forms that align incentives with environmental conservation, encourage the generation and dissemination of ecological information through market exchange, and "strengthen property rights where possible" (p. 172). Among the steps "short of privatization" (p. 181) that they endorse are user fees for government-run parks and reserves, making park managers more accountable and responsible to the visiting public, and localized efforts at pollution control, such as watershed-based effluent trading. While such approaches will not satisfy all free-market devotees, they are pragmatic steps toward adopting property rights in environmental resources and developing market institutions to address environmental concerns. More far-reaching institutional change will not occur overnight. Yet upon completing *Free Market Environmentalism* one cannot help but be optimistic that more widespread adoption of FME principles is only a matter of time.

Jonathan H. Adler
Case Western Reserve University
School of Law

The Big Problem of Small Change
Thomas J. Sargent and François R. Velde
Princeton: Princeton University Press, 2002, 405 pp.

Thomas Sargent of Stanford University and the Hoover Institution and François Velde of the Federal Reserve Bank of Chicago have expanded their article of the same title from the *Journal of Money, Credit, and Banking* of May 1999. They tell the fascinating story of how monetary authorities groped slowly over many centuries toward the ultimate solution to recurrent shortages of small change. The solution is to issue minor coins as mere tokens with no pretense at metallic contents worth anywhere near their face values and, further, to keep those tokens interconvertible at fixed rates with the definitive money (e.g., full-bodied gold coins under a gold standard). This "standard formula", as the authors call it, following Carlo Cipolla, may seem trivially obvious nowadays, but it was not always so. Furthermore, it became a stage in an intellectual process that eventuated in the rationale for modern fiat money.

Sargent and Velde attribute perhaps the first clear statement of the formula to Sir Henry Slingsby, master of the London Mint, in a 1661 memorandum to King Charles II; but Slingsby's proposal was not implemented for over a century. The long delay was not due merely or especially to intellectual failure. Implementing the solution had to await advances in the technology of coinage. Mere token coinage would have offered great profit opportunities to counterfeiters, and identifying counterfeits would have been difficult when primitive minting techniques produced crude and irregular coins. Counterfeiters could reap no special profit, however, by using gold or silver to imitate official coins.

Centuries of ineffectual groping with the problem had consequences worse than mere inconvenience in retail trade. Failure to solve it contributed to a secular upward drift of price levels. Monetary conditions can be important for countries' prosperity or stagnation. The authors (pp. 275–76) quote Thomas Macaulay's *History of England, from the Accession of James the Second* on the consequences of underweight currency in 1695, when

> It was mere chance whether what was called a shilling was really a tenpence, sixpence, or a groat . . . [I]t may well be doubted whether all the misery which had been inflicted on the English nation in a quarter of a century by bad Kings, bad Ministers, bad Parliaments, and bad Judges, was equal to the misery caused in a single year by bad crowns and bad shillings . . . When the great instrument of exchange became thoroughly deranged, all trade, all industry were smitten as with a palsy. The evil was felt daily and hourly in almost every place and by almost every class, in the dairy and on the threshing floor, by the anvil and by the loom, on the billows of the ocean and in the depths of the mine. Nothing could be purchased without a dispute. Over every counter there was wrangling from morning to night.

Sargent and Velde explore history from the Middle Ages to modern times. Experiences of medieval Florence, medieval Venice, France, Castile, Catalonia, the German states, Russia, the Ottoman Empire, Britain, and the United States enter the story. The authors review doctrines of Roman law and canon law, evolving economic doctrines, and advances in coinage technology. Their scholarship ranges widely; they cite works in English, Latin, French, Italian, Spanish, Catalan, German, Dutch, and Swedish. Portraits and coin photographs reinforce an antiquarian tone that has strong Romantic appeal for the present reviewer, especially as modern monetary theory illuminates it all.

