. In this case, there would be at least one market that is not clearing. As noted earlier, the demand curve is the locus of price-quantity combinations corresponding to simultaneous utility maximization by all consumers. Similarly, the supply curve represents simultaneous profit maximization by all producers. In the disequilibrium situation where Arrow's complaint does apply, we should be asking whether any imperfect competition theory of price adjustment that Arrow might recommend would ever satisfy the neoclassical requirements of methodological individualism. This question is not easy to answer without seeing explicit examples of such a theory of price adjustment, but if they are typical textbook examples then there will always be unexplained non-natural givens such as those constraints or externalities that limit the number of competitors.

Here we are interested in a more general methodological problem. The question is not just, as Arrow asks, whether we can use the same behavioral theory in disequilibrium as we do in equilibrium. Rather it is whether the same methodological tools and concepts that make complete sense in the long-run equilibrium explanation can be used in a situation that is not a long-run equilibrium.

1. Critiques of Partial Equilibrium Explanations

Some critics of neoclassical economics are not satisfied that partial equilibrium explanations are appropriate at any time. To appreciate the views of the critics, let us itemize the critical elements of the partial equilibrium explanation which are apparent even in this simple version. *First* is the question of the realism of the primary behavioral assumption of optimization or maximization. *Second* is the methodological question of whether the individual firm or consumer actually can ever calculate marginal profits or marginal utilities. *Third* is the question of why the firm or consumer would ever be price-takers, that is, be unable to affect the given prices.

1.1. Realism of Maximization

Herbert Simon [1979] has directly disputed the realism of the maximization assumption of neoclassical economics. But it would be difficult if not impossible to determine empirically whether a decision-maker is a maximizer – particularly so where it is a question of maximizing utility. George Shackle [1972] offers an indirect way to dispute the realism of the maximization assumption by questioning its logical possibility. Following Hayek and Keynes, Shackle argues that maximization must presume that the knowledge necessary for the process of choosing the 'best' alternative has been acquired. That is, if maximization is a deliberate act, Shackle argues the actor must have acquired all the information necessary to determine or calculate which alternative maximizes utility, profit, wealth, etc. He argues further that such acquisition is impossible so deliberate maximization is an impossible act. Unfortunately, the only basis for Shackle's impossibility argument is his explicit espousal of inductivism [Shackle, 1972, p. 407]. Since there is no *necessary* reason for any neoclassical economist to endorse inductivism there will be no reason to think that maximization is necessarily impossible. For a more detailed critique of these two criticisms of the neoclassical maximization hypothesis, see Boland [1981b].

1.2. Necessity of Maximization

There is a related dispute which is concerned with whether the individual decision-maker is a calculating maximizer in the sense of explicitly calculating such things as marginal productivity [e.g. Lester, 1946, 1947; Machlup, 1946, 1947]. But this celebrated dispute missed the point. The question for the economic theorist is whether the decision-maker is maximizing only in the sense that the 'best' alternative has been chosen. How the individual makes that judgment is an entirely separate question. In many cases, the maximization may be unintentional. For example,

when the firm, with only two inputs, say labor and capital, and constant returns to scale, is maximizing profit *with respect to labor* and is forced by market competition to be producing where total excess profit is zero, by equation [1.1] the firm, regardless of its intentions, will be maximizing profit with respect to capital, too. That is, the firm's marginal productivity of capital will just equal the real price of capital regardless of whether the firm actually calculates the marginal productivity of capital. (For our tomato firm, the real price of capital is P_K/P_t.) It still should be recognized that even this possibly unintentional maximization with respect to one input depends on the intentional maximization with respect to the other input, as well as to the existence of a competitive equilibrium. Nevertheless, we can see that maximization *per se* does not have to be intentional.

