

Resisting Electronic Payment Systems: Burning Down the House?

by Ben Craig

In the Cleveland Museum of Art hangs a famous painting, *The Burning of the Houses of Parliament*, by J.M.W. Turner. The painting depicts an event that provides a fascinating case study of the difficulty of changing payments systems in the face of new technology. This difficulty is surfacing again as modern economies face the switch from paper-based payments systems to a variety of electronic systems. The Rivlin Committee called attention to the phenomenon in its 1998 report when it observed that "...the reliance on paper-based retail payment methods is striking in an electronic age."¹ The report estimates that the percentage of paper makes up 78 percent of all noncash transactions in the United States and only 37 percent in Europe. Why has the United States been so slow to change? Much insight into the reason can be gained by examining the events surrounding the original adoption of paper as a means of public record keeping—events which led to the disastrous fire depicted in Turner's masterpiece.

This *Economic Commentary* explores *path dependence* as a reason for the choice in payment systems, as well as for other economic phenomena. Path dependence means that historical decisions made in the remote past will often determine the decisions made today. It is related to the physical concept of *hysteresis*. Hysteresis refers to the failure of a system to return to its original value once the source of a change has been removed. Thus, when you put pressure on a bar beyond a certain point, it will bend, and hysteresis will keep the bar bent when you remove the pressure. The bar's shape reflects the historical pressures that made it bend and will therefore show its path dependence. This

Economic Commentary will show how path dependence and hysteresis work to determine economic events, particularly when network economies are in effect, and will suggest that policy intervention may be justified where hysteresis is clearly at work. *The Burning of the Houses of Parliament* represents an event that illustrates the ability of network economies to create a path dependence in payment conventions.

Turner's painting portrays an 1834 fire which destroyed Britain's historic Parliament buildings. Subsequent investigation revealed the cause of the fire to be the burning of a stockpile of old tally sticks. Tallies were hazelwood sticks used in Britain from the twelfth to the nineteenth centuries to maintain tax accounts. Sticks were notched to show the amount paid and then split lengthwise so that both the taxpayer and the Exchequer would have a record of the payment. The larger piece, called the stock, belonged to the payer, and the smaller, the foil, was kept by the government. When foils were no longer needed, they were used for fuel and burned in the fireplace of the tally room at frequent intervals.

Although it was certainly clear by the seventeenth century that paper was a cheaper and far more efficient means of record keeping, the tally system remained in effect as the means of tax recording until 1826, when it was formally abolished. However, reluctance to accept the new medium delayed the complete transfer to paper for nearly a decade and sowed the seeds of the fire. During the transition to paper, tally sticks were used as a backup, and old foils were allowed to pile up.

Electronic innovations such as smart cards can significantly reduce the cost of payment transactions and increase their accuracy and efficiency—but only if people use them. This *Economic Commentary* explores *path dependence* as a cause of the difficulty in adopting new payment system technologies, even when their advantages are apparent.

When Parliament finally decided to dispose of the eight-year accumulation of foils, the clerk assigned to the task decided to burn them in the furnace of the House of Lords. The fire burned intensely and eventually grew out of control. (There is some evidence that the workmen also enjoyed the "astonishing blaze" created by the sticks and may not have been as careful as they should have been.²) By morning, the House of Lords, the House of Commons, the Painted Chamber, and a variety of other buildings had been completely destroyed.

■ Path Dependence

The use of tally sticks until 1826 reminds us that much of what we do today is determined by what was done yesterday or, indeed, by a minor decision centuries ago. It is an example of what economists term *path dependence*, where the direction an economy takes at a given point depends on a previously chosen path. The path that an economy initially follows may depend on seemingly trivial considerations, or upon technical details that might be very important at the time of the choice but are subsequently unimportant. Once the path is chosen, however, it becomes dif-

ficult to change—even when other considerations indicate that the path is less desirable relative to other alternatives.

For example, why would anyone live in Chicago? Most people prefer to live in a climate that is warm and sunny. Chicago is windy and cold much of the year (but hot in the summer) and dark and dreary much of the time. Most people prefer mountains or at least hills to provide variation in their geography. Chicago is flat. Yet Chicago is the third largest city in the United States. Indeed, so many people live in Chicago that the city's congestion provides another reason not to live there.

