Causality in Macroeconomics

KEVIN D. HOOVER
University of California, Davis

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The Problem of Causality in Macroeconomics

> England has not a guinea at our service; economy and Hume are the fashion there.
>
> – Stendhal, *The Red and the Black*

The ultimate justification for the study of macroeconomics is a practical one – to provide secure knowledge on which to base policy. Policy is about influencing outcomes, about control or attempted control. The study of causality in any particular context is the study of the particular connections that permit control of one thing to influence another. Causal understanding is implicit in policy discussions. The never-ending debate over whether the Federal Reserve should raise or lower the federal funds rate hinges on disputed causal beliefs: An increase in the rate will result in lower inflation, higher unemployment, lower investment, and lower stock prices.

Causal questions can be generic ("do monetary shocks or technology shocks cause business cycles?") or singular ("did the Iraqi invasion of Kuwait cause the 1990/91 recession in the United States?"). They can be retrospective (as in Peter Temin's 1976 title, *Did Monetary Forces Cause the Great Depression?*) or prospective ("will a cut in the tax rates on capital gains cause a boom in investment?"). Causal language is often explicit, but not always. Classic disputes in macroeconomics frequently turn on causal questions, even when causal language is explicitly eschewed. The modern argument over monetarism is really a question of the causal direction between money, on the one hand, and prices and nominal income, on the other. For some participants the issues are stated in forthrightly causal language (see, e.g., Laidler 1991); for others, the causal issues are recast in noncausal terms (Milton Friedman 1956 prefers to talk about the stability of the demand for money). Yet, for all participants, the question is, what happens to the economy as a result of the money supply increasing? The question is one of control, although it

may be posed in every tense and mood: Did the Federal Reserve cause the Great Depression? If it had expanded the money supply in 1929, would it have caused the good times to continue and so avoided the Great Depression? Are its current policies the cause of the current boom? If it were to raise interest rates would it cause that boom to end?

It is sometimes argued that control is not the central issue, that as disinterested scientists, economists (who love to think of themselves as scientists) should be concerned with explanation. The issues of control and explanation operate on different levels. A practically minded policy-maker might want to know only what causal relations in fact obtain. That knowledge is, however, grounded in a causal explanation. A more disinterested economist might want to know why a particular causal relation holds – what is its deeper explanation? What is sought, however, is understanding of why control is possible. An adequate causal explanation provides the basis for informed attempts to control particular variables.

Causal analysis has a long history in philosophy, and causal reasoning has a long history, not only in the sciences, but in everyday life. The issue posed in this book is, what is the place of causal analysis in macroeconomics? The questions to be faced are partly philosophical ("what are causes?" and "what is the nature of causal talk?") and partly methodological ("what procedures of causal inference are suitable to macroeconomics?"). While these questions are discussed in a detached and, sometimes, abstract manner, their importance stems entirely from the practical policy orientation of macroeconomics. The last two chapters illustrate the practical lessons of the first eight.

1.1 THE LEGACY OF DAVID HUME

A river does not have a definite beginning. Before its stream bears a name, lakes and springs and hidden rivulets combine to supply its waters. For all that, we recognize the headwaters. Before David Hume's discussion of causality there was Aristotle and the Scholastics and Nicolas Malebranche; before Hume's account of the quantity theory of money there was Jean Bodin, John Locke, and Richard Cantillon. Yet Hume, the central figure of the philosophical school of British empiricism and the author of the definitive eighteenth-century statement of the quantity theory of money, stands at the headwaters of all modern discussions of both causality and macroeconomics. Let us begin with Hume.

Accounting for Macroeconomics – Causally

Hume's contribution to what may be called – anachronistically – the macroeconomics of the eighteenth century was fundamental. It is found

in the three essays "Of Money" (1754a), "Of Interest" (1754b), and "Of the Balance of Trade" (1754c). Explicitly and implicitly, Hume's discussions of the role of international trade and specie flows are unabashedly causal. And Hume is clear on the reason:

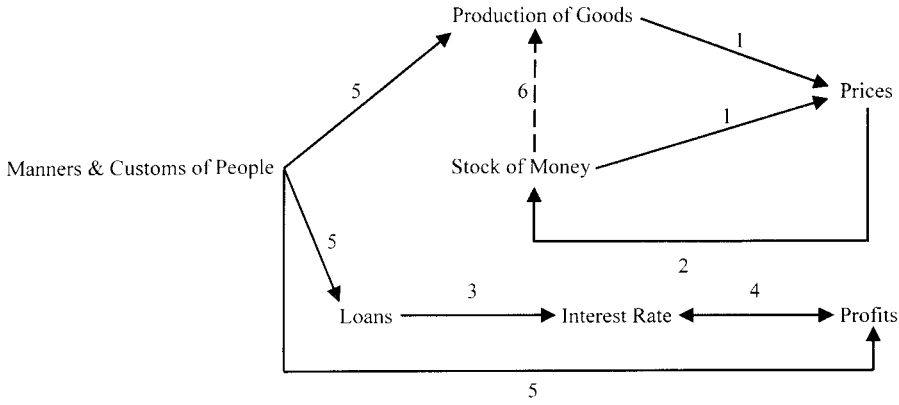
> But still it is of consequence to know the principle whence any phenomenon arises, and to distinguish between a cause and a concomitant effect. Besides that the speculation is curious, it may frequently be of use in the conduct of public affairs. At least, it must be owned, that nothing can be of more use than to improve, by practice, the method of reasoning on these subjects, which of all others are the most important; though they are commonly treated in the loosest and most careless manner. [Hume 1754b, p. 304]

In a word, Hume's interest in a causal account of the macroeconomy is both that of the detached philosopher (or scientist) – "the speculation is curious" – and of the would-be policy advisor for whom causal knowledge "may frequently be of use."