The authors' theory handles the following conditions. Traditionally, all coins, including the standard penny of medieval Europe, were supposed to contain precious metal worth their face values less an allowance for costs of minting and perhaps a small margin of seigniorage. (Actually, stamping their denominations on coins was a relatively late development, so "face value" often means officially declared value.) When the general price level was low enough to make the thus-implied mint or official price of silver attractively high (in other words, when the mint would sell coins cheap for silver), people would bring metal to the mints. When, at the other extreme of the no-arbitrage interval, a high general price level made the mint price of silver relatively low, people would melt coins (or export or hoard them) as the cheapest way of obtaining the metal. When coins of various denominations existed, notably including gold coins sometimes having supposedly fixed (though adjustable) prices in silver units of account, and because coining money was more costly in small than in large denominations, the problem arose of keeping the coining-

and-melting intervals of the different coins appropriately aligned with one another as market conditions changed. Some coins or other would disappear from circulation from time to time in accordance with Gresham's Law, and official exchange rates between coins would need adjustment.

But the situation had an asymmetry. Large coins could be used only in large transactions, while small coins were usable in both small and large transactions and were essential for small ones. Hence the special inconvenience of a shortage of small coins. A frequent remedy was to "debase" the small coins by reducing their weight or fineness. (Governments' hunger for revenue was sometimes another motive.) The effective rise in the mint price of silver would make taking silver to the mint profitable again and melting coins unprofitable. But the cumulative effect of successive debasements would be a secular upward trend in the general price level, given that the units of account were traditionally silver coins.

Sargent and Velde present a model in which a shortage of small coins, even apart from any debasement of them, causes large coins to *appreciate* relatively. Rates of return on the different coins, vaguely alluded to, apparently enter into explaining this paradox. The authors even present a model in which growth of real income in the face of constant stocks of coins produces price *inflation*. The intuition behind this curious result seems to be that the above-mentioned asymmetry between large and small coins splits the application of the quantity theory of money into two branches and that an emerging shortage of small coins disrupts trade in items of low value in a way equivalent to a decline in their supply. Much back-and-forth comparison among various diagrams, equations, definitions, and bits of text is necessary to reach that interpretation, which may be wrong anyway; for Sargent and Velde do not clearly spell out just what peculiarities of their assumptions are crucial to their result. Nor do they link it to any historical episodes.

Jacket blurbs praise the authors' "penetrating and clearly worded analysis"; the book is "well written and aesthetically pleasing"; it "is also unusually clear and has none of the apparent obfuscation that other scholars accuse economists of practicing." Large chunks of the book do indeed deserve this praise. I wonder, though, whether the blurb-writers had read the book as closely as a reviewer is supposed to do. I wonder how closely each of the coauthors vetted the other's contributions. The style is uneven. The economic analysis is fragmented, as is understandable in a work covering experiences in many times and places. Still, it seems to me that the authors might well have assembled the fragments into a unified effort at clear exposition. Occasional ambiguities are annoying (as about which way an exchange rate between coins is expressed or whether two different words are used as synonyms or indicate a contrast). True, the reader can usually figure out what the authors mean, but he would have preferred being spared the trouble and would have welcomed occasional reassurances that he and they were on the same wave-

length. Ideally, a sympathetic reader of the manuscript could have conjectured at exactly what the authors were trying to say. Back-and-forth discussion between him and them might then have converged on agreed and clear formulations.

Part of the trouble is that the much of the writing is in code. My complaint is not about bona fide mathematics but about the use of numerous Latin and Greek letters instead of words in ordinary sentences and in the labeling of diagrams. True enough, a few tables do translate the symbols, but these are not conveniently pulled together in one place; and the authors bypass opportunities to remind the reader of the meanings of symbols labeling the diagrams. Symbols admittedly save paper and ink. But there are plenty of opportunities for such savings in everyday writing by using various abbreviations (for example, using the standard symbols rather than English to name the chemical elements); yet we do not do so, for obvious costs would outweigh the material savings.

Symbols are often indispensable, of course; but even in mathematics, too much reliance on them impedes the flow of ideas. Paul Halmos so warns his colleagues (in his and coauthors' *How to Write Mathematics*, American Mathematical Society, 1973, 1981). Nobody thinks in symbols. Coding by the author and decoding by the reader waste the time of both. Halmos advises trying to write a mathematical exposition as one would speak it, falling back on symbols only when actually necessary. More broadly, he recommends trying to write correct and clear English, keeping Fowler, Roget, and Webster at hand. A writer who works eight hours to save five minutes for each of 1,000 readers saves over 80 man-hours.

Despite stylistic defects, which I hope a second edition will remedy, my overall opinion of the book is strongly positive. It provides an exciting story of how apparently minor technical details can affect the course of history.

Leland B. Yeager
Auburn University