The Changing Nature of the Payments System: Should New Players Mean New Rules?

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During the past 25 years a multitude of mavens have written the obituary of the paper check, predicting that by the time the new millennium arrived everyone would be paying bills electronically. But the demise of the paper check has been greatly exaggerated—checks are still a very important means of payment in the U.S. Indeed, according to the Bank for International Settlements, 66 billion checks were written in the U.S. in 1997.[1] Check volume over the preceding five years had been rising between 2 and 3 percent a year, albeit the share of transactions made via check fell slightly.

Similarly, it seems you cannot pick up a newspaper or turn on the TV without hearing that electronic forms of banking and finance, includ-

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[1]The data reported in this article were those available as of January 11, 2000. Unlike many government statistics, much of the data on payments is not systematically collected by government agencies. These data come from both private-sector sources and government sources, often rely on surveys, and are subject to more error than other government-collected statistics.

ing Internet and PC banking and electronic bill-paying, are taking over the financial services industry. But *will* electronic means of payments become dominant, and if so, how soon? This article discusses some of the recent developments in electronic payments in the U.S. and what the future may hold.

The payments system refers to the parties that make or receive payments and the means by which monetary value is transferred between these parties. In 1997, the U.S. payments system generated 650 billion payments worth about $22 trillion among businesses, households, and governments (see BAI/PSI Global, p. 2). In terms of the number of transactions, the majority (about 590 billion) were from households to businesses; in terms of dollar volume, the largest amount ($8.2 trillion) was between businesses. A well-functioning payments system is crucial to a well-functioning economy, and to function well, the payments system needs to be reliable, accurate, secure, and efficient.

The most popular forms of retail payments in the U.S. have been currency, coin, and paper checks.[2] Electronic forms of payments, like those made via an automated clearing house, ATM, or credit card, have become more popular and are an increasingly important part of the retail payments system.[3] For example, between 1992 and 1997, the share of the number of consumer payments made in cash at the point-of-sale fell markedly, from 79 percent to 53 percent, and the share paid by check grew by six percentage points to about 22 percent; the share made by credit cards showed the largest increase, growing threefold, to 19 percent[4] (BAI/Global) (Figure 1). Estimates put cash payments at about 27 percent of the total dollar value of consumer payments made at the point-of-sale in 1997, while check payments represented about 40 percent of the dollar value, and credit cards around 25 percent.[5] Most recently, a number of new electronic forms of payments and components of the payments system have been added to the mix, for example, stored-value cards, smart cards, debit cards, electronic check truncation, PC banking, and banking over the Internet.

Traditionally, the payments system in the U.S. has been built around the banking industry. It is estimated that the payments business represents about a third of the banking industry's revenues, expense, and profits.[6] It makes sense that banks

[2]Retail payments refer to payments between an individual and another party.

[3]An automated clearing house (ACH) is an electronic interbank payments system used for small and recurring payments, such as direct deposit of payrolls or automatic payment of utility, mortgage, or other bills. The Federal Reserve System runs the largest ACH network; there are private systems as well.

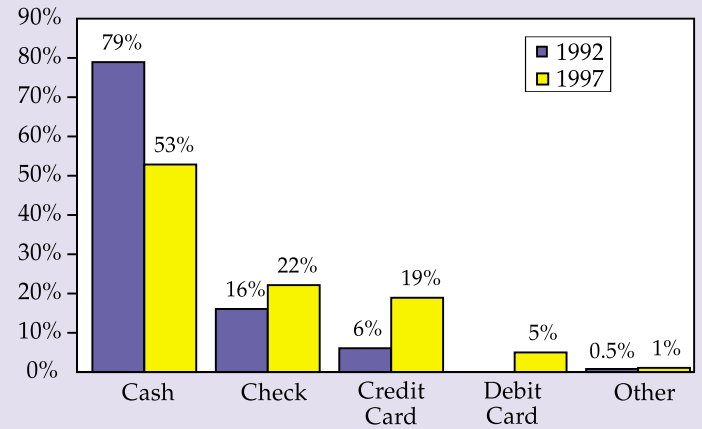
[4]In 1997, payments made at the point-of-sale represented 93 percent of all payments, while bill payments represented 5 percent and government represented 2 percent of all payments (BAI/PSI Global).

[5]Data on the dollar-value shares were not available, so I roughly estimated these based on the shares of the number of transactions and data on the average size of transactions by payments means, given in Table 1. Since for checks, the average size of transactions at the point-of-sale is likely to be less than the average size given in Table 1, which covers checks written at both the point-of-sale and also to pay bills, the check payment share at the point-of-sale is probably less than 40 percent.

[6]In a recent speech, Federal Reserve Board Vice Chairman Roger Ferguson put the payments system share of banking revenues, expenses, and profits at a third (April 4, 1998), and a study by Lawrence J. Radecki of the New York Fed estimates that payments services represent two-fifths of operating revenue of the 25 largest bank holding companies operating in 1996. Revenue from banks' payments services includes demand deposit and other transaction account fees, bad check fees, checkbook charges, certified transaction fees, ATM fees, ACH wire fees, commercial services like lockbox processing and trade finance, processing of electronic benefits transfers, correspondent processing charges, and cash handling services.

A BAI/PSI Global study (pp. 73-75) estimates that banks obtain about 24 percent of the total revenues generated by the payments business, while technology vendors and other third parties (such as credit card pay-

FIGURE 1
Distribution of the Number of Point-of-Sale Consumer Payments by Type



Source: BAI/PSI Global, "Profiting from Change in the U.S. Payments System," 1998, Figure 9, p. 18.

would be at the center of the payments system, since they are experts at assessing and handling risk, an attribute of any means of payment, and they are experienced at clearing and settling transactions. But new nonbank players have entered the payments arena. Electronic technologies enable settlement and clearing to be done by different entities, which are not necessarily banks. Currently, the Fed plays an important role in ensuring safety and soundness, efficiency, and access to the payments system. Should new players mean new rules?

INNOVATIONS IN ELECTRONIC PAYMENTS

Electronic funds transfer is not new. Wholesale banking, involving large-scale payment transfers, has been electronic for some time. What is relatively new is the electronic transfer of payments in the retail market. There are two types of developments in today's retail payments system. Some of the new means of payments are really just extensions of instruments that have been around for decades. For example, if I buy books over the Internet using my credit card, this is a new way to buy books rather than buying them in person at the bookstore. However, the means of payment is only a little different: sending my credit card information, encrypted, over the Internet versus handing my credit card to the sales clerk in the store. Types of payments that are really just extensions of existing payment instruments include debit cards; electronic check presentment (in which information on the amount of the check and the account is sent to the paying bank electronically); PC banking; electronic benefits transfer, through which the government will pay welfare benefits; and direct deposit through the ACH.[7] These instruments use current technologies and are tied to bank deposits, so bank regulators are tuned in to these instruments.[8]

ment processors) each obtain almost 38 percent, and the Federal Reserve System obtains less than 1 percent of payments services revenues (from check clearing, check return fees, Fedwire transfer services, and automated clearing house services).

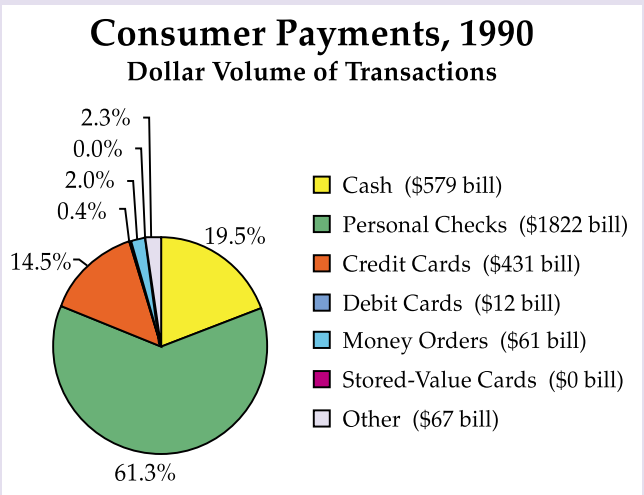
[7]Stephen Franco and Timothy Klein provide an informative description of PC banking and other electronic payments methods.