1.3. Realism of the Price-Taker Assumption

Partial equilibrium analysis in its most direct form usually presumes that all but the choice variables are fixed and given. For the theory of the firm, it usually takes the form of choosing the level of one input and the consequent level of output while everything else is fixed. Specifically, all other inputs are fixed as are all prices. In the simplest case of the theory of the consumer, the variables in question are the single choice variable, such as the level of consumption of one good, and a consequential variable, such as the resulting level of utility or satisfaction, while the income constraint and the prices are fixed and given. The reason for only two actual variables is that the fundamental tool of analysis is the familiar partial derivative, which in the case of the firm represents either marginal productivity or marginal cost (i.e. marginal labor requirements). In the simple case of the consumer, the partial derivative represents marginal utility.

As was noted in Chapter 3, the use of the partial derivative is not restricted to the analysis of Marshallian partial equilibria since Walrasian general equilibria (where all endogenous variables are determined simultaneously) can be analyzed in a similar way. In the Walrasian case, the partial derivative for the various endogenous variables are dealt with simultaneously by considering how they interact. Since calculus is still calculus in both cases, we will restrict our present discussion to the more common Marshallian use – that is, to the idea that individuals are making constrained maximization choices while taking prices as fixed parameters given in the decision making process. In neoclassical economics the use of the partial derivative almost always takes prices as fixed parametric givens for the purposes of explaining the optimizing choice of some real variable, such as the level of inputs or the level of consumption of goods.

Now, if the price is to be determined by the resulting supply or demand decisions, somehow the actions of the firm or the consumer must affect the market price. So, why should the price be considered given? There are two justifications that are often given for the assumption that the decision-makers are price-takers. One presumes that the price is a long-run equilibrium price, in which case the firm would not want to offer a different price since at the equilibrium price total (excess) profits are zero, and if the firm charged a higher price no one would buy its product, and if it charged a lower price it would necessarily be making losses and would thus go out of business. The other assumes that prices are not decided by the firm in the process of deciding its level of output or input, but that prices are determined separately at market time (in Marshall's very short run). This applies equally well to demanders and suppliers.

These justifications reveal a weakness in the partial equilibrium method of explanation. The former implies that the partial equilibrium method can only be used whenever the prices are fixed at long-run equilibrium levels. The latter begs the question of how the firm could ever know what the relevant price levels will be. If we are going to avoid these two questionable justifications, while at the same time relying on the partial equilibrium method of explanation where the individuals are considered price-takers, then we still have to explain why prices are fixed. It would seem that for the fixity of prices, relative to the variables decided by the firm or the consumer, the following is necessary. The quantity, either supplied by a single firm or demanded by a single consumer, must have *no* effect on the resulting market price whenever the individual changes his or her quantity in the market. This will be the case only if the individual decision-maker is very small relative to the market.

For some theorists [e.g. Sraffa, 1926; Koopmans, 1957; Arrow, 1959], this is much too demanding, since this requirement is either inconsistent or impossible. The individual cannot be both affecting the price by his or her demand or supply decision and expecting to take the price as a given since that is contradictory. Opting for the view that the individual is too small will be logically satisfactory only if there is an infinity of participants such that each individual's share of the market is infinitesimal or zero. But, having to argue with a concept of infinity is really admitting that the assumption of fixed (given) prices involves an impossibility. Thus we might conclude that the only time we can have price-taking individual decision-makers is when we are in a state of long-run equilibrium. In this sense, there is an urgent need for understanding the limitations of the very special short-run equilibrium corresponding to the long-run equilibrium. Specifically, how can we ever explain a state of disequilibrium using the method of partial equilibrium analysis?

2. Disequilibrium vs. Individualism

We have seen how the role of any particular individual can be explained as being his or her marginal contribution to the state of the equilibrium. The marginal contribution is explained on the basis that the individual is in a state of partial equilibrium represented by one optimizing point along an implicit continuum of potential choices. We traditionally conceive of the maximizing individual as moving back and forth along a continuum to choose the optimum point. To validate the idea of maximization, the individual is supposed to calculate the appropriate partial derivative and it is for us to show that this calculable partial derivative is necessarily diminishing along the continuum and is necessarily zero at the optimum point. The fact that there are other points along the continuum is very important for the establishment of a necessary maximization condition (falling marginal utility or falling marginal profit). Our explanation thus must not only be why the individual chose the one point that he or she did but also why the individual did not choose any other of the potential points.