As the philosopher who first insisted on a sharp distinction between "is" and "ought to be" (Hume 1739, book III), Hume realized that a useful macroeconomics (normative) must begin with a successful speculation (positive) on the mechanisms of the macroeconomy.[1] Despite Hume's literary style, his three essays are recognizably economics – and the mechanisms described explicitly and implicitly causal. The quantity theory has been debated in various forms since the sixteenth century. It remains "always and everywhere controversial" (to use David Laidler's 1991 phrase), not least because of the causal issues involved. These issues are particularly clear in Hume's essays, which provide us with an excellent exemplar of the place of causal reasoning in macroeconomics – all the more excellent because, with due account for changing institutional structure, Hume's doctrines or close relatives remain central to the contemporary debate.

Five interrelated causal mechanisms dominate the three essays. The first is the *quantity theory of money* proper: The stock of money in relation to the stock of available goods causes the level of prices to be what it is. If foreign prices are given, then an increase in the stock of money causes relative prices (i.e., domestic prices relative to foreign prices) to rise. The second is the equally famous *specie-flow mechanism*: Relative prices cause money (precious metals) to vary inversely. The third is what might be called the *loanable funds doctrine*: The supply of and demand for loans are one cause of interest rates. The fourth doctrine holds that there is another causal mechanism in financial markets: Interest rates and

[1] The positive/normative distinction is, of course, merely the economist's translation of the distinction between "is" and "ought."



Hume's Theoretical Explanation for the Causal Links

1. Quantity Theory of Money	4. Arbitrage Doctrine
2. Specie-flow Mechanism	5. Sociological Doctrine
3. Loanable Funds Doctrine	6. Temporary Non-neutrality of Money

Figure 1.1

profit rates are mutually causal. This might be called the *arbitrage doctrine*. Finally, fifth, Hume maintains a crucial portmanteau mechanism, which we might regard as the ultimate *sociological doctrine*: The "manners and customs of people" cause the production and demand of goods, the supply of and demand for loans, and the rate of profits. Figure 1.1 uses arrows (each one marked to indicate which element of Hume's doctrine justifies the linkage) to show the causal influences among these macroeconomic variables as Hume understands them.[2]

A number of features of Hume's discussion are worth noting. For Hume, causation is a process. Although he refers to the time order of causes before effects relatively infrequently, the idea of causes unfolding is central. Hume dismisses money in the long run as a cause of prosperity; but, along the path to a long run in which prices have fully adjusted to increases in the money stock, increases in production and employment are important. Cause is quantitative as well. It is not just that an increase in money causes prices to rise in the long run, it is that it causes prices to rise one for one: money is "neutral" in modern terminology. (The short-run non-neutrality of money is indicated by the

[2] There is no reason to believe that Hume would have regarded the linkages reflected in Figure 1.1 as the complete set of causal connections in the macroeconomy, although they are the ones that receive his fullest consideration.

broken arrow running from the *Stock of Money* to the *Production of Goods* in Figure 1.1.)

Cause is asymmetrical in Hume's account. He recognizes cases of mutual causality. The quantity theory taken together with the specie-flow mechanism is a case of money causing relative prices and relative prices causing money. Hume envisages these mechanisms as separated in time and distinct. They nevertheless provide the notion of an equilibrating mechanism in which the issue of time ordering is secondary. The mutual causality of the arbitrage relationship between profits and interest rates is so direct that Hume hardly implies, much less discusses, time ordering. In the language of the modern statistician, correlation is not causation for Hume.

Correlation is not causation in another sense as well. Causes are often hidden below their surface manifestations in Hume's account. An apparent correlation between interest rates and money is explained, at least in the long run, by a common third cause: Both are the effects of the manners and customs of people. That the specie flow fails to correspond to Hume's causal mechanism is explained by a countervailing or confounding cause: Paper money displaces precious metals.

Causes are efficacious. Hume's essays are famous for a series of thought experiments: "Were all the gold in ENGLAND annihilated at once, and one and twenty shillings substituted in the place of every guinea . . ." (Hume 1754b, p. 296); or "suppose that by a miracle, every man in GREAT BRITAIN should have five pounds slipt into his pocket in one night . . ." (Hume 1754b, p. 299); or, again, "[s]uppose four-fifths of all the money in GREAT BRITAIN to be annihilated in one night . . ." (Hume 1754c, p. 311). Hume rarely reasons from a correlation, a repeated conjunction, to an effect. Instead, as with the consequences he draws from these antecedents, Hume starts with a prior, or commonsense, understanding of elementary causal connections and composes them into larger causal structures in which effects can be reliably expected to follow causes. He takes it, for example, to be obvious that money flows alter expenditure and that prices rise in the face of rising expenditure, and so concludes that money causes prices. The implicit message of Hume's thought experiments is that causation is *counterfactual* (determining "what would happen if?") and *compositive* (causes can be linked together to connect to effects in ways that are indirect and not obvious). Causes are implicitly defined by their efficacy in producing effects. This property of connecting what-is with what-is-not-yet underwrites inference beyond experience and connects Hume's positive analysis of the macroeconomy with his normative interests, in the sense that causal understanding may permit us to guide and shape future outcomes according to our goals and desires.

Hume did not hesitate to conduct causal analyses with the aim of giving policy advice. In "Of Money" Hume argued that the true cause of national prosperity was not, as the mercantilists had thought, the abundance of precious metals. In "Of Interest" he argued that the true cause of the low rates of interest was, again, not the abundance of precious metals. In each case, "a collateral effect is taken for a cause, and . . . a consequence is ascribed to the plenty of money; though it be really owing to a change in the manners and customs of the people" (Hume 1754b, p. 294). The causal direction was in fact exactly opposite to what the mercantilists believed: "when commerce is extended all over the globe, the most industrious nations always abound most with the precious metals" (Hume 1754b, p. 304). Hume provided evidence for a causal account to satisfy his philosophical curiosity and concluded "Of the Balance of Trade" with categorical policy advice:

> In short, a government has great reason to preserve with care its people and its manufactures. Its money, it may safely trust to the course of human affairs, without fear or jealousy. Or, if it ever give attention to this latter circumstance, it ought only to be so far as it affects the former. [Hume 1754c, p. 326]

The ultimate rationale for macroeconomics is to give policy advice, even when the advice, as it is for Hume, is to do nothing.