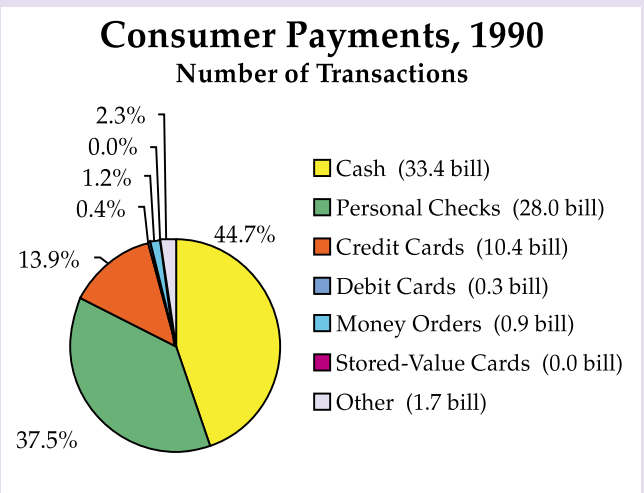
[8]Of course, that's not to say there aren't issues that must be dealt with: for example, how to best oversee the development of third-party systems that intermediate information between regulated counterparties; how to prevent abuse and fraud; and how to handle the very rapid development of technologies.

Other types of payment instruments are really new forms of payment. These new forms, called electronic money or electronic cash, include stored-value cards, smart cards, and electronic purses or software-based money.[9] Under current regulation, these instruments can be offered by both banks and nonbanks. Electronic money, or e-money, involves using traditional money to purchase a claim on a merchant or vendor, then trading this claim for goods and services with merchants willing to accept the claim.[10] The claims can be stored on cards, called stored-value cards, using either a magnetic strip, as on a traditional credit card, or a computer chip, which turns the stored-value card into a smart card. Or the claims can be stored on the customer's PC, in an electronic purse or wallet, and used to purchase goods over the Internet or to pay anyone who has a similar type of account. E-money was designed for small-value payments.

Often, an electronic money system is a closed one in which the issuer of the claim is also the merchant selling the good. For example, many subways, telephone companies, and universities run closed systems, which are similar to the traditional bank-based payment system. But there can also be open systems. Cards in open systems are usable in more locations and for more types of goods, and such systems could, in principle, operate independently of banks and outside the traditional payments system. So long as merchants were willing to accept the claims and then were able to use the claims to purchase the goods and services they themselves wanted, the claims need not ever be redeemed for cash.

FIGURE 2

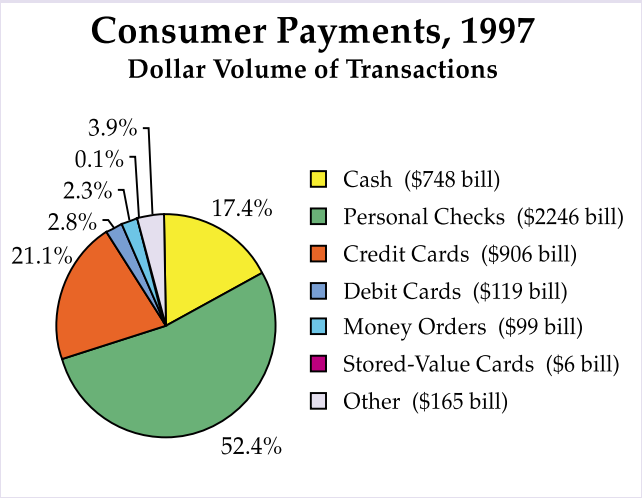


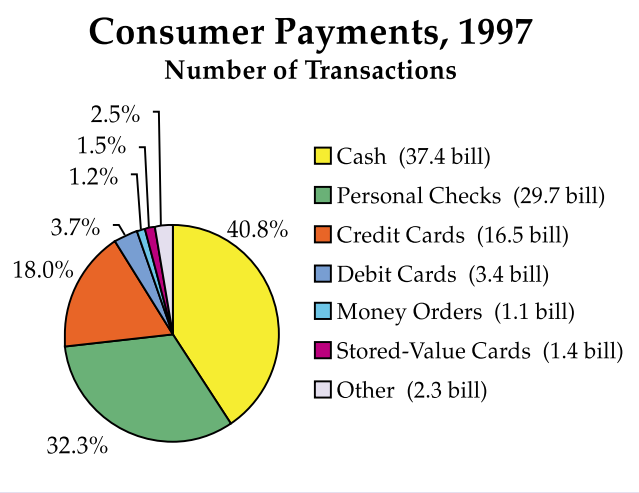


"Other" includes official checks (cashier's, teller, and certified checks), food stamps, traveler's checks, EBT cards, preauthorized payments, and remote payments (payments made using telephone, on-line computer, the Internet, or ATMs).

[9]Karsten Schulz provides an informative description and discussion of electronic money. See also the article by Felix Stalder and Andrew Clement for an analysis of the Mondex electronic money system.

[10]See the U.S. Treasury, "An Introduction to Electronic Money Issues," September 1996, for a nice overview of terms and issues.





Source: *The Nilson Report* (www.nilsonreport.com), a newsletter covering consumer payment systems worldwide, Oxnard, California, Issue 599, July 1995, and Issue 680, November 1998. Used with permission.

They would constitute their own payments system, separate from the one that exists today.[11]

Unfortunately and surprisingly, there is no one official source for data on U.S. payments transactions.[12] But data from several sources suggest that the adoption of new forms of payments has been slow to date. Figure 2 and Table 1 present data on consumer payments for 1997 from The Nilson Report (www.nilsonreport.com) in Oxnard, California, a newsletter covering consumer payment systems worldwide (Issue 680, November 1998). As shown, although their usage grew between 1990 and 1997, stored-value cards, debit cards, and preauthorized payments accounted for only 6 percent of the number of transactions made by consumers in 1997; in terms of dollar value, they accounted for less than 5 percent. Cash and checks are still the favored means of payment, followed by credit cards.[13]

Of course, even the traditional means of payment are becoming more electronic, although this

[11]The Mondex electronic money system allows person-to-person (in addition to person-to-merchant) transfers of electronic money from one smart card to another.

[12]I thank Bill Conant of Payment Technologies, Inc., Kathy Paese of the Federal Reserve Bank of St. Louis, and Blake Prichard of the Federal Reserve Bank of Philadelphia for informing me about several data sources.

[13]Checks are a relatively important means of payment in the U.S., Canada, the U.K., and France, but they are much less important in other countries, including Germany, Switzerland, and Belgium. According to figures from the Bank for International Settlements, checks represented over 73 percent of the total number and over 10 percent of the value of all cashless transactions (both retail and wholesale) in the U.S. in 1997. Comparable figures for Canada are 36 percent and 97 percent; for the U.K, 31 percent and 4 percent; for France, 42 percent and 4 percent; for Germany, 6 percent and 2 percent; for Switzerland, 1 percent and less than 1 percent; and for Belgium, 8 percent and 3 percent (Bank for International Settlements, 1998). The 1999 study by the Bank for International Settlements provides an informative overview and cross-country comparison of various means of retail payments.