For there to be a general disequilibrium (with respect to the long-run equilibrium), at least one individual is not maximizing. The individual's behavior is the basis for explaining the state of disequilibrium. One individual is not in a state of partial equilibrium because he or she has chosen a non-maximizing point along the continuum of possible choices. The key question here concerns our explanation of this individual who is causing the 'disequilibrium'. Should we encounter an individual who is causing a disequilibrium by not maximizing, we can still use the partial derivative to describe this individual's behavior, since the partial derivative also provides a frame of reference to argue that one of the above necessary conditions for maximization is not satisfied for the individual causing disequilibrium. If the partial derivative is diminishing, the individual has chosen a non-maximizing point, that is, one where marginal profit or marginal utility is not zero. How do we explain the individual's non-maximizing choice if the maximizing choice is on the continuum of possible choices? Obviously we cannot say the individual's choice is a maximizing choice whenever a maximizing choice was possible!

These considerations show that a state of disequilibrium cannot be explained in the usual way. We cannot explain it as being a slight deviation from an equilibrium state caused by just one individual's choice while assuming that everyone else is in a state of long-run equilibrium. The only possible exception is when the individual causing the disequilibrium is somehow constrained from choosing the point which would be consistent with everyone's long-run equilibrium choices. Thus, any disequilibrium must be explained by arguments where we are either retreating from the view that everyone is a maximizer or violating the requirements of methodological individualism. Methodological individualism would be violated because we would have to say that some individual is maximizing but subject to possibly unacceptable exogenous constraints. If we are willing to deviate from methodological individualism, perhaps there are many ways to explain the occurrence of a state of disequilibrium. All that is needed is to arbitrarily (i.e. without explanation) fix some of the many endogenous variables as if they were exogenous. Once we have selected an endogenous variable to arbitrarily fix, we can easily return to the use of partial equilibrium analysis. There are many examples of such arbitrarily fixed variables in present day disequilibrium models [see Drazen, 1980].

2.1. Disequilibrium as a Non-individualist Arbitrary Distortion

How can we explain a state of disequilibrium and still use the usual partial equilibrium method of explaining the behavior of individuals? One approach is to view the disequilibrium as a result of prices being fixed at non-market clearing levels. This is often called 'non-Walrasian' economics since no auctioneer is presumed to operate so as to suspend transactions until the equilibrium has been reached at market-clearing prices. Some versions of this approach merely give the auctioneer a different role, namely to ration the supply quantity when there is excess demand or ration the demand quantity when there is excess supply. Once the rationing scheme is set by the auctioneer, the individuals are thought to optimize with respect to the new quantity constraints as defined by the rations. The alleged theoretical issue is to define a rationing scheme which will produce an equilibrium for the given fixed prices [see Bennassy, 1975, 1976; Dreze 1975; Grandmont, 1977a].

Somehow, arbitrarily fixing endogenous variables (such as the real wage-rate) at disequilibrium levels, as has been done in so many macroeconomic disequilibrium models, only begs the question about why decision-makers would choose to fix it at such a level [see Drazen, 1980]. As always, any state of disequilibrium may be explained as temporary in the sense that not enough time has been allowed for adjustment to a new equilibrium after some exogenous variable unexpectedly changed [cf. Grandmont, 1977b]; and, either the insufficient speed of adjustment is a natural given or it, too, is a matter of choice. While the latter possibility seems to hold considerable promise, it really transforms the decision-making situation into one of choosing the optimum dynamic path towards the eventual equilibrium state. How would the individual know what is the optimum path unless he or she already knows what will be the eventual equilibrium state?

Unfortunately, answering this question may require that we assume that each individual possesses *a priori* knowledge of the eventual equilibrium state. Such a requirement would surely expect too much of any individual, except perhaps, in the close neighborhood of the eventual equilibrium.