Hume's discussion is remarkably fresh. Allowing for appropriate modifications to adapt to substantial institutional changes, his theories remain, in broad outlines, active in the economic debate, in large measure reflected in monetarism and the monetary approach to the balance of payments. The problems that he posed have been continuously before economists and policymakers for the past 250 years. A topical concern for current economic policy animated the debate, just as it had for Hume. Many of the issues raised in the essays – e.g., the appropriate definition of money or the quality of economic statistics – have remained important. But no issues have been as central as the questions of causal direction between money and prices and output. Let us trace the main lines of the debate from Hume to modern times.[3]

The English Bullionists of the early nineteenth century and the Currency School of a generation later supported an essentially Humean view of the monetary mechanism. On the basis of substantially improved

[3] Laidler (1991) provides an excellent survey of the history of quantity theory of money directed at the question of why the debate over it remains unresolved – why it is "always and everywhere controversial." A central element of Laidler's explanation is that it is principally a causal theory and the problem of inferring causal direction from empirical data remains unresolved. See also Blaug (1995a, b).

statistics, painstakingly collected, Thomas Tooke (1838–57, 1844), a leader of the Banking School (the opponents of the Currency School), argued that causality ran exclusively from prices to money – in the opposite direction of Hume's quantity-theoretic causal linkage (linkage 1 in Figure 1.1). Opinion shifted away from the quantity theory. Toward the end of the nineteenth century, it was revived by Simon Newcomb and Irving Fisher, with another classic formulation in Fisher's (1911/1931) *Purchasing Power of Money*. Fisher's understanding was clearly causal, as was that of his opponents, J. L. Laughlin among others. Paralleling Fisher's revival of the quantity theory in the United States, Alfred Marshall and the Cambridge school revived it in England. John Maynard Keynes was at first a doctrinaire quantity theorist, and in the *Treatise on Money* (1930/1971, p. 120) expressed his theoretical ambitions in explicitly causal language. By the time of *The General Theory* (1936), Keynes turned away from both the quantity theory, in which he was joined by the Stockholm school, particularly Bertil Ohlin and Gunnar Myrdal, and explicit causal argument, in which he was not. In opposition to Keynesianism, Friedman and his students and colleagues reasserted the quantity theory once more.[4] Again, the debate was implicitly causal throughout – and sometimes explicitly so. James Tobin (1970) argued that Friedman was misled by the timing of money and price and income data to conclude that money caused nominal income and prices (see Friedman 1970 for his reply).[5]

Friedman is emblematic of the fate of causal discourse in macroeconomics. The disputes over the quantity theory in which he has engaged are clearly disputes over causes. J. Daniel Hammond's (1996) book is subtitled *Causality Issues in Milton Friedman's Monetary Economics*. Yet, as Hammond (1992, pp. 91–98) documents, Friedman is reluctant to use the language of causality, preferring to talk of stable associations and functional relationships among variables. Causal language has fallen into disrepute, and Friedman, like many other modern macroeconomists, instinctively or self-consciously avoids it. Ironically – for he is himself promiscuous in talking of causes in macroeconomics – the avoidance of causal talk arises from an empiricist sensibility of which Hume is the intellectual wellspring.

[4] Especially in Friedman's edited volume *Studies in the Quantity Theory of Money*, and, in particular, his own essay in that volume (Friedman 1956). Also see Friedman and Schwartz (1963a, b; 1982), Friedman (1968).

[5] Christina Romer and David Romer (1989) have argued a position meant to parallel Friedman and Schwartz's, backed up by more sophisticated econometric evidence. Hoover and Stephen Perez (1994a) played Tobin to the Romers' Friedman and Anna J. Schwartz. Also see Romer and Romer (1994) and Hoover and Perez (1994b).

Accounting for Causes – Economically

The empiricist sensibility embodied in the received view of the philosophy of science, represented by logical positivism and its constructive critics, such as Karl Popper, Willard Quine, and Imré Lakatos, is the (often unacknowledged) background to the portrait of the economist as scientist, which economists typically paint when they engage in methodological reflections on their discipline.[6] It is no accident that Friedman, reluctant to use causal language, is the author of the famous "Methodology of Positive Economics" (1953), a work squarely in the tradition of the received view. The received view is one line of descent from Hume's empiricism. Hume's empiricism is presented in his essential philosophical work, *A Treatise of Human Nature* (1739), and more engagingly in *An Enquiry Concerning Human Understanding* (1777).

Hume's empirical philosophy is an economical construction, animated by a single premise: All human perceptions derive from sense impressions. Ideas, which form the other variety of perceptions, are themselves analyzed as a faded variety of sense impression, so that every idea is ultimately resolvable into sense impressions.

The idea of cause is no different than any other idea. What sense impressions give rise to the idea of cause and effect? Hume believes that the idea of one billiard ball striking another and causing it to move resolves into three elements.[7] First, the cause is spatially contiguous with the effect (one billiard ball causes another to move when it touches it). Second, the cause precedes the effect (the ball that moves first is the cause; the other is the effect).[8] Third, the cause must be necessarily connected to its effect (the action of the first ball reliably sets the second into motion). (Hume (1739, pp. 77, 90–91) considers the idea of *necessary connection* to encompass what others mean when they refer to causes as "productive" or as having "power" or "efficacy.")