Yet in the 1840s there were cogent reasons for choosing Chicago as a place to live and work. A new canal had just linked the Great Lakes watershed with the Mississippi at Chicago. In addition, the richest corn-growing land in the world lay on the Illinois prairie. These considerations were paramount at a time when boats were the major carriers of an agricultural nation's produce. Later, when railroads assumed this role, most went through Chicago because the warehouses and grain elevators were there. In the 1870s, when steel and other manufacturing overtook agriculture in the nation's output mix, much of this manufacturing was done in Chicago because railroads and workers were there.

A person today will rationally choose to live in Chicago because of the rich employment opportunities and family ties that result from this history. Businesses start in Chicago because many people making these rational choices create a skilled labor force. A social planner with perfect foresight might have selected Boulder, Colorado, as a better place to locate all of these people today. However, the costs of changing are too prohibitive, and people continue to live in Chicago—all because of a path chosen long ago. Path dependence is a common economic tool in explaining urban patterns.³

■ Network Economies

Path dependence is thought to be most endemic where there are networks. A network is an economic interaction in which one person's participation creates positive effects for other people participating. These positive effects are an *externality*—where all the benefits of a person's action do not go to him alone but also benefit other people in the network. For example, the fact that a video

viewer uses the VHS format for video tape creates a market for the owners of VHS rental libraries, who expand their collections to meet the needs of this market. In turn, this benefits other consumers of the VHS-formatted video tape. The VHS format is not chosen because it offers the clearer picture or cheaper means of production. It is chosen because of a minor historical incident: Matsushita was initially very slightly more effective at selling VHS players than Sony was with its better-engineered Beta design. Network economies then made the VHS recorder the chosen path. Network economies make it difficult for an individual to change until it is well understood that most of the network will also make the change.

■ Payment Conventions

Perhaps the most obvious example of network economies lies in payment systems. When a new medium of exchange becomes available, enough people must accept it, or it quickly becomes worthless. Each person drawn into the network (that is, they accept the medium) enhances the medium's value to other members of the network. Because the success of a new exchange medium depends on quickly achieving a critical mass of users, hysteresis is sometimes observed in payment-system network economies. It can often explain why technically outmoded means of exchange are retained long after more efficient methods could have been adopted.

For example, hysteresis is the likely cause of the failure of "smart cards" to catch on in the United States. Smart cards look a lot like credit cards, but they are distinguished from them in several important ways. Microchips are embedded onto smart cards, enabling them to retain and update account information, so debits from the purchaser's account are made immediately. Credit cards require credit-card providers to act as middlemen, billing the buyer and paying the merchant. Of course, credit-card providers must charge a high transaction fee (between 1 and 2 percent of the value of the purchase) to handle the exchange.⁴

Indeed, smart cards are more similar to cash than credit cards. While smart cards need not change monetary policy (after all, they are backed by demand deposits just like checks), they offer many advantages over cash or checks. Bookkeeping is much simpler because each smart-card transaction creates an entry in magnetic form for both the pur-

chaser and the seller. Carrying smart cards—even with huge balances—is much safer than carrying large amounts of cash; smart-card microchips provide a level of security that reduces the risk of armed robbery and fraud.

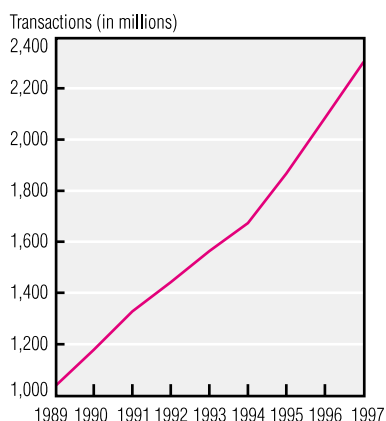
Yet in the United States, people continue to use other exchange media. In fact, the use of cash has increased in recent years at the expense of credit cards and checks. Experiments in introducing smart cards in Atlanta, St. Louis, and other places have been fairly unsuccessful. In the Atlanta trial, people were reluctant to use smart cards, even when given a free balance to spend! The problem has been that no purchaser benefits from using a smart card until enough shops accept them, and no shop is willing to invest in a machine that will read smart cards until it attracts enough sales from potential purchasers.