TABLE 1
Consumer Payments

Method of Payment	Dollar Value (Billions)	% of Total Dollar Value	Number of Transactions (Billions)	% of Total Number of Transactions	Average Size of Transaction
			1990		
1. Cash[b]	$ 579.32	19.5%	33.37	44.7%	$ 17
2. Personal Checks[c]	$ 1822.05	61.3%	27.99	37.5%	$ 65
3. Official Checks[d]	$ 11.15	0.4%	0.09	0.1%	$ 124
4. Food Stamps	$ 14.20	0.5%	0.88	1.2%	$ 16
5. Money Orders	$ 60.88	2.0%	0.89	1.2%	$ 68
6. Traveler's Checks	$ 21.84	0.7%	0.41	0.5%	$ 53
7. Credit Cards	$ 430.96	14.5%	10.37	13.9%	$ 42
8. Debit Cards	$ 11.74	0.4%	0.29	0.4%	$ 40
9. Stored-Value Cards	$ 0.00	0.0%	0.00	0.0%	$ 0
10. EBT Cards[e]	$ 0.01	0.0%	<0.01	0.0%	$ 20
11. Preauthorzied Payments[f]	$ 17.98	0.6%	0.29	0.4%	$ 62
12. Remote Payments[g]	$ 1.98	0.1%	0.02	0.0%	$ 99
13. Total[a,h]	$ 2972.10	100.0%	74.59	100.0%	$ 40

[a]May not add up to sum of rows because of rounding.
[b]Cash includes cash advances via credit or debit cards and personal checks written for the purpose of obtaining cash.
[c]Personal checks include checks written to cover the receipt of goods and services; checks written to prepay or repay another form of payment (e.g., to purchase money orders or to pay a credit card bill) are excluded from this category to avoid duplication.
[d]Official checks are cashier's, teller, and certified checks.
[e]EBT cards are electronic benefits cards that replace food stamps at participating merchants.
[f]Preauthorized payments refer to payments that the consumer preauthorizes to be debited from his/her account and are handled electronically through an automated clearing house.

might not be apparent to the consumer. For example, electronic check presentment (ECP) still accounts for only a small portion of the checks cleared annually, about 5 percent, but the volumes have been growing. Check conversion (also called electronic checking) is also being developed. In this process, the consumer writes a check to pay a merchant, who then uses a reader to send the information on the check to an automated clearing house that transfers the funds. The paper check is not routed to the paying bank or cleared.[14] Conversion is currently being used for less than 1 percent of checks written at the point-of-sale (which represent less than one-third

Method of Payment	Dollar Value (Billions)	% of Total Dollar Value	Number of Transactions (Billions)	% of Total Number of Transactions	Average Size of Transaction
			1997		
1. Cash[b]	$ 747.58	17.4%	37.42	40.8%	$ 20
2. Personal Checks[c]	$ 2246.31	52.4%	29.67	32.3%	$ 76
3. Official Checks[d]	$ 18.85	0.4%	0.12	0.1%	$ 157
4. Food Stamps	$ 14.64	0.3%	0.64	0.7%	$ 23
5. Money Orders	$ 99.01	2.3%	1.11	1.2%	$ 89
6. Traveler's Checks	$ 20.20	0.5%	0.34	0.4%	$ 59
7. Credit Cards	$ 905.85	21.1%	16.51	18.0%	$ 55
8. Debit Cards	$ 119.14	2.8%	3.39	3.7%	$ 35
9. Stored-Value Cards	$ 5.91	0.1%	1.38	1.5%	$ 4
10. EBT Cards[e]	$ 4.08	0.1%	0.18	0.2%	$ 23
11. Preauthorzied Payments[f]	$ 86.55	2.0%	0.83	0.9%	$ 104
12. Remote Payments[g]	$ 20.87	0.5%	0.21	0.2%	$ 99
13. Total[a,h]	$ 4289.00	100.0%	91.80	100.0%	$ 47

[g]Remote payments refer to payments made using telephone, on-line computer, the Internet, or ATMs.

[h]The share of the dollar value of paper payment instruments, rows 1-6, decreased from 84.5% in 1990 to 75.2% in 1996 to 73.4% in 1997. The share of the value of payments made with cards, rows 7-10, increased from 14.8% in 1990 to 22.5% in 1996 to 24.1% in 1997. The electronic bill payment share, rows 11 and 12, rose from 0.7% in 1990 to 2.3% in 1996 to 2.5% in 1997.

Source: *The Nilson Report* (www.nilsonreport.com), a newsletter covering payment systems worldwide, Oxnard, California, Issue 599, July 1995 and Issue 680, November 1998. Used with permission.

of all checks written). (See the article by Oria O'Sullivan.)

[14]Usually the consumer keeps the voided paper check, but there is currently some debate about whether the merchant or consumer should keep it. See the article by Debra Janseen.

While more and more banks are offering some form of electronic banking, and more and more households are beginning to use these electronic forms, the in-person visit is still the most common means of interacting with one's bank, according to the 1995 Federal Reserve Survey of Consumer Finances (SCF). This survey of more

than 4000 households, designed to represent the 99 million households in the U.S., for the first time in 1995 contained questions on the use of electronic banking.[15] Over 60 percent of households have an ATM card (Table 2), indicating this form of electronic banking is now mainstream (although only about 25 percent of households that have a financial institution report this as their main way of doing business with the institution) (Table 3).[16] As shown in Table 3, 75 percent of households say the main way they do business with at least one of their financial institutions is in person. The data also show that the use of various methods of dealing with one's financial institution differs by age, income, and education. For example, very few households,

[15]See the article by Arthur Kennickell, Martha Starr-McCluer, and Annika Sundé for a description of the survey. The paper by Arthur Kennickell and Myron Kwast also uses the survey data to analyze the use of electronic banking. The 1995 SCF survey data are available on the web at www.bog.frb.fed.us/pubs/oss/oss2/95/scf95home.html.

[16]The survey indicates that over 93 percent of households have a relationship with at least one financial institution. Referring to each financial institution with which the household does business, the survey asked: "How do you mainly do business with this institution?" Respondents could list multiple methods, with the main method listed first. The 25 percent refers to the number of households that listed ATM first for at least one of their financial institutions. If we include all the methods respondents listed, ATM usage rises to 34 percent.

TABLE 2

Percent of U.S. Households That Use Each Instrument[a]

	ATM[b]	Debit Card	Direct Deposit	Automatic Bill Paying	Smart Card	Any of These
All Households	61.2%	17.6%	46.8%	21.8%	1.2%	76.5%
By Age:						
Under 30 years old	71.1%	24.5%	31.1%	17.9%	1.8%	75.2%
Between 30 and 60 years old	67.2%	19.7%	42.9%	24.5%	1.5%	77.4%
Over 60 years old	43.1%	9.6%	63.2%	18.2%	0.3%	75.2%
By Income[c]:						
Low income	36.0%	7.1%	32.7%	9.8%	0.8%	54.5%
Moderate income	60.1%	16.0%	43.1%	17.7%	0.6%	77.0%
Middle income	69.4%	20.3%	48.3%	23.4%	1.3%	83.6%
Upper income	76.6%	25.0%	58.3%	32.0%	1.8%	89.1%
By Education						
No college degree	52.8%	14.3%	40.4%	18.2%	0.8%	69.8%
College degree	80.1%	25.2%	61.0%	30.1%	2.1%	91.5%

[a]The percentages reported are based on the population-weighted figures. (For further discussion see the Survey of Consumer Finances codebook at www.bog.frb.fed.us/pubs/oss/oss2/95/scf95home.html.)

[b]The question on ATMs asked whether any member of the household had an ATM card, not whether the member used it. The other questions asked about usage.

[c]See note on Table 3

Source: 1995 Survey of Consumer Finances, Federal Reserve System. update to table

about 1.75 percent, say that the computer is the main way they deal with their financial institutions.[17] But youth, high income, and a college degree are associated with a higher incidence of computer banking. In fact, 7 percent of upper income households where the head of household is less than 30 years old and has a college

[17]If we include households that listed computers as one of the ways they mainly conduct business with at least one of their financial institutions (although not necessarily as *the* main way), this percentage rises but, at 3.75 percent, is still small.