The first two elements of the idea of cause are given in sense experience. But we do not directly perceive necessary connection. Still, Hume (1739, p. 77) is loath to dispense with necessary connection, arguing that it "is of much greater importance" than the other two elements. After canvassing a variety of alternative sources for the empirical basis of the idea of necessary connection, Hume concludes that it could only be the

[6] See Nagel (1961) for a standard account of the received view. See Blaug (1992) and Hausman (1992) for recent critical accounts with reference to economics (cf. Hoover 1995a).

[7] Hume's account of causality is developed in book I, part III of the *Treatise.* See also the *Enquiry*, sections IV–VIII.

[8] Because of worries about mental causes, Hume ultimately drops the requirement of spatial contiguity.

experience of the "constant conjunction" of cause and effect that gives us the idea of a necessary connection between them. The necessity is the "custom" or "determination" of the mind, a result of frequent repetition, to connect the cause with the effect rather than a property of the objects that are related causally (Hume 1739, p. 156).

The customary conjunction of cause and effect is, for Hume, truly constant. Laws of nature codify the exceptionless regularities between particular observables that constitute scientific knowledge. There is no chance in the world – only ignorance of real causes (Hume 1739, p. 125; 1777, p. 56). The idea of laws as exceptionless relations between facts may well predate Hume; but, after Hume, it has cast a powerful spell over philosophers and, indirectly, over the conception of a law of nature held by scientists and laymen alike. Hume has been read as dismissing necessary connection in favor of constant conjunction, so that cause becomes a mere honorific title – best dispensed with – for law-governed regularity. Famously, Bertrand Russell (1918, p. 180) dismissed causality as "a relic of a bygone age, surviving like the monarchy, only because it is erroneously supposed to do no harm."[9]

Hume's skepticism is thorough. In the course of overthrowing the notion that necessary connection resides in the causally connected objects, Hume (1739, p. 89) states the *problem of induction*: "There can be no *demonstrative* arguments to prove *that those instances, of which we have had no experience, resemble those, of which we have had experience*." The problem of inductive warrant undermines Hume's own account of causality (Mackie 1980, p. 26). Hume wants to use the constant conjunction of cause and effect in the past to reason from causes to effects in the future, yet there can be no demonstration that the conjunction will remain constant. The philosophical tradition that includes logical positivism has taken Hume to have dismissed necessary connection and replaced it with constant conjunction. But the problem of induction has remained a festering sore on this law-based empiricism. Deeper reflection suggests further difficulties and paradoxes: If laws are statements of regularity, are all regularities lawlike? Or is there a distinction between accidental regularities and nonaccidental (lawlike) ones? If not, how is the lawlike regularity to be picked out? If conjectured laws are confirmed by their instances, what counts as a confirming instance?[10]

[9] Cartwright (1989, p. 7) directs her criticism of an acausal approach to science explicitly at Russell, rather than Hume, and so seems to agree that the standard reading misconstrues Hume.

[10] Two famous examples of paradoxes involving these questions are due to Hempel (1945, esp. p. 13 ff.) and to Goodman (1965, p. 73 ff.). Hempel's paradox is why do the numerous examples of nonblack nonravens (e.g., snow or water) not confirm the induction "all ravens are black," since it is logically equivalent to all nonblack things are non-

Hume's skepticism is a powerful solvent. He does not deny that there are powers at work behind sense impressions. He does deny that we can know anything about them. And he argues that we should not let the vague idea of them lead us astray from the clear and distinct ideas we do possess (Hume 1739, p. 68). He does not deny that there is some ultimate connection between cause and effect beyond their constant conjunction, but only that we can know what it is (Hume 1739, pp. 91–92). And he does not deny "that the operations of nature are independent of our thought and reasoning" (Hume 1739, pp. 168–169). Rather, he denies that the necessary connection of cause to effect is independent of our minds.[11] For Hume, knowledge is either knowledge of the empirically observable or of the logical and mathematical relations among ideas. (Hume (1739, book I, part II) gives an empiricist account of mathematics as well.) His inquiry into the foundations of knowledge, which began with sense impressions as the source of all knowledge, terminates in complete intellectual housecleaning:

> *Does it contain any abstract reasoning concerning quantity or number?* No. *Does it contain any experimental reasoning concerning matter of fact and existence?* No. Commit it then to the flames: for it can contain nothing but sophistry and illusion. [Hume 1777, p. 165]

Hume's uncompromising empiricism inspired generations of philosophers. It is evident in the logical positivist distinctions between sense and nonsense and in the interest of Popper, Lakatos, and others, in the criteria that demarcate science from nonscience. It would be an easy surmise, but a wrong one, to think that Hume anticipated Russell and regarded causal connection as a barbarous relic – one of those bits of metaphysics that should be committed to the flames. Causality, for Hume, remains the central element in scientific understanding, whether regarded with disinterested intellectual detachment or completely practically. In the *Enquiry* he writes:

> For surely, if there be any relation among objects which it imports to us to know perfectly, it is that of cause and effect. On this are founded all our reasonings concerning matter of fact or existence. By means of it alone we attain any assurance concerning objects which are removed from the present testimony of our memory and senses. The only immediate utility of all sciences, is to teach us, how

ravens? Goodman's paradox is why do observations of emeralds up to the present, which is before time *t*, confirm "all emeralds are green" but not "all emeralds are grue," where "grue" is defined to mean green before time *t* and blue after time *t*? While these appear to the outsider to be trivial (almost silly) puzzles, they are, in fact, difficult to resolve in a Humean framework.