This contrasts with the situation in France, where smart cards are rapidly gaining acceptance (see figure 1). Interestingly, this may be because other exchange media have not penetrated the French markets. In the United States credit cards are widely used and widely accepted, whereas in France this is not the case. Thus, in France a shop may invest in a smart-card reader knowing that smart cards are more likely to be used by its customers, who do not carry credit cards. France, which has a poorer exchange technology because of its different historical path, is more likely to adopt the newer technology than the United States.

The way payments are processed may also have more to do with historical process than with the most efficient current technology. For example, many of our payments are made by paper checks. Checks, once deposited at the seller's bank, are then physically sent to the purchaser's bank. This involves a lot of paper sorting and shipping. Figure 2 illustrates the increase in the total weight of these checks in the last decade. Large resources are required to move this considerable weight of paper from city to city each night. The process could easily be accomplished by sending electronic images of the checks by wire. Why is the physical paper sent?

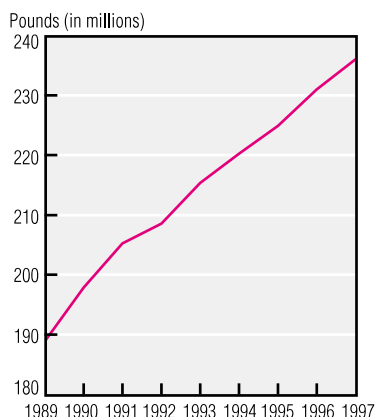
Again, network economies may be at work. Checks are honored on the basis of common laws dating from a time when drafts were made on vellum. One such law specifies that checks are ultimately returned to the payer and have legal standing as receipts. The network

FIGURE 1 VOLUME OF SMART-CARD USAGE IN FRANCE



SOURCE: Bank for International Settlements, *Payment Systems in the Group of Ten Countries*, various issues.

FIGURE 2 WEIGHT OF CHECKS PROCESSED IN THE UNITED STATES



SOURCE: Board of Governors of the Federal Reserve System.

here is a social convention, with the standing of common law. These conventions are hard for an individual to change, especially in light of a conservative legal system. They lead to methods of handling payments that have more to do with the historical context of the eighteenth century, when much of the law was adopted, than they have to do with current technological capabilities.

The high cost of bouncing a check is another example of network economies and path dependence in action. A bounced check must be sorted and processed by hand. These checks could be handled by machine if enough banks were willing to mark bounced checks with magnetic ink, so that they could be electronically sorted by check-

processing companies. Because not enough banks are willing to do this, it remains economically unfeasible for check sorters to buy the machines that read the ink. As a result, the path-dependent convention in the United States is to charge the bouncer of the check the cost of hand sorting and entering it.⁵

■ Warnings and Conclusion

Policy may be especially effective when applied to phenomena that exhibit hysteresis. To carry on the simple example at the beginning of this *Economic Commentary*—that hysteresis represents the tendency of an iron bar when bent to stay bent—a role for policy may exist to make a crooked bar straight. In the examples given here, it might be argued that there is a role for a regulatory agency to encourage the use of smart cards or the use of a scanned image of a check rather than the paper check itself. Path dependence may explain an inefficiency in a market or technological protocol that could be corrected by an enlightened policymaker or regulator. If a policy recommendation is made, however, it is important to apply a caveat to any use of hysteresis as an explanatory device in social science.

The observation of a prima facie irrationality should never be taken as evidence of hysteresis. It is very easy to “explain” a behavior as a result of the particular path the behavior took. This explanation may obscure a more rational motive that might be discovered with further analysis. For example, the QWERTY configuration of the keys on a keyboard is often invoked as an example of hysteresis. The configuration was developed by Christopher Sholes, who, after a little experimenting, discovered that the QWERTY design seemed to minimize two keys sticking on the primitive typewriter.

Is QWERTY clearly the result of a very specific solution to a problem that is no longer relevant? Dvorak and others have thought so, and since the 1940s there have been many competing designs which optimize the keyboard according to different, more relevant standards. These keyboards, for example, place letters that are used often in places where they can be easily accessed by the strong fingers, while relegating relatively unused letters to weaker fingers.