TABLE 3

Percent of U.S. Households With at Least One Financial Institution Using Each Method As the Main Way of Conducting Business With at Least One Of Their Financial Institutions[a]

	In Person	Mail	ATM	Phone	Computer	Electronic[b]
All Households	75.1%	52.2%	24.6%	13.3%	1.7%	37.1%
By Age:						
Under 30 years old	64.6%	54.9%	39.2%	8.5%	2.9%	47.7%
Between 30 and 60 years old	75.2%	57.2%	27.7%	14.5%	2.1%	41.3%
Over 60 years old	79.9%	40.2%	11.2%	13.2%	0.4%	23.2%
By Income[c]:						
Low income	73.7%	28.4%	13.7%	4.8%	0.7%	19.3%
Moderate income	76.7%	44.7%	22.8%	9.0%	0.5%	30.4%
Middle income	74.6%	52.4%	27.2%	11.0%	1.9%	40.0%
Upper income	75.5%	69.8%	30.8%	21.5%	2.8%	49.6%
By Education						
No college degree	76.9%	45.5%	19.6%	8.9%	1.3%	29.1%
College degree	71.3%	66.0%	35.1%	22.4%	2.6%	53.6%

[a]Referring to each financial institution with which the household does business, the survey asked: "How do you mainly do business with this institution?" Respondents could list multiple methods, with the main method listed first. This table reports on the first method listed for each of the household's financial institutions. The percentages reported are based on the population-weighted figures. Note, the percentages do not add up to 100 percent across columns, since households could have more than one financial institution.

[b]Electronic refers to ATM, phone, payroll deduction and direct deposit, electronic transfer, or computer.

[c]Low income is defined as less than 50 percent of the median household income; moderate income is 50 to 80 percent of the median; middle income is 80 to 120 percent of the median; and upper income is greater than 120 percent of the median. Median income was $32,264 in 1994, the year to which the survey questions refer. So, low income is less than $16,132; moderate income is $16,132 to $25,811; middle income is $25,811 to $38,717; and upper income is over $38,717.

Source: 1995 Survey of Consumer Finances, Federal Reserve System. update to table

degree report that the main way they deal with their financial institution is by computer.[18]

Certainly, since 1995, when the SCF was conducted and the first Internet banking was offered, the use of PC banking has increased, but it still hasn't taken off. According to the information-market research firm Dataquest, at the end of 1998, 7 percent of all households did some banking by PC.[19] Dataquest's March 1999 survey of 16,000 consumers suggests that over 5 percent of U.S. adults view their account data on line, 3.75 percent transfer funds online, and 2 percent pay bills online (*Bank Network News,* 1999). According to a PSI Global survey, small companies' use of PC banking has risen over the last few years from about 1 percent in 1996; but still, in 1999, fewer than 10 percent of the respondents reported using it.[20] According to the survey, about 200,000 small businesses currently bank online.

One development that makes predictions of double- or even triple-digit growth of PC banking more credible now than at any time in the past is the growth of the Internet. Internet banking, one form of PC banking, offers customers 24-hour access and the ability to bank from multiple venues, since proprietary software need not reside on each machine. According to estimates, 30 to 40 percent of all households access the Internet now, and this number has been growing quickly.[21] According to the Graphics, Visualization, and Usability (GVU) Center's 1998 survey, over 90 percent of the Internet users surveyed are making purchases online and about 60 percent are also paying for the items over the Internet most or all of the time. This indicates that these buyers have some confidence in the security of the Net for financial transactions.[22]

As people have gained confidence, more banks have begun to offer Internet banking web sites through which their customers can perform transactions. One motivation is profit: data from Fleet Boston Corp suggest that while its average web-only customer generates less revenue than its average customer who uses both the web and branches, the web-only customer is half as costly to service and, therefore, is a more profitable customer (Kutler, 1999b). Interesting findings by Lorin Hitt and Frances Frei, based on case studies and customer data from four institutions, suggest that users of PC banking tend to be more profitable customers for the bank, but this is due more to characteristics that existed before they started using PC banking rather than the fee structure, cost savings, or possible cross-selling opportunities that PC banking affords the institution. In other words, users of PC banking tend to be high-profit customers regardless of which method of banking they choose.

A study by staff at the Office of the Comptroller of the Currency (Egland, Furst, Nolle, and Robertson, December 1998) estimates that the number of commercial-bank web sites through which a customer can move or access funds more than tripled in 1998; the number continued to grow in 1999.[23] According to the *Wall Street Journal* (May 10, 1999), Bank One announced it was not planning any more major acquisitions but

[18]It's important to remember that this group makes up only 1.5 percent of all households.

[19]As reported by Bill Orr, 1999a.

[20]Reported in *Future Banker,* May 1999, p. 34. PSI Global surveyed 900 financial decision-makers designed to represent about 2.2 million small businesses overall, including so-called small office and home office businesses. The survey had a margin of error of plus or minus two percentage points.

[21]As reported in Orr (1999a), Dataquest estimates that 37 percent of households access the Internet. The brokerage firm Piper Jaffray (in Franco and Klein) puts the number at about 32 percent in 1998, rising to about 41 percent in 1999.

[22]The GVU Center is located at Georgia Tech University. The 10th survey was conducted between October and December 1998. There were 645 respondents to questions about making purchases on the Internet.

now planned to concentrate on expanding via the Internet. In June, it established the web bank WingspanBank.com, an institution separate from Bank One. In August, Citibank unveiled its web bank and brokerage firm, Citi f/i.[24] And, of course, several banks have only a web presence and no physical brick-and-mortar presence at all, for example, NetB@nk.[25]

Consumers can pay bills electronically even if they don't have a PC. The SCF indicates that in 1995, about 22 percent of households used automatic bill-paying services, whereby the customer preauthorizes a debit from his or her account for regularly scheduled payments, such as utility bills and mortgage payments; the transactions are cleared through an automated clearing house facility (Table 2). According to *The Nilson Report* data (shown in Table 1), in 1997 these payments represented only 2 percent of the dollar value of consumer payments, and when payments authorized by telephone or over the Internet are included, this percentage rises only to 2.5 percent (up from 0.7 percent in 1990 and 2.3 percent in 1996). A recent survey of 2800 households by PSI Global found that 63 percent of respondents felt sending payments through the mail was more secure and reliable than sending them electronically; 74 percent felt paper checks offered more privacy; and 72 percent felt that paper checks were more convenient (Souccar, 1999b).

Smart cards are another relatively new electronic payments instrument—at least in the U.S.—and they have been slow to develop here. As shown in Table 2, only 1.2 percent of households report using a smart card, that is, a card including a computer chip on which financial information, including value, may be stored. (Again, the percentages using these cards are higher for the younger, richer, and more educated.) This is consistent with reports that trials of smart cards in various places in the U.S., including New York's Upper West Side in 1997 and 1998, have not been very successful, as users have not found the cards more convenient than cash or credit cards. A trial of a new smart-card technology in Canada by Bank of Montreal and the Toronto Dominion Bank in 1997 also saw extremely low usage of the card.[26]

About 85 percent of smart cards are deployed in Europe, while only 1 percent have been issued in North America. According to data cited in the *American Banker,* the U.S. was expected to have 50 million smart cards in 1999, while Europe had 1 billion.[27] Analysts project faster growth in the U.S. over the next three years, but even this would leave U.S. usage at just 10 percent of the total. One reason for the fast adoption abroad and the slow adoption in the U.S. is that in the 1970s, when the first patents for smart

[23]While the number of such sites continued to grow in 1999, as of July 31, 1999, still less than 7 percent of banks and thrifts offered transactional web sites (personal correspondence from the OCC).

[24]The entry of these very large banks into the Internet arena has caused North Fork Bancorp, New York, with $11 billion in assets, to scale back its plans for a separate Internet bank (see Senior).

[25]A special problem that web banks have to solve is how to deliver cash to their customers and how to accept deposits. Some are allowing customers to access ATMs without cost. Direct deposit can be used to make some deposits, but in other cases, deposits have to be mailed to the bank. So much for the electronic age! (See the article by Rick Brooks for further discussion of the pros and cons.) Bank of Montreal, with $144 billion in assets, punted: it ended its web-only bank, mbanx, in August 1999, and gave mbanx customers access to physical branches (see Power, 1999).