The question at issue here is how the economy can reach a state of equilibrium when individuals do not have the eventual state of equilibrium in sight? This is not a difficult question whenever we try *not* to think of the individual interacting with other individuals, such as the people encountered in the market place. Whenever the individual is considered as being isolated, and just facing given prices (whether or not they are equilibrium prices), and so insignificant that any adjustment to the quantity demanded or supplied in the market would not cause a change in those given prices, then we can continue to use the partial equilibrium method of analysis. As we noted in the Introduction, this merely raises Arrow's problem about how we are ever going to explain the determination of the price. Nevertheless, so long as we do not try to explain the givens by showing that they are consistent with the remainder of the economy, we can show how an individual might appear to be maximizing utility by purchasing a specific amount of a good or is maximizing profit by producing a specific amount of a good. The explanation would be indistinguishable from the one employed when explaining the behavior of the individual in a state of equilibrium.

So, why is this explanation still considered inadequate by so many economic theorists (Fisher, Hahn, Arrow, etc.)? Surely, if the individual consumer is maximizing utility or profit subject to the specified givens, then the behavior is as explained. Well, there is at least the possibility of a problem of logical consistency which concerns whether the givens taken together make sense apart from the decisions made by the individual. Of course, the givens will make sense if we presume that all other individuals are in a state of equilibrium, such as in the case when the givens are equilibrium prices. But if we do presume this, the situation explained is really an equilibrium situation anyway. This leads us to conclude that if we want to examine an individual in a state of disequilibrium then the givens faced by the individual cannot all have equilibrium values – even if we are using the usual partial equilibrium analysis. Some of the givens must have disequilibrium values. This is why so many theorists insist that to discuss disequilibria we must allow disequilibrium transactions and hence disequilibrium prices [Solow, 1980; Clower, 1965; etc.].

The key issue here is whether there are any limits on what the disequilibrium model-builder can assume about the arbitrarily given non-equilibrium prices or non-individualist and non-natural constraints. The only conceivable limits are those corresponding to the necessary conditions for an equilibrium configuration of prices and the requirements of methodological individualism. If the prices are disequilibrium prices, yet the individual in question is assumed to be maximizing, it means some other individuals are not maximizing. We need to be careful here or we will return to the problem that there cannot be just one individual failing to maximize. To explain the existence of a disequilibrium, while at the same time explaining that the individual in question is maximizing, we need to explain why many other individuals are not maximizing, too. That is, if it is possible for the individual in question to be maximizing while facing the disequilibrium prices, why are the other individuals (those necessary for a state of *dis*equilibrium) not maximizing? It was easier to explain a state of equilibrium since the method of explaining one individual's behavior was consistent, in principle, with the explanation of all other individuals. When we have a state of disequilibrium to explain it appears that our explanation for one individual's behavior will be inconsistent with our explanation of other individuals' behavior.

How is it possible that a single individual's marginal adjustments in search of the optimum quantity to purchase or produce has a zero effect on the price but the aggregation of many individuals does affect the price? The aggregate effect is shown by the downward slope of the demand curve or upward slope of the supply curve which together are the basis for defining any market. Put another way, how small must an individual's adjustment be so as not to affect the given price yet still be a partial equilibrium adjustment in terms of the idea of a maximizing choice? If an individual consumer decides that the optimum amount to purchase requires an increase in demand, the total demand should increase too. Why does this not affect the given price? The given price cannot be the equilibrium price since the equilibrium price is determined by the intersection of the demand and supply curves. But those curves, by definition, require universal maximization by the demanders and suppliers in question. Again, so long as the individual is the only one deviating from a personal equilibrium then there is no difficulty in our theory, as long as that individual does not affect the price and thereby cause other individuals to make compensating adjustments. There is no telling where things would end up if every individual's adjustments did affect the price.

We still have not explained how a single individual is supposed to be making small adjustments to act out the idea of a partial equilibrium and at the same time not affecting the market's equilibrium price. While the idea of freedom to make such adjustments is important for our idea of individualism, the related idea that such partial equilibrium adjustments do not affect the equilibrium price puts into question the role of the

individual in the determination of the equilibrium price. But most important, not only are we unable to explain the role of the maximizing individual in the determination of the equilibrium price, but we cannot use such a method (*ceteris paribus* maximization) to explain the presence of a disequilibrium price.