[11] Hacking (1983, p. 48) writes, "Hume seldom denies that the world is run by hidden and secret causes. He denies that they are any of our business."

to control and regulate future events by their causes. [Hume 1777, p. 76; cf. p. 26 and 1739, pp. 73, 89)

The constant conjunction of cause and effect is the source of the idea of causal necessity, and it cannot, says Hume, be analyzed further: "It never gives us any insight into the internal structure or operating principle of objects, but only accustoms the mind to pass from one to another" (Hume 1739, p. 169). It is not the irreducible impression of constant conjunction, but the idea of necessary connection that it conveys, that gives casual knowledge its utility. Even if constant conjunction fails to provide insight into internal structures, causes compound to form complex structures, which are knowable through analysis:

A peasant can give no better reason for the stopping of any clock or watch than to say, that commonly it does not go right: But an artizan easily perceives that the same force in the spring or pendulum has always the same influence on the wheels; but fails of its usual effect, perhaps by reason of a grain of dust, which puts a stop to the whole movement. [Hume 1739, p. 132]

Again, while the impression of causal necessity may derive from constant conjunction, the utility of causal knowledge does not depend on repeated experiments. A single experiment properly arranged may convey particular causal knowledge, because it is supported by a complex of causal knowledge long established.

In discovering the origin of the impression of causal necessity in the constant conjunction of a cause to its effect, Hume does not seek to deny the reality of necessary connection or to replace it with regularity. For it is the necessity with which effects follow causes that permits us to know the future and to control it. The constancy of the conjunction is essential to our ability to project it into the future. A relationship that sometimes held and sometimes did not would not warrant this projection. Hume (1739, pp. 125, 171–172; 1777, p. 56) argues that such a relationship involves "chance," and chance is the antithesis of causality. Chance is pure ignorance; causality is knowledge. Where there is exceptionless universal law, knowledge is possible.

In practice, causal reasoning for Hume is only probabilistic (in a broad sense of that term). There are no genuine chances, but there are, as the example of the stopped watch makes clear, countervailing causes – often hidden, and sometimes likely to remain so. We should not expect to find *constant* conjunction in most practical cases. True causal mechanisms are often not what first impressions suggest, but are below the surface and must be discovered through reason and experiment.[12]

[12] Hume (1739), book I, part III, section XV, provides rules for drawing causal inferences that anticipate Mill's (1851, vol. I, p. 393 ff.) more famous rules.

With this we come full circle. Hume the economist is the artisan of public policy. He uses his causal account of the macroeconomy – based on evidence and experience, although not on repeated experiments – to reveal the grains of dust in the works, to overturn the facile first impressions of politicians and vulgar commentators as to the true sources of prosperity, and to ground antimercantilist policy.

Causal Issues

At least four issues are evident in Hume's philosophical analysis of causality and its practical application to macroeconomics.[13] The first is conceptual: What does it mean for one thing to cause another? The second is ontological: What is the essential nature of causes, in Hume's (1739, p. 165) phrase, "in the objects"? The third is epistemological: How could we infer the existence of causal relations from observations? The fourth is pragmatic: How do we employ causal understanding as actors in the world?

In the *Enquiry* (p. 76), Hume distinguishes the concept of causality from its conditions of inference. He writes:

> we may define a cause to be *an object, followed by another, and where all the objects similar to the first are followed by objects similar to the second.* Or in other words *where, if the first object had not been, the second never had existed.*

The primary meaning of causality for Hume is necessary connection, the efficacious property that permits us to connect an action with effects beyond the immediately available sense impressions. But no terms are so "obscure and uncertain" as "power," "force," "energy," and "necessary connection" (Hume 1777, p. 62). Looking behind those terms, one finds only constant conjunction as their source. There would appear to be a danger of collapsing the meaning of causation to the conditions of causal inference, a danger of conflating conceptual analysis and epistemology. But Hume is careful to avoid it. Hume distinguishes between practice and philosophical curiosity (Hume 1777, p. 38).[14] Custom and mental

[13] Cf. Humphreys 1989, pp. 3–4.

[14] On the difference between philosophical speculation and practical affairs, Hume (1739, pp. 268–269) writes:

> But what have I here said, that reflections very refin'd and metaphysical have little or no influence upon us? This opinion I can scarce forbear retracting, and condemning from my present feeling and experience. The *intense* view of these manifold contradictions and imperfections in human reason has so wrought upon me, and heated my brain, that I am ready to reject all belief and reasoning, and can look upon no opinion even as more probable or likely than another. Where am I, or what? From what causes do I derive my existence, and to what condition shall I return? Whose favor shall I court, and whose anger must I dread? What beings surround me? and on whom have I any influence, or who have influence on me? I am confounded with all these questions, and begin to fancy myself in the most deplorable condition

habit are the guides to practice (Hume 1777, p. 44). Hume's macroeconomics exemplifies his practical reasoning. In the *Essays*, he virtually never reasons directly from constant conjunctions to causes. Instead, Hume relies on established background knowledge and a few cases to construct arguments for particular causal structures. In principle, far up the causal chain, Hume supposes that the established background knowledge is grounded in constant conjunctions. Constant conjunction is the source of the idea of necessary connection, but not the touchstone for practical causal inference in the world.

Similarly, there could be a danger of conflating ontology and epistemology. But again, Hume does not fall into the trap. Careful investigation of cause and effect convinces Hume that we must be "sensible of our ignorance" of the ontology of causation and rest content with knowing that our minds are formed to make customary causal inferences irrespective of what causes may really be in the objects.

With respect to causal inference itself, we can distinguish two questions – both of which are practically illustrated in the *Essays*. The first question is the direction of causation. Hume considers questions such as, does prosperity cause money or money prosperity? The second is the question of causal strength. As we have already observed, Hume proposes quantified causal hypotheses such as, an increase in the stock of money causes an *equiproportional* increase in the level of prices. And he asserts inferential rules such as, an effect must be proportional to its cause.

In the remainder of this chapter and in later chapters, we shall return frequently to these four issues in the analysis of causality.

1.2 PROBABILISTIC CAUSALITY IN THE HUMEAN TRADITION

Constant conjunction is, in Hume's view, the source of the idea of causal necessity; yet, as we have seen, he downplays the importance of perceived repetition in the epistemology of the *Treatise* or the *Enquiry* and ignores it virtually completely in the practical causal inferences of the

imaginable, inviron'd with the deepest darkness, and utterly depriv'd of the use of every member and faculty.