[26]Christopher Plouffe, Mark Vandenbosch, and John Hulland researched this trial and found that consumer and merchant participants viewed the smart-card system as an additional way for the bank to charge fees, rather than as a benefit to themselves; they were concerned about security of personal information; and they found the processing time at the point-of-sale too slow.

[27]Jeffrey Kutler (1999a) reported on a presentation by MasterCard Vice President Michael Tempora, who cited projections from the research firm Datamonitor.

cards were obtained, telephone lines were relatively scarce and expensive in Europe, which meant that credit card authorizations were expensive in Europe and off-line transactions via a smart card were advantageous. In the U.S., on the other hand, the credit card took off, since it was relatively cheaper than the smart card. Visa and MasterCard are reported to be trying to expand usage of smart cards in the U.S. and Canada. Visa is running a 450-card trial with the federal government's General Services Administration, with the smart cards issued by Citibank. (See the article by Miriam Souccar, 1999a.) Hibernia National Bank is planning a smart card trial in the first quarter of 2000; the cards will be issued to its PC banking customers so that they can access their accounts remotely from various locations (Souccar, 1999c). Mondex Canada Association ran a trial in Guelph with some success and plans a further trial in Sherbrooke, near Quebec. (See the paper by Joanne DeLaurentiis.)

As with smart cards, electronic money systems in which customers have an electronic purse or wallet on their PCs have been slow to catch on. A three-year U.S. trial of eCash, DigiCash's electronic money that uses the Internet, ended abruptly in September 1998; DigiCash announced it was filing for Chapter 11 bankruptcy protection in November 1998 (Schulz). First Virtual Holdings has also left the e-money business. (See the Tim Clark reference.) Perhaps one reason demand for this type of e-money has been low is that as better security software has been developed, people have become more comfortable using their credit cards to pay for purchases over the Internet. And credit cards are more convenient, since consumers aren't tied to particular computers that hold their electronic purses to make purchases.

SLOW ADOPTION AT FIRST MAKES ECONOMIC SENSE

Given all the publicity new payment instruments have received, it might seem surprising that the traditional methods are still the most popular. Computer technologies mean that the cost of processing an additional transaction using one of the new instruments is less than the marginal operating cost of a transaction using one of the older instruments. For example, according to a study by Booz, Allen & Hamilton, a typical transaction over the Internet costs about one cent, compared to 27 cents at an ATM, and $1.07 at a teller window (Orr, 1999b). According to an Ernst and Young study (as cited in Franco and Klein), the average cost to the bank of handling a transaction via the Internet is about 26 cents versus 53 cents at an ATM, and 84 cents using a telephone call center; an ACH deposit is estimated to cost about 8 cents (Furst, Lang, and Nolle, September 1998). Hence, electronic forms of payment are potentially much more efficient than paper-based and other traditional methods of payment.

But this does not mean the older instruments will be quickly replaced. One reason is that the new instruments require large expenditures for computer systems and other fixed costs upfront, before they can offer low additional costs per customer served. The fixed costs mean that the average cost of the new instrument can exceed the average cost of an older instrument for some time to come. Indeed, the 623 respondents in a 1998 survey by the Treasury Management Association (a professional association of treasury and financial management executives in industry, government, and universities) cited the cost of the technology and the need to integrate it with existing financial systems as important barriers to their organizations' making more use of electronic payments. These barriers were cited even more often by those firms that, at the time of the survey, could not initiate payments electronically. (See the study by Aaron Phillips.)

Network effects are also at work. Consumers' acceptance of a new payment instrument depends on how many merchants accept it, and merchants' acceptance depends on the expectation of sufficient customer demand as well as

the decisions of competing merchants about whether to adopt the new means of payment.[28] And widespread adoption by consumers and merchants depends on their confidence in the medium's safety and soundness.

How fast a payments instrument is adopted also depends on how the risk, costs, and benefits of the new instrument are distributed among participants. For example, David Barstow points out that the greater cost efficiency of the government's shift to electronic provision of welfare payments and food stamps (electronic benefits transfer) has yet to benefit the recipients of such relief in New York.[29] This certainly affects how recipients feel about using the new electronic system compared to the old paper-based system, although they do not have a choice. But other consumers do have a choice in their payments method. The traditional payments instruments—cash and checks—are convenient and work quite well from a consumer's viewpoint.[30]

Until very recently, consumers have not explicitly paid for the costs of using checks (for example, many accounts offered free check-writing privileges), and they receive the float—the use of the money between the time the check is written and the time the person's account is actually debited.[31] Paying banks also benefit from float. Consumers implicitly paid for check services by receiving lower rates on deposits or paying higher rates on loans, but the costs were not apparent. This situation is changing as consumers are paying more explicit fees for banking services. It is still an unanswered question whether the discrepancy between what a payor pays to use a particular instrument (the private cost) and the total production and processing costs of the instrument (the social cost) can explain the continued dominance of paper checks.[32]

An alternative explanation is that users don't necessarily view checks and preauthorized bill payments cleared through an automated clearing house as close substitutes. Checks give users more control over when to initiate a payment; preauthorized payments are automatically debited or credited to a consumer's account. Businesses can easily attach remittance information to a check; for an ACH transaction they need special software that allows financial electronic data interchange (Wells).[33] There are fixed costs

[28]In a 1999 study, Gautam Gowrisankaran and Joanna Stavins present empirical evidence that network externalities exist in ACH processing. See also the article by James McAndrews (1997).

[29]In their study, Jeanne Hogarth and Kevin O'Donnell examine the ways in which lower income households use banking services and the implications of the government's move to electronic payment of welfare and benefits.

[30]According to the BAI/PSI Global study, approximately 40 percent ($45 million) of total revenue from the payments business is generated from paper checks. This revenue comprises bank fees associated with checking account transactions and services, vendor revenues from check processing systems and equipment sales, third-party service revenues, and bill-payment postage. Banks get nearly half of this (about $21 billion).

[31]Of course, float can also hurt customers when they are on the receiving end of a payment.

[32]Studies include those by David Humphrey and Allen Berger; Kirsten Wells; Joanna Stavins; and Jeffrey Lacker. Using 1987 data, Humphrey and Berger found that the private cost of a check was less than the social cost of an ACH payment because of float. This difference encouraged the payor to choose to pay by check even though the social cost of the check was greater than the social cost of an ACH payment, making the check a less efficient means of payment. But using 1993 data, Wells found that both the social cost and the private cost to the payor of making an ACH payment were less than that of writing a paper check. Based on these estimates, the domination of checks remains a mystery.

[33]According to the Treasury Management Association's survey, while over two-thirds of the 623 respondents had the ability to make or receive electronic payments, fewer than 60 percent of these had the ability to transmit or receive remittance information with the payment (so-called electronic bill presentment and payment services).

involved and also a network externality—each individual business takes into account only its private benefit of joining an ACH network, but the social benefits grow as more and more businesses join. So the market could be underproviding electronic payments relative to checks.

In any case, consumers and businesses have been slow to adopt many of the new forms of electronic payment, like smart cards, stored-value cards, and electronic purses. Furthermore, these methods have been designed for making mainly small-value payments and are not likely to represent large dollar values of liabilities even if or when fully adopted. For the time being, new forms of electronic payment do not seem to be a threat to the safety and soundness of the existing payments system.[34] But they still deserve monitoring. For example, they may expose individuals and institutions using them to substantial liability through fraud. (See *What Are the Risks?*, page 25)

REGULATING NONBANK PROVIDERS OF NEW FORMS OF PAYMENTS

The Federal Reserve works to ensure the integrity of the nation's payments system. By and large this is accomplished by prudential oversight of banks and by requirements imposed on clearing arrangements that wish to use the Federal Reserve's net settlement services. Nonbank participation in the payments system is not new (consider Western Union moneygrams and American Express traveler's checks). But to date, nonbank participants represent only a small part of the payments system. Given that the new instruments, like smart cards and other forms of electronic money, are not expected to involve large sums or represent a large part of total U.S. payments in the near future, permitting nonbanks to compete in this market is unlikely to threaten the dominant position of banks in the payments arena in the near term.

