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counterfactuals. Counterfactuals are what ifs, thought experiments, *Gedankenexperimenten*, alternatives to actual history; they imagine what would have happened to an economy if, contrary to fact, some present condition were changed; in the philosophical literature therefore they are known also as 'contrary-to-fact conditionals'.

The notion has been used most self-consciously in historical economics. For example: 'If railroads had not been invented the national income of the United States in 1890 would have been at most 5 per cent lower.' Counterfactuals are implied, however, in many other parts of economics, such as macroeconomics: 'If a monetary rule with a small growth rate of M_1 were adopted then the rate of inflation would fall.' Or industrial organization: 'If the instant camera industry had 100 suppliers it would be competitive.'

The philosophical problem that counterfactuals raise, and part of the reason they have attracted the attention of modern philosophers, can be seen in the last example. We wish to contrast the present monopoly of instant cameras with (nearly) perfect competition. Perhaps we wish to do so in order to measure the welfare cost of the monopoly and to advise a judge. Now of course if somehow the instant camera industry were to have 100 sellers then each seller would be small relative to the whole demand or supply. Speaking mechanically, the usual formulas for elasticities imply that the elasticity of individual demand facing any one of them would be large, roughly 100 times the elasticity of total supply plus 100 times the elasticity of total demand. Such calculations are the heart of applied economics: If the cigarette tax were lowered what would be the new relative price of cigarettes? If the money supply were increased what would happen to the price level? If foreign doctors could practise freely in the United States what would happen to the cost of American medical care?

Such questions involve looking into a world having, say, an instant camera industry with 100 sellers rather than one. It would not be our world, which saw the miraculous birth of Polaroid, the struggle with Kodak, and the final triumph of patent over antitrust law. So much is clear. But how then is the counterfactual world to be imagined? A world in which the conditions of technology, personality, and law resulted in 100 Edwin Lands and 100 miniature Polaroid companies would be a different one - there's the condition contrary to fact.

The problems which can afflict counterfactuals are two: vagueness and absurdity. The vagueness arises when the model has not been fully specified. The world could arrive at 100 companies in many different ways, each with different implications for the original question about welfare. One can imagine getting 100 Polaroid companies, for example, by fragmenting edict now, well after the invention, in the style of the American Telephone and Telegraph case. Whatever the advantages, there might be inefficiencies in this. It would certainly change the future patent law. The change in law would in turn change things for good or ill elsewhere in the economy. A world in which patents are granted and then prematurely abrogated differs from the present world. Alternatively one might imagine subsidies in the 1940s that would have resulted originally in 100 alternative technologies of instant cameras (though actually only two were invented). This counterfactual likewise would have its costs, though different ones, changing for example the expectations of inventors about subsidies. A counterfactual requires a model broad enough to do the job.

Vagueness is solved by explicitness. The conditions required for various counterfactuals are made explicit, and being explicit can be tested for plausibility. Historical economists have been making counterfactuals explicit since the 1960s, using them to explore the causes of the American revolution and the consequences of American slavery (the counterfactual work is well surveyed by McClelland, 1975).

In the most famous use of counterfactuals Robert W. Fogel (1964) calculated what the transport system of the United States in 1890 would have looked like without railroads. He argued that evaluating the 'indispensability' of the railroads entailed calculating what American life would have been like without them. Some historians were reluctant to talk about such a counterfactual, saying that it was 'as if' history, quasi-history, fictitious history - that is not really history at all ..., a figment' (Redlich, 1968, in Andreano (ed.), pp. 95f). But economists find the notion natural, and philosophers accept it as routine. Indeed, the philosophers point out that the following are nearly equivalent (Goodman, 1965, p. 44):

Scientific Law: All inflations arise from money growth.

Causal Assertion: Money growth alone causes inflation.

Factual Conditional: Since inflation has changed, money growth has changed.

Dispositional Statement: Inflation is controllable with money growth.

Parallel Worlds: In a world identical (or sufficiently similar) to ours except that money growth differed, inflation would be different.

Counterfactual: If money growth were to be held at zero, inflation would be zero.

The philosophy of counterfactuals revolves around the translation of one of these into another. Historians, not realizing that one is translatable into the other, flee the counterfactual in terror and cling to the causal statement. Yet economists have on this score no cause for smugness, since they have parallel philosophical fears. Economists flee the causal statement as historians flee the counterfactual, and believe as historians do that the thing itself can be avoided by suppressing its name.

Fogel's calculations stirred great controversy, but were robust (Fogel, 1979). Since he was interested in long-term economic growth he did not imagine a sudden closure of the railroads in 1890: that clearly would have resulted in a very large drop in national income. Mental experiments like this commonly lie behind claims that railroads (or airlines or postal services or garbage collection) are 'essential'. Fogel imagined instead what the American economy would have looked like without access to railroads from the beginning, forced from the 1830s onward to rely on substitutes.

Such an economy would have invested more in canals and roads (Fogel introduced some of these into his counterfactual world, using contemporary engineering studies proposing them). It would have been an economy closer to waterways, with a bigger St. Louis and a smaller Denver. It would doubtless have invented more improvements in road transport, arriving at internal combustion a little earlier than the world we know.