There is an even more sophisticated problem lurking behind the need to explain why some individuals are maximizing and some are not. How many non-maximizing individual price takers do we have to have to be assured that there really is a state of disequilibrium? This concerns the usual presumption that all decision-makers are price takers, since each individual's contribution to the market is insignificant or 'infinitesimal' (relative to the aggregate contribution of all other individuals). This is another way of saying that a disequilibrium cannot be the result of one individual's choice alone. Somehow, we would have to provide a non-individualist explanation of the state of disequilibrium. Our explanation would be non-individualist because we would have to distinguish a group of non-maximizing individuals each of which is unable to affect the price, even though the group can be large enough to do so. It should be clear that to explain any state of disequilibrium we would have to deviate significantly from the requirements of methodological individualist explanations.

2.2. Disequilibrium as a Failure of Calculus

The source of this problem is not an inconsistency between equilibrium and disequilibrium price behavior as Arrow argues [1959], but the concept of the partial derivative itself. Let us consider again a firm that is not in a state of long-run equilibrium because it is unable to change one of its inputs to the long-run optimum value. Let the fixed input be K. Now, as is common practice in calculus textbooks, the total differential of a function such as the production function f for good X using inputs L and K,

$$X = f(L, K), \qquad [4.1]$$

is *defined* as

$$dX = (\partial X/\partial L)dL + (\partial X/\partial K)dK. \qquad [4.2]$$

It is common to interpret this definition to represent the contribution of L and K to any change in X due to a change in either or both of L and K. The coefficients in front of dL and dK are, of course, the respective partial derivatives. If we were defining L and K here to be the only inputs, or if we were examining a point which is a long-run equilibrium, then f must be linear-homogeneous and thus, as noted in Chapter 1, equation [4.2] can be used to show that

$$X = (\partial X/\partial L)L + (\partial X/\partial K)K \qquad [4.3]$$

by simply setting $dL = aL$ and $dK = aK$ and remembering that the resulting dX equals aX for any arbitrary positive number, a. But here we have said that the firm is not at a long-run equilibrium as it cannot alter one of its inputs (K). Surprisingly, this implies a contradiction. It means that equation [4.3] does not hold unless X, L and K happen to have the correct long-run equilibrium values – which they do not by our initial construction. If there is something constraining the adjustment of K, that something must also be one of the inputs, and it too has a partial derivative. If we represent the constraint as J, then instead of saying equation [4.3] must be true, we say the following is true.

$$X = (\partial X/\partial L)L + (\partial X/\partial K)K + (\partial X/\partial J)J. \qquad [4.3a]$$

What we are saying here is that if there is a constraint causing the disequilibrium, that constraint must be something affecting the level of output. And since the determination of the level of output is represented by equation [4.1], we should alter that equation to be as follows.

$$X = f(L, K, J). \qquad [4.1a]$$

Of course, this only begs the question of the optimality of J, and if it is not optimal then why not? Is it also being constrained? There is an infinite regress hiding here.

If equation [4.3] does hold, but we are still looking at a disequilibrium situation, then the level of the output X is not analyzable into the sum of separate contributions of L and K. That is, each contribution cannot be measured by the size of the input weighted by its respective partial derivative. But, the disequilibrium means the partial derivatives do not truly represent the *ceteris paribus* contributions of the respective inputs since the effects of the variable J must be impounded in the partial derivatives. This failure of analysis arises because of the way economists use functions and partial derivatives. A function, such as equation [4.1], is supposed to represent all things affecting the level of output through the production process; thus anything affecting the level by constraining one or more of the inputs must itself be an input in the process. The partial derivative is used solely because it is implicit in the calculus of a constrained maximization process. But given the way economists use partial derivatives – as parameters of the production function regardless of maximization – what does the partial derivative mean when the individual firm is not maximizing with respect to all inputs?