Nonbanks are subject to some regulation. Laws in 44 states regulate nonbanks that issue physical stores of value, for example, traveler's checks or money orders. Some require 100 percent reserves, minimum capital levels, licensing, bonding, and periodic examinations and audits. The laws might also cover, or be amended to cover, issuers of electronic money. In addition, the Federal Reserve has some authority to regulate new forms of electronic payments used by consumers under Regulation E. This regulation implements the Electronic Funds Transfer Act and includes provisions to protect consumers when they use electronic payments. Nonbank issuers of smart cards and other forms of electronic money fall under the regulatory purview of the Federal Reserve with respect to this consumer protection regulation. Other relevant forms of regulatory authority over electronic forms of payment are laws that relate to reserve requirements, deposit insurance, privacy, consumer protection, access, and antitrust.[35]

[34]Moreover, at least in the near term, the new forms of payment aren't likely to have a large effect on the conduct of monetary policy. If use of these payment methods were to take off, the measured velocity of money could be affected, but measures of money have become less important in the conduct of monetary policy. The Fed would adjust, as it has adjusted to previous financial innovations. New forms of payment could eventually reduce the demand for cash. This would reduce the government's income from seignorage, but the reduction is likely to be inconsequential. Nevertheless, the monetary policy implications of electronic money are worth contemplating. See Alan S. Blinder's testimony for a review of the issues from the Fed's perspective.

[35]Under current U.S. law, stored-value cards, smart cards, and e-wallets are being viewed as liabilities but not deposits, thus allowing nonbanks to issue these instruments. Whether they will continue to be viewed this way as they develop and, therefore, whether nonbanks will continue to be able to offer them is unclear. Also, if a depository institution issues stored-value cards, it's possible the balances on those cards would be treated as deposits in the future. (Currently, the Fed does not consider these balances to be deposits if the card does not

Nonbank competitors are not automatically covered by the federal regulatory system for ensuring the safety and soundness of the payments system. Hence, it is still an open question as to whether the Federal Reserve or any other regulator enjoys adequate authority to protect the payments system in a world where nonbanks play a much larger role in retail clearing arrangements. Although new payments methods haven't taken off yet, the adoption rate of new forms of payment, as with many new technologies, is likely to be slow at first and then accelerate. Regulators like the Fed need to continue to track these new forms of payment even if none seems dominant today.

In terms of how to treat these new types of payment instruments, at least three regulatory approaches are possible, each with pros and cons. One approach would be to allow all types of firms to issue new forms of payment instruments. Such laissez-faire would encourage innovation and allow the market to develop, but the failure of an issuer might lead to a loss of confidence in electronic systems from which it might be difficult to recover. Another approach would be to allow only banks to issue new payment instruments like smart cards.[36] The bank regulatory system already in place could then be used by regulators to oversee electronic-payment instruments. But this might limit competition and stifle innovation. A third approach would be to allow a variety of different kinds of firms to issue electronic money but only with prior regulatory approval. Regulators could then impose a greater regulatory burden on issuers and systems that pose greater risk to the payments system as a whole. Disclosure requirements and perhaps restrictions on the portfolios of electronic-money issuers (similar in spirit, for example, to those on money market mutual funds) could be part of this "light-handed" regulatory approach.

Which regulatory regime is best depends on the tradeoff between having a very secure but perhaps less efficient payments system today versus allowing for innovation to enhance the efficiency and security of tomorrow's payments system. While heavy regulation might mean a more secure system today (although this is debatable), it would likely stifle any innovation undertaken by private-sector participants in the payments system. This could mean a less secure and less efficient system in the future. But some type of regulatory oversight is desirable. The success of a new form of payment depends on its being adopted by large numbers of consumers and merchants, and this adoption depends on consumers and merchants having confidence in the safety and effectiveness of the system. Light-handed regulation can foster their confidence. Even nonbank issuers might find some regulation useful, since the failure of a large nonbank provider because of inadequate oversight could set back the ultimate adoption of the

access a deposit account.) In other words, there is the possibility of disparate treatment between bank and nonbank issuers. This is not unprecedented: traveler's checks issued by banks are subject to reserve requirements and are covered by deposit insurance, but those issued by nonbanks are not. (Note, however, that many states require nonbank issuers to hold ample reserves against the instruments they issue.) In another case, as cited in a study by the Congressional Budget Office, the FDIC issued an unpublished advisory opinion (Oct. 20, 1995) that granted passthrough deposit insurance to the customers of an institution that issues electronic scrip. This opinion was based, in part, on the grounds that the issuer of the electronic scrip holds the funds as an agent for the owners of the funds. The marketing literature for DigiCash's system of online scrip, on the other hand, stated that it was equivalent to cash rather than a deposit.

[36]The European Central Bank recommends that all issuers of electronic money be subject to prudential supervision, that multi-use smart cards be treated as deposits, and that these cards and other forms of electronic money be issued only by credit institutions (see European Central Bank, August 1998).

new payment instruments—users of new payment instruments have long memories. The PC-banking systems in the 1980s were so slow that consumers were turned off, and it was very difficult to get them to try PC banking again once the technology improved.[37]

Another benefit of the light-handed approach is that it recognizes that we still don't know which new payment instruments and which technologies will turn out to be the best. Light-handed regulation offers a better chance for various technologies and different forms of instruments to compete until the best types win out. Since it is unclear which instruments will survive the market test, it makes sense to avoid setting up a regulatory scheme based on how the system looks today, since it could look quite different in the future. In a speech, Vice Chairman Ferguson discussed the benefits of a light-handed approach (see Ferguson, 1998).

THE FEDERAL RESERVE AS A SERVICE PROVIDER

The Fed needs to ensure a well-functioning *wholesale* (that is, large dollar, interbank) payments system to support economic growth. To this end, it provides the Fedwire funds transfer system to ensure final settlement of interbank payments, and it offers net settlement services for payments cleared outside the Fed. But the Federal Reserve is also directly involved in providing *retail* payments services, in particular, check and ACH services. Together, the Federal Reserve Banks are the largest ACH operator and process about three-fourths of interbank ACH transactions, including all ACH transactions initiated by the federal government. (The main private-sector ACH operators are the New York Clearing House [now called Electronic Payments Network], Visa, and the American Clearing House.) The Federal Reserve also clears about one-third of interbank checks collected in the U.S.

Federal Reserve Board Vice Chairman Ferguson has pointed out that the rationale for the Fed's involvement in the check business stems from the early 1900s when checks were used to make interbank wholesale transfers. Today, the Fed's involvement in retail payments is aimed at facilitating competition, guaranteeing universal access to the payments system, and exerting some influence on developments in retail payments (Ferguson, 1998). For example, the Fed is the "provider of last resort." That is, it provides payments services such as check clearing in any area underserved by the commercial sector. As such, the Fed can influence the market by promoting efficiency and ensuring access.

In 1997, the Fed undertook a study to determine whether it should remain a provider of retail payment services and to see what role it should play, given the electronic developments taking place. Senior Federal Reserve officials, the so-called Rivlin Committee, held meetings with various participants in the retail payments system, both users and providers of these services, and issued a final report in January 1998 ("The Federal Reserve in the Payments Mechanism").

The study found that most participants want the Fed to continue to provide check and ACH services. Many participants questioned whether private-sector suppliers would meet the needs of all depository institutions, especially small ones in remote areas. Thus, one of the study's major conclusions was that the Fed "should remain a provider of both check collection and ACH services with the explicit goal of enhancing the efficiency, effectiveness, and convenience of both systems, while ensuring access for all depository institutions."