Most fortunately it happens, that since reason is incapable of dispelling these clouds, nature herself suffices to that purpose, and cures me of this philosophical melancholy and delirium, either by relaxing this bent mind, or by some avocation, and lively impression of my senses, which obliterate all these chimeras. I dine, I play a game of back-gammon, I converse, and am merry with my friends; and when after three or four hour's amusement, I wou'd return to these speculations, they appear cold, and strain'd and ridiculous, that I cannot find in my heart to enter into them any farther.

Here then I find myself absolutely and necessarily determin'd to live, and talk, and act like other people in the common affairs of life.

Essays. Many modern accounts of causality, meant to be Humean in spirit, have relied nonetheless upon the criterion of constant conjunction. These may be referred to collectively as *regularity accounts*. The most important regularity account for macroeconomics is the *probability account*.

Modern probabilistic theories of causality (Suppes 1970 is the classic statement) begin with the assumption that truly constant (i.e., exceptionless) conjunction is too strong a condition to be useful. And, as we have seen, Hume would not disagree, although he would locate the reason for any exceptions in countervailing or intervening causes. Whether Hume is right or whether instead causal relations are fundamentally probabilistic or whether chances are both real and causal are questions on which probabilistic accounts are typically agnostic.[15] Rather than constant conjunction, probabilistic accounts look for relationships that tend to hold on average and for the most part. Crudely, A causes B on probabilistic accounts if $P(B|A) > P(B)$, where "$P(X)$" means "the probability of X" and "$X|Y$" means "X conditional on Y."[16] The most prominent causal analysis in macroeconometrics, due to C. W. J. Granger (1969, 1980), falls into the class of probabilistic accounts.[17]

Probabilistic causality aims to answer questions such as, does taking aspirin cause headaches to end? This might be investigated in a controlled study in which headache sufferers are given aspirin and the results noted. The conjunction will not be constant. But aspirin will be said to cause headaches to end if the probability that one's headache will end if one takes an aspirin is greater than the probability of its ending unconditionally (i.e., whether one takes an aspirin or not). Consider an example: suppose that, in a trial using 100 patients (50 given aspirin, 50 given a placebo), the results are as reported in Table 1.1. Since P(*Headache Ending* | *Taking Aspirin*) = 30/50 = 3/5 > 40/100 = 2/5 = P(*Headache Ending*), the probabilistic account implies that taking aspirin causes headaches to end.

Some commentators have considered whether the inequality in the rule A causes B if $P(B|A) > P(B)$ should be "greater than" or simply "does not equal" (so that A causes B if $P(B|A) \neq P(B)$). The question is,

[15] Paul Humphreys (1989, p. 46) provides a classification of different varieties of theories of probabilistic causality based on how each answers such questions.

[16] This simple formulation clearly omits the nuances and qualifications that advocates of probabilistic accounts insist upon; see Suppes (1970), Cartwright (1989), Eells (1991), and Humphreys (1989) for examples of sophisticated treatments of probabilistic accounts.

[17] See Spohn (1983a), for a discussion of the relationship of Granger's analysis to other probabilistic accounts; and see Chapter 7, Section 2 in this book for a thorough discussion of so-called Granger-causality.

Table 1.1. Results of 100 Trials

		Treatment	
		Placebo	**Aspirin**
Headache	**Does Not End**	40	20
	Ends	10	30

must causes increase probabilities or merely affect them?[18] Similarly, some have argued that a cause must make an event probable; that is, A causes B only if $P(B|A) > 50$ percent (Papineau 1985, p. 57 ff.). But these appear to be largely terminological disputes. Aspirin may increase the probability of a headache continuing (the cure is worse than the disease) or it may be relatively ineffective, but nevertheless help in some cases (e.g., $P(B|A) < 50$ percent, yet $P(B|A) > P(B)$). We can agree either way that aspirin would be *causally relevant* to headaches even if we did not wish to honor it with the name "cause." The language of causes often reflects our practical interests more than the underlying reality. Had we posed the question, does aspirin cause headaches to continue?, rather than, does it cause them to end?, the data in Table 1.1 would still be relevant, and they would tell against our hypothesis. We might, then, refer to aspirin as an "inhibitor" of headaches, rather than a cause of their ending. The tone of our description would be different, but the causal claims would have remained unchanged.

The probabilistic theory of causality in its simplest form is faced with a formidable difficulty: $P(B|A) > P(B)$ implies that $P(A|B) > P(A)$; that is, if A causes B, then B causes A.[19] Notice that the data in Table 1.1 show that $P(\textit{Taking Aspirin} \mid \textit{Headache Ending}) = 30/40 = 3/4 > 1/2 = 50/100 = P(\textit{Taking Aspirin})$. According to the definition, the headache ending causes patients to take aspirin. But even the advocates of the probabilistic account naturally resist this implication.

This is an example of an important problem in econometric analysis known as *observational equivalence*.[20] The problem does not arise for Patrick Suppes (1970) or Nancy Cartwright (1989, ch. 1),

[18] Granger (1969, p. 376), for example, defines causality in terms of an increase in conditional over unconditional probability, while Granger (1980, p. 330) defines it as inequality between conditional and unconditional probability.

[19] Proof: $P(A, B) = P(B|A)P(A) = P(A|B)P(B)$, where $P(A, B)$ is the joint probability of A and B, by Bayes' theorem. If $P(B|A) > P(B)$, then by substitution $P(B)P(A) < P(A|B)P(B)$, so $P(A|B) > P(A)$. QED.

[20] See Simon (1953b), Basmann (1965, 1988), Sargent (1976), and Glymour (1980, pp. 316–317).

because, following Hume, they also impose the condition that causes must precede effects. Thus, $P(B_{t+1}|A_t) > P(B_{t+1})$ does not imply that $P(A_{t+1}|B_t) > P(A_{t+1})$), where the subscripts are time indices. We rule out the conclusion that the headache ending causes the patient to receive the aspirin, because in no case does the ending of the headache precede the receiving of the aspirin.