Champion typists often use the newer keyboard configuration. Most typists,

however, stubbornly stick to the QWERTY system. This is often viewed as a technological example in which the cost to change lies in the way that the tradition of typing is passed on to the next generation of typists. In spite of the clear advantages offered by the new key mappings and the ease with which the configuration can be incorporated into a personal computer (a public domain program that does this has been offered since the early days of the IBM PC), people learn what their parents learn when it comes to keyboarding.

But not so fast! All of the evidence is not in. It turns out that ease of typing for the vast majority of typists depends only partly on whether an often-used letter is associated with a strong finger. Minimizing the serial use of a finger is also important. In other words, letters that often come in pairs should be assigned to different fingers to minimize typing fatigue. When QWERTY-style keyboards are matched on this broader criterion, they do about as well as any design and are far superior to the Dvorak-style keyboards that seem such excellent replacements. When viewed with respect to this subtle ergonomic feature, the decision to use QWERTY may make more sense as a rational response to our needs today. Abandoning the search for a cause based on current rational considerations in favor of hysteresis obscures this subtle but important observation.

Nonetheless, path dependence is an important tool in economic theory for explaining the reasons cities continue in their current form and network economies develop stickiness that makes them hard to change. Some of this stickiness may be evident in payment systems and may help to explain why smart cards are used in France and not in the United States. The stickiness in payments systems, in particular, represents an important policy phenomenon to understand. Indeed, Humphrey, Kim, and Vale (1998) estimate that payments impose a social cost of only 0.5 percent of gross domestic product (GDP) in Norway, compared to the United States, where reliance on antiquated paper imposes costs of 3.0 percent.⁶ Large costs were similarly imposed when the Houses of Parliament burned down as a result of a payment convention that had been outmoded for centuries.

The fire was not lost as a metaphor on its contemporary observers. Many shared the views of Carlyle that the fire

was just retribution for the venality of Parliament.⁷ Of course, J.M.W. Turner turned it into a visual metaphor for the smallness of man in the face of disaster. Years later, Victorians were still drawing moral lessons from the disastrous fire. In 1855 Charles Dickens, in a speech to the Administrative Reform Association, mentioned the accumulation of tally sticks as an important example that “all obstinate adherence to rubbish, which time has long outlived, is certain to have in the soul of it more or less that is pernicious and destructive; more or less that will some day set fire to something or other; more or less, which, freely given to the winds, would have been harmless, which, persistently retained, is ruinous.”⁸

■ Footnotes

1. “The Federal Reserve in the Payments Mechanism,” Committee on the Federal Reserve in the Payments Mechanism, Board of Governors of the Federal Reserve System, 1998.
2. Minutes of Meetings of the Privy Council, October 20, 1834, Great Britain: Privy Council, p. 35, quoted in Katherine Solender, *Dreadful Fire! The Burning of the Houses of*

Parliament, The Cleveland Museum of Art, Indiana University Press, 1984, p. 31. This book contains a great discussion of the painting and the fire.

3. See Arthur W. Brian, “Urban Systems and Historical Path Dependence,” in *Increasing Returns and Path Dependence in the Economy*, Ann Arbor: University of Michigan Press, 1994, pp. 99–110.

4. For a detailed explanation of smart cards and their advantages relative to other exchange media, see Barbara Good, “Electronic Money,” Federal Reserve Bank of Cleveland Working Paper 97–16 (1997).

5. See Magda Bianco, Andrea Gerali, and Riccardo Massaro, “Financial Systems across Developed Economies: Convergence or Path Dependence?” *Research in Economics*, vol. 51, no. 3 (Sept. 1977), pp. 303–331.

6. David Humphrey, Moshe Kim, and Bent Vale, “Realizing the Gains from Electronic Payments: Costs, Pricing, and Payment Choice,” in the proceedings of the 34th Annual Conference on Bank Structure and Competition, May 1998, pp. 158–164.

7. Thomas Carlyle to Alexander Carlyle, October 24, 1834, in the *Letters of Thomas Carlyle, 1826–1836*, ed. Charles Eliot Norton, New York and London: Macmillan and Co., 1889, p. 455.

8. Charles Dickens, *Speech to the Administrative Reform Association*, June 27, 1855, in *Speeches of Charles Dickens*, ed. K.F. Fielding, Oxford: The Clarendon Press, 1960, p. 206, quoted in Katherine Solender, 41.

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