Another of the study's major conclusions was that the Fed should play a more active role, working closely with providers and users of the payments system, to help new, more efficient payment instruments evolve. The Fed would en-

[37]See Frances Frei and Ravi Kalakota for an interesting discussion of the history of PC banking and current developments.

courage participants to communicate with one another. It would also encourage changing regulations and laws to allow the emerging payment instruments to evolve, rather than promote any particular payment method.[38]

For example, the Fed could play a role in helping to clarify some legal issues regarding electronic forms of payment, which would help facilitate their adoption. It is still not clear when these payment instruments are considered deposits, and what the potential liabilities, rights, and responsibilities of issuers, merchants, and consumers are. For example, under the Uniform Commercial Code, a set of laws that govern commercial and financial activities, presentment of checks for payment by the electronic transmission of information is allowed, but paying banks still have the legal right to insist on paper presentment (U.S. General Accounting Office, p. 4). Also, some states still require banks to offer canceled checks to their customers. According to the GAO's reading of a 1997 Boston Fed survey, 41 states plus the District of Columbia had at least one law or regulation that required individuals or organizations to retain their canceled checks for various purposes, including documentation for state and local governments.[39] These types of laws hinder the adoption of electronic check presentment. Legal ambiguities surround other new payment instruments as well.[40] For example, if an issuer were to become bankrupt or insolvent, what would be the status of the claim represented by a balance on a smart card?[41]

The Fed could also help facilitate standard-setting in the electronic payments industry. Having a set of standards that all current and potential providers follow will solve a problem of coordination and, thus, encourage faster adoption. One reason the Internet has been so successful and has developed so quickly is that it is based on a common standard that is widely available. Standards also help a payment method achieve a volume sufficiently large to attain the benefits of network effects. The value of a new payment instrument depends on how many others adopt it. If compatibility standards can be agreed on, there's greater potential that more consumers and merchants will use the instrument, making it more attractive, and leading to even wider adoption. There is a risk, however, that the wrong set of standards will be adopted, which could retard developments. Hence, analysis should be done before a particular set of standards is settled upon.

The Fed has been modestly proactive in setting standards in areas where it is a direct provider. For example, the Fed has implemented an enhanced net settlement service, set new risk management guidelines, promoted electronic check imaging and presentment, and undertaken

[38]The results of the Treasury Management Association's survey suggest that government can play an important role in fostering the move to electronic payments: federal mandates, followed by state mandates, were the dominant factors cited by the 544 respondents with electronic payment capability in their decision to originally adopt it.

[39]My canceled check, with the city's account information stamped on the back, saved the day when I had to prove I'd paid a city tax.

[40]Two bills introduced in the House during the last Congress attempted to clarify some of the legal issues about the use of electronic signatures, one component of making electronic payments. HR 1714, the Electronic Signatures in Global and National Commerce Act, sought to extend U.S.-style electronic signature policy overseas and to recognize electronic signatures as legally valid, even though they aren't in the traditional written form. This bill narrowly failed in the House on November 1, 1999. HR 1685, the Internet Growth and Development Act of 1999, proposed recognizing electronic signatures in interstate and foreign commerce.

[41]With credit cards, if the issuing bank fails, the credit card association guarantees payment to merchants with outstanding transactions and then has a creditor's claim on the failed bank.

an electronic checks initiative. Since the Fed does not have any more relevant expertise than others in the area of new types of electronic payment instruments, the Fed may not want to set standards for technology in this area. It may, however, want to be involved in setting guidelines pertaining to security and risk management with these new instruments.

The Fed's study also recommended that the Fed work with other participants in the retail payments system to assess the potential use of the Fed's electronic payments infrastructure for clearing or settling new forms of electronic retail payments to help spur their growth. The report, however, did not recommend that the Fed become a direct provider of new electronic payment instruments. As Governor Ferguson has stated, a rationale for the Fed's being a provider of these new payment instruments would be the existence of some type of market failure, which would mean that the private sector was unable or unwilling to provide these services. There is insufficient evidence that this is true today. Further, it is not clear which payment instruments will ultimately be best—the market will have to decide. Thus, rather than provide these payment instruments directly, the Fed intends to work toward creating an environment that fosters the development of more efficient electronic payment instruments in the private sector.

This decision is not without consequences. It means that over time, if new electronic forms of payment become dominant, the Fed will no longer be a major provider of payment services. So it will lose one of the mechanisms through which it can influence the safety and efficiency of the payments system. For example, currently, the Fed is the dominant provider of ACH and net settlement services, and it sets conditions that must be met by all participants. These conditions help ensure safety and soundness of the system. If the Fed loses market share, its conditions for participation become less relevant. It is still an open question about how important the loss of this mechanism for influencing the market is. The Fed would still retain the authority to oversee and regulate, as necessary, the payments system.

CONCLUSION

Electronic instruments for making payments are developing, some more quickly than others, and nonbanks are beginning to become payment providers. Does this necessarily mean that the rules must change? No. The Fed will continue to monitor developments in the payments system to help ensure its safety and soundness. The Fed has some authority to regulate certain aspects of electronic payments. Moreover, the Fed will remain a provider of its traditional services of ACH and check clearing. At this point, the Fed is not planning to become a provider of e-cash or other new electronic payment instruments, but it will work to foster an environment to encourage a move toward more efficient electronic payment instruments. This might include helping the private sector develop standards to facilitate coordination among providers and users of the payments system and helping to clarify some of the legal issues surrounding new means of payment.

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What Are the Risks?

New forms of retail payments, like traditional payment methods, involve some risks. *Fraud and counterfeiting* are probably the most significant risks in using the new instruments, at least in the short run.[a] Even though each transaction in the wholesale market is much larger, it is easier to make the wholesale payments system secure than it is the electronic retail system, because the wholesale market involves a relatively small number of participants. The electronic security of the Internet, of internal or closed payment networks, and of new instruments is difficult to ensure, and breaches have occurred. Kimelman, in the *American Banker,* reports on a "bank" that took in $6 million from customers over the Internet in 1997 and 1998, with the intent to defraud. Off-line transactions, like those initiated by smart cards, are more difficult to monitor for fraud than on-line transactions. There is a risk the card can be counterfeited and the value erroneously transferred or replicated. Ensuring security of credit card information over the Internet is complex, since packets of information can pass through many different computers, each one accessible to a large number of people, before reaching its final destination. Also, a dishonest bill-paying outfit can abscond with customers' money.

Concerns about fraud can slow the adoption of electronic payment methods. Regulators and bank officials interviewed by the GAO indicated that one thing that might deter banks from moving to electronic check presentment (ECP) was their feeling that ECP had higher potential for fraud because in their view it was more difficult to detect forged signatures than with paper checks (U.S. General Accounting Office).[b]

Some estimates show a higher incidence of fraud for credit cards, an electronic means of payment, than for checks. According to William Roberds, while annual losses due to credit card fraud are small compared with losses due to check fraud, as a percent of the dollar value of transactions, credit card losses are higher than check losses.[c] He estimates that in 1995, the incidence of loss on credit cards was about 10 to 20 basis points; the loss on checks was less than 2 basis points. To date, the losses from breaches of organizations' computer systems for the purpose of committing financial fraud have not been very large. Sweeney reports that in a 1999 Computer Securities Institute survey of 521 organizations, including corporations, financial institutions, universities, and government agencies, 27 respondents reported break-ins into their computer systems for the purposes of executing financial fraud, which resulted in $39.7 million in losses. However, there are concerns that the proliferation of computers and electronic payment instruments will make financial fraud much more common.

Methods are being developed to try to contain fraud. Digital signatures or public-key technology can allow users to know whether they have gotten to a financial institution's true web site. Digital

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[a]See the article by William Roberds for a thorough analysis of potential fraud in the use of new retail payment instruments. See also the article by James McAndrews (1999), which discusses e-money and risks to the payments system.

[b]But some argue that because of the speed that electronic check and bill presentment brings to the check collection process, it may enhance security by reducing float and, therefore, the uncertainty about receiving a payment (see Sweeney).