Fogel could not specify every feature of the 'true' counterfactual world. But he suspected anyway that the true counterfactual would give a national income only a little below the actual. To test the suspicion, therefore, he biased the case against himself, choosing a 'practical' counterfactual world in which income would be if anything lower than in the true counterfactual: he did not introduce the internal combustion engine before its time; and he did not shift the location of the population to accommodate the non-railroad transportation. He forced his practical counterfactual to carry supplies by river, canal and horse cart (not by the motor trucks that might have been) to a Denver no smaller than it actually became at the height of the railroad age. The result was a calculable upper bound on the true impact on national income: since the 'true' counterfactual would have economized relative to the clumsy 'practical' counterfactual, a use of the practical counterfactual biases the case against a large impact. Fogel reckoned that the impact was at most five per cent of 1890 income, a couple of years of economic growth.

He was merely applying in a bold way the usual methods of economics. The usual method is to imagine an explicit economic model, M , with parameters, P , and initial conditions (or exogenous variables), I , and results by way of endogenous variables, R . The counterfactual varies some element of the setup, the simplest being a variation in I – where I might be a tax rate in a model of cigarette consumption or the number of firms in a naive model of instant camera pricing – and examines the results. Fogel removed from the initial conditions one of the technologies of transportation. In similar fashion a 500-equation model of the American economy permits experimentation in counterfactual worlds: What would happen if the price of oil fell? What would be the effect of a tax change? (The main empirical attack on Fogel's finding, indeed, was an highly explicit general equilibrium model of the Midwest and East (Williamson, 1974).)

Counterfactuals are one of the two main ways that economists at present explore the world (the third, controlled experiment, is still not common). The first is regression, or the comparative method, asking how *in fact* results have varied with initial or exogenous conditions. The second is the counterfactual, or simulation, asking how the results *would* vary. The regression infers parameters P from data on initial conditions I and results R and from arguments about the model, M ; the counterfactual simulation infers R from data on P and from arguments about M and I .

But in solving the vagueness of counterfactuals by positing explicit models the economist runs against the other philosophical problem of counterfactuals: absurdity. Consider again the counterfactual of a 100-firm industry selling instant cameras. The problem is that the initial conditions that would lead to such an industry may themselves be absurd. Indeed, they may violate the very model used. The counterfactual assertion 'If the instant camera industry were perfectly competitive then price would be lower than it is now' takes on the character of the proverbial line 'If my grandmother had wheels she'd be a tram.' The model may be true (wheeled grandmothers may indeed be trams) but the counterfactual may be impossible – that is, a contradiction of the model itself or of some other, wider model felt to be persuasive.

It is possible to argue on these grounds that *all* counterfactuals are absurd. One might argue, as did Leibniz, that a world that did not invent the railroad would strictly speaking have to be a world different from ours right back to the big bang. Such a world might be one in which the seas were boiling hot or pigs had wings, with different transportation problems. The theory being violated by the counterfactual is the theory that the world hangs tightly together. As J.S. Mill remarked in attacking counterfactual comparison of free trade and protection, 'Two nations which agreed in everything except their commercial policy would agree also in that' (1872, p. 575).

A less intense scepticism on the matter has figured widely in economics. The theory of games, for example, can be viewed as an inquiry into counterfactuals, which sometimes violate wider theories (Selten and Leopold, 1982); the usual criticisms of the Cournot solution made by students of industrial organization involve the same point. Most notably, the Lucas Critique of econometric policy evaluation (Lucas, 1976) can be restated as a criticism of the usual counterfactual. The usual counterfactual imagines the effects of a change in the initial conditions I on a model M with given parameters P , fitted under the old regime. A new monetary policy would change the regime under which people believed they operated, changing P and M as much as I . Some broader model of how people adjust to regime changes is necessary to decide which would change: a new policy believed to be temporary would have very different effects from one believed to signal a revolution in government. The usual counterfactual violates the broader model, by supposing that people do not anticipate changes of regime or understand them when they occur. A broader model of rational expectations shows the counterfactual to be absurd.

John Elster, in a penetrating discussion of the role of counterfactuals in the economic sciences, posed the Basic Paradox of Counterfactuals: the less vague the theory, the more likely is a counterfactual using the theory to encounter absurdity. If Fogel had developed a theory of invention to draw a less vague picture of road transport without railroads he would have faced the problem that the very theory would predict the existence of railroads. After all, railroads were actually invented and therefore should be predicted by a sound theory of innovation. Elster wrote, 'If he attempted to strengthen his conclusion ... he would be sawing off the branch he is sitting on. In this kind of exercise it is often the case that more is less and that ignorance is strength' (1978, p. 206). The counterfactual must be 'capable of insertion into the real past'.

The Basic Paradox illuminates the discussion in economics about simplicity of models. A simpler model is harder to believe in its simulation because it is not so rich; but because of its lack of richness it is more likely to be insertable into the real past. A 500-equation model of the economy will more tightly constrain the past from which it comes than will a 10-equation model. Model selection has its own type I and type II errors.

Many of the meta-criticisms of economics, then, reduce to remarks about a counterfactual. This is scarcely odd, since counterfactuals are equivalent to causal statements and the point of economics is to make causal statements. The philosophical literature on counterfactuals is illuminating, though large, technical, and mainly inconclusive (Lewis, 1973; Goodman, 1965). It comes to a position more sophisticated than mere scepticism. Counterfactuals are a way economists speak, and philosophers wish usually to assist the speaking, not end it. Self-aware or not, economists will go on speaking counterfactually about non-cooperative games, macro-economic policy, and the retrospective welfare calculations of historical economics. The task of a philosophy of the economic counterfactual would be to understand the practice, not to change it.

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See also CLIMETRICS; MODELS AND THEORY; PHILOSOPHY AND ECONOMICS.

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