If A precedes B and $P(B_{t+1}|A_t) > P(B_{t+1})$, Suppes (1970) refers to A as a *prima facie cause* of B. A is not a cause *simpliciter*, because there are clear circumstances in which we do not believe that A causes B, even though the conditions for *prima facie* causality are fulfilled. The classic example is a falling barometer. Although it is a *prima facie* cause of a storm, we do not generally regard it as a genuine cause of a storm. Economic examples also exist. The money supply rises in late November and early December; it is a *prima facie* cause of Christmas spending; yet we do not think that the rising money supply genuinely causes Christmas spending.[21] Hume provides a similar example. Rising stocks of precious metals are *prima facie* causes of falling interest rates, yet he argues that they are not genuine causes. His reasoning carries the same form as the other two examples. In each case, a third factor is the genuine cause of both the *prima facie* cause and the *prima facie* effect.

The idea of a common third cause is illustrated in Figure 1.2. Here later times are indicated above earlier times (t_3 later than t_2 later than t_1) and the arrows show the true causal connections. Reichenbach (1956, pp. 158 ff.) refers to this characteristic pattern as a *conjunctive fork*. The conjunctive fork is also reflected in a characteristic pattern of conditional probabilities. While in each case in Figure 1.2 $P(B|A) > P(B)$, $P(B|A\&C) = P(B|C) > P(B)$.[22] Conditional on C, A does not raise the probability of B at all. C is said to *screen off* A (see also Salmon 1984, pp. 43–45, passim). A more satisfactory definition of probabilistic cause might then be: A causes B if A is a *prima facie* cause of B and there are no C's that screen A off from B. As we shall see presently, even this is not enough.

Reichenbach (1956) places the conjunctive fork and the no-screening-off condition in the center of his causal analysis. He adopts an axiom that he calls the *common-cause principle*: "If an improbable coincidence has occurred, there must exist a common cause." So, if A and B are corre-

[21] J. Simon (1970, p. 234); Kaldor (1970, p. 6), who writes: "Nobody would suggest (not even Professor Friedman, I believe) that the increase in note circulation in December is the cause of the Christmas buying spree. But there is the question that is more relevant to the Friedman thesis: could the 'authorities' prevent the buying spree by refusing to supply additional notes and coins in the Christmas season?"

[22] Time subscripts are omitted to keep the notation uncluttered; we continue to assume that causes must precede effects.

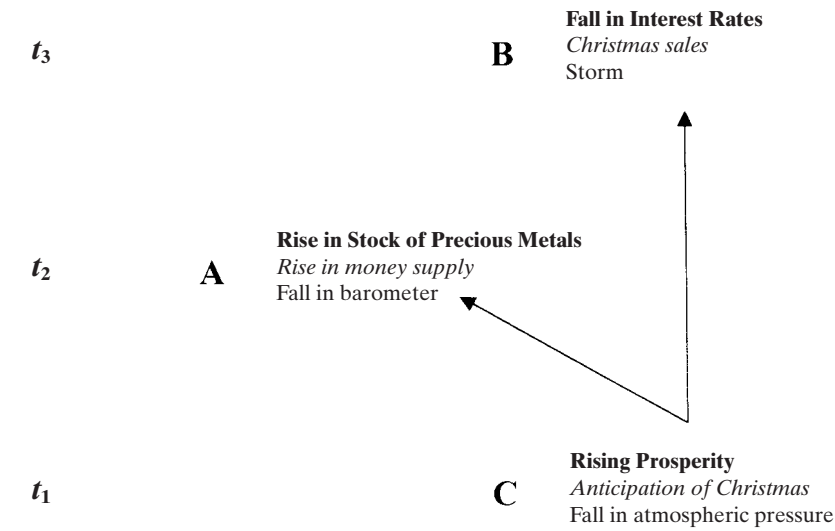


Figure 1.2

lated, either A causes B, B causes A, or they have a common third cause C.

The common-cause principle has been subjected to substantial criticism (e.g., see van Frassen 1977). Some of the problems are practical. For example, spurious correlations may appear in small samples that do not reflect characteristics of the population and would not appear in large samples (as Reichenbach 1956, pp. 157–158, was aware). Any two series that trend over time appear to be correlated, even though *ex hypothesi* they have no causal connection (see Chapter 7, Section 2). More substantially, Cartwright argues that the common-cause condition interpreted strictly as a screening criterion is violated whenever causes operate indeterministically, and that such indeterminism threatens the basis of any probabilistic account of causality (see Chapter 4, Section 3).[23]

The history of the probabilistic approach is one of posing counterexamples in which the probabilities violate our causal intuitions and then making adjustments to the probabilistic definition of the causal relation

[23] For critical discussions of the common-cause principle, see van Frassen (1977) and Humphreys (1989, pp. 66–70).

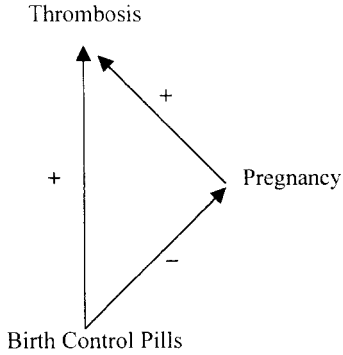


Figure 1.3

that preserve the insight of the original notion of *prima facie* cause while rendering it adequate to our intuitions.

One famous example is due to G. Hesslow (1976). Birth control pills contain chemicals that are known to clot blood, yet the probability of coronary thrombosis (i.e., blood clots in the heart) conditional on taking birth control pills is *lower* than the unconditional probability of thrombosis (i.e., $P(Thrombosis|Pills) < P(Thrombosis)$), which suggests that birth control pills do not cause thrombosis, but reduce or inhibit it. The puzzle is explained by observing that pregnancy raises the probability of thrombosis and birth control pills lower the probability of pregnancy. The observed probability of thrombosis conditional on taking birth control pills is the net result of a direct and an indirect effect as indicated in Figure 1.3. The "+" and "–" signs indicate whether the adjacent link indicates a cause that promotes (raises the probability of) or inhibits (lowers the probability of) the effect. Whether $P(Thrombosis|Pills)$ is greater or less than $P(Thrombosis)$ depends on the relative quantitative strength of the three causal linkages (cf. Cartwright 1989, pp. 99–101).

If Figure 1.3 describes the situation accurately, then the example suggests further restrictions that might be placed on the probabilistic definition of cause. First, the definition might be restricted only to direct causes with a more general *cause simpliciter* defined with relation to the causal ancestors of the effect (Cartwright 1989, p. 128).[24] But this is not quite enough, for while it clears up the linkages between birth control pills and pregnancy, and pregnancy and thrombosis, it leaves the initial puzzle unresolved. Pregnancy is not an intervening third cause in the

[24] This is only one of a number of strategies for dealing with issues such as those raised by Hesslow's example that Cartwright (1989, ch. 3) investigates. See also Eells (1991, ch. 4) and Chapter 4, Section 3 in this book.

sense that it will completely screen-off the effect of the birth control pills. It is a partial screen. Suppose that we were to divide women in the sample into those who became pregnant and those who did not, then for each of these subgroups $P(Thrombosis|Pills) > P(Thrombosis)$. A second restriction might then be imposed: The definition might require *contextual unanimity*; that is, the change in probability must be the same in all homogeneous backgrounds (e.g., whether pregnant or not) (Cartwright 1989, pp. 55–56, 143; Eells 1991, p. 86).

Another puzzle for probabilistic causation is known as "Simpson's paradox."[25] It can be illustrated with a simple example. Consider the problem of sex discrimination in faculty salaries.[26] Consider a cohort of male and female professors closely matched for age and professional stature. Suppose that there are 35 males with an average salary of $62,857 and 15 females with an average salary of $57,333.[27] We would be tempted to declare that female faculty were discriminated against in compensation. But now suppose that we dig deeper and divide the faculty up according to departmental affiliation. Imagine that all of the faculty are drawn either from the Engineering Department or the English Department and that the average salaries are distributed as in Table 1.2. The paradox is that, if we apply the same standard that tempted us to declare that female faculty were discriminated against in the larger pool, we would now have to declare that no individual department discriminates against its female faculty.

A typical response to the paradox is to argue that the initial evidence for discrimination was incorrect because Engineering and English professors were mixed up in the conditioning class, which confuses the probability criterion.[28] The problem is similar to Hesslow's birth control pill/thrombosis example. Consider departmental affiliation as an

[25] C. Simpson (1951) originally considered the case in which a positive association in subpopulations disappeared when the whole population was considered. A number of situations in which statistical dependencies that are consistent in subpopulations disappear or are reversed in whole populations have come to be referred to as Simpson's paradox, even though they are different from the case actually considered by Simpson (see Spirtes, Glymour, and Schernes 1993, pp. 64–70). Cartwright (1983, p. 24) traces the paradox back to Morris Cohen and Ernst Nagel (1934, p. 449) and Yule (1903). The paradox is also discussed *inter alia* in Cartwright (1989, pp. 55–56), Eells (1991, pp. 62–64, 72), and Irzik (1996, p. 251).

[26] The example is suggested by an actual study of graduate admissions at the University of California, Berkeley (Bickel, Hammel, and O'Connell 1975; cf. Eells 1991, pp. 62–64). It is easy to imagine other cases.

[27] The discussion is conducted here in terms of average salaries because the dispute is with respect to a continuous variable, but it could without any loss be recast into the form of conditional probabilities.

[28] Eells 1991, pp. 71 ff.; Cartwright 1983, pp. 37–38.

Table 1.2. Salaries by Sex and Academic Department

		Male	Female
Engineering	**Salary**	$80,000	$86,000
	Number	20	5
English	**Salary**	$40,000	$43,000
	Number	15	10

intervening third cause. The data in Table 1.2 reverse the causal assessment.[29] There is contextual unanimity: Being female raises salaries in both departments.

The analogy to Hesslow's example is imperfect. The third cause does not confuse the initial assessment of probability because of the presence of a direct and an indirect effect (at least not necessarily) in which one link counteracts the other. Instead, it arises entirely from the lack of homogeneity of the original conditioning class (i.e., faculty from both departments considered together). Departmental affiliation does not screen-off the influence of sex – even partially. Rather it interacts with it to determine the size of salaries. The relationship can be expressed visually as in Figure 1.4. Causal influence runs directly from both *Sex* and *Department* to *Salary*, but *Sex* and *Department* also interact as shown by the arrows into and out of the circle. For example, such a diagram might represent a situation in which being an English professor, regardless of sex, was worth $40,000 a year; while being an engineering professor, regardless of sex, was worth $80,000 a year. Being female, regardless of discipline, carried a premium of $3,000 a year over being male. And, being a female engineer carried a premium of $3,000 a year in addition to everything else. The causal possibilities are underdetermined by the data presented; one can easily imagine other quantitative mechanisms to generate Table 1.2. Whatever the mechanisms, the need for them reinforces the restriction (implicit in the requirement of contextual unanimity) that legitimate conditioning must be with respect to homogeneous classes.

Notice that acceptance of a joint causal linkage of *Sex* and *Department* to *Salary* does not resolve the question of sex discrimination. Sex and departmental affiliation are correlated, and, according to the

[29] Had the data shown the same average salaries for males and females (or more generally if salary conditional on departmental affiliation were probabilistically independent of sex), then departmental affiliation would have been a screen.