[c]Roberds reports estimates of gross fraud losses in the U.S. on credit cards of $2-3 billion in 1993 and $1.3 billion in 1995. Estimates of gross fraud losses on checks range as high as $10 billion (with banks' share of these losses amounting to $615 million in 1995, according to a survey by the Federal Reserve). Gross losses do not include any recoveries made of lost funds.

What Are the Risks? (continued)

encryption is built into smart cards and software-based money. Encryption provides a higher level of security than magnetic strips on credit cards. But because it is very cheap to duplicate cards, any security breach could result in large losses to an institution. Limits on the amount of value that can be put on a card or on the size of a transaction could help limit this risk. Security methods involving biometrics are also being developed, for example, smart cards with built-in fingerprint scanners (see Bruce) or iris scanners. However, existing biometrics can be unreliable: some rely on hand geometry, but according to Jim Wayman, director of the U.S. National Biometric Center, about six out of 1000 people have the same hand characteristics. Also, as he demonstrated at a conference, the best available systems were unable to recognize that two sets of fingerprints were from the same person: the prints were taken just six weeks apart but under different conditions (Bruce).

A second risk involves potential for *criminal activity* (which is closely related to fraud). While not a new risk, the new modes of payment make it more likely that criminal organizations will be able to evade regulations aimed at curtailing their payment transactions. For example, a smart card is easier to conceal than a large volume of currency.

Liquidity, market, and *settlement risk* are additional risks. In a world of large international capital flows, the possibility of a problem spreading from one country's payment system to another and then another, until payment systems worldwide are affected, creates a potential for crisis in electronic payment networks, particularly for large-value clearing arrangements. Systemic risk arising from clearing *retail* payments is relatively small. In general, systemic risk is greatest when the value of settlements represents a significant share of participating institutions' capital or when the gross value of transactions is much larger than the net amounts to be settled. Most clearing arrangements for retail payments do not involve settlement values that are a significant share of an institution's capital. There is some room for caution, however, because most small-value clearing arrangements have less sophisticated risk controls than do the large-value clearing arrangements.

Operational risk also needs to be considered. At least initially, problems with errors, reliability, and compatibility of systems should be expected. But if the problems are large enough, they could deter adoption of new and better technologies. The initial tries at PC banking left a bad taste in consumers' mouths. Also, electronic bill-payment services currently have a higher error rate and are more costly to the recipients of the payments than traditional check payments, partly because of the difficulties of sending remittance information along with the payment (Franco and Klein, p. 16). Technologies are being developed to help solve this problem.

From Cycles to Shocks: Progress in Business-Cycle Theory

*Satyajit Chatterjee**

Early analysts of business cycles believed that each cyclical phase of the economy carries within it the seed that generates the next cyclical phase. A boom generates the next recession; that recession generates the next boom; and the economy is caught forever in a self-sustaining cycle. In contrast, modern theories of business cycles attribute cyclical fluctuations to the cumulative effects of shocks and disturbances that continually buffet the economy. In other words, without shocks there are no cycles.

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The evolution of thought about business cycles from an emphasis on self-sustaining behavior toward one in which random shocks take center stage is a significant development in macroeconomics, and it is an especially important one for policymaking institutions like the Federal Reserve. The view that cycles are self-sustaining implies that a market economy cannot deliver stable economic performance on a sustained basis. Generally speaking, this view points to aggressive countercyclical policies or institutional reform as the appropriate response to cyclical fluctuations.

In contrast, the view that shocks are the ultimate sources of business cycles does not point

to a particular policy stance. Whether a countercyclical policy should be pursued depends on the nature of the shocks. If shocks can be eliminated, macroeconomic policy should endeavor to do so because a more stable economic environment is preferable to a less stable one. But if shocks cannot be eliminated, it may be in the long-run interests of society to adapt to the shocks. To the extent that countercyclical policies interfere with the necessary adaptations, they may do more harm than good.[1]

Not surprisingly, the shift of professional opinion toward the shock-based view of business cycles has been accompanied by increasing debate about the sources of cyclical volatility. Few macroeconomists doubt that random shocks underlie business cycles, but they have been unable to agree on which random shocks, historically, have been the main causes of cyclical volatility.

To a person not versed in business-cycle theory (including economists who are not macroeconomists), this situation must seem somewhat paradoxical: How can macroeconomists be certain that shocks cause cycles, yet not agree on *which* shocks are responsible for cyclical volatility? Moreover, if a person is told that despite this ignorance, macroeconomists have made great strides in understanding business cycles, his or her perplexity can only increase. How can there be any understanding of business cycles (let alone an improvement in it!) if economists don't know the causes of cyclical volatility?

This article will answer these questions by sketching the historical evolution of the shock-based theory of business cycles. The answer to the first question delineates the key discoveries that led macroeconomists away from the self-sustaining view of business cycles and toward the shock-based view. The impetus for the shock-based view of business cycles came in the 1920s when mathematicians made a major breakthrough in the statistical description of cyclical phenomena. They established that many kinds of irregular cyclical phenomena (in fields as diverse as economics, geology, and physics) are best explained by random shocks.

This discovery set economists on the search for a shock-based theory of business cycles. Initially, economists thought that observable random events, such as an unexpected increase in government spending or a financial panic, would turn out to be the shocks causing business cycles. And to some extent they are. But they are not the major source of cyclical volatility. The major source appears to be shocks that manifest themselves as deviations of macroeconomic variables from their model-predicted values. Such shocks cannot easily be connected to observable real-world events. The unobservable nature of these shocks is the fundamental reason macroeconomists disagree about the ultimate causes of cyclical fluctuations. Yet, most macroeconomists agree that some set of unspecified shocks must be ultimately responsible for business cycles.

Although macroeconomists lack firm knowledge about the ultimate sources of cyclical volatility, they do understand how these shocks, once they occur, contribute to business cycles. Thus, the answer to the second question is that advances in business-cycle theory have provided a better understanding of how industrial economies respond to random shocks. One outcome of these developments is a new appreciation of the role that erratic changes in business-sector productivity play in cyclical fluctuations. According to the real business cycle, or RBC, theory (arguably one of the most successful shock-based business-cycle theories to date), random variation in business-sector productivity is the key *proximate* cause of post-WWII U.S. business cycles.

Let's now examine the historical process by

[1]For instance, a boom in residential construction could reflect speculative excess or changing demographics. An increase in the interest rate can eliminate speculation, but it cannot change demographics. Thus, policy action is desirable in the former case but probably not in the latter.

which business-cycle theorists have come to this conclusion.

THE STATISTICAL THEORY OF RANDOM WAVES

The fact that random disturbances may underlie business cycles was clearly demonstrated by the Russian statistician and economist Eugen Slutzky. In an article published in Russian in 1927 (and reprinted in English in 1937), Slutzky described in compelling detail how chance events could generate cyclical movements in economic data.[2]

Slutzky began with a series of many random numbers, each an integer between 0 and 9. If such numbers are plotted on a graph, they produce a line that moves up and down without displaying any particular pattern (Figure 1). This simply reflects the fact that the numbers, being drawn at random, don't bear any relationship to each other. Next, Slutzky constructed a new series by adding the random numbers 10 at a time in the following way. The first number in the new series was the sum of the first 10 random numbers; the second number in the new series was the sum of the second through the 11th random number, and so on. Thus, each member of the new series was a 10-item sum of random numbers. In the new series, the difference in value between adjacent members could be at most nine, but the difference between widely separated members could be much larger.

Slutzky recognized that this combination of facts—adjacent members of the series are likely to be similar in value, and widely separated members are *un*likely to be similar in value—implies wavelike, or cyclical, movement. Indeed, when plotted as a graph, the 10-item moving sums of the random numbers shown in Figure 1 display an unmistakable wavelike pattern (Fig-

FIGURE 1
Numbers Between 0 and 9 Drawn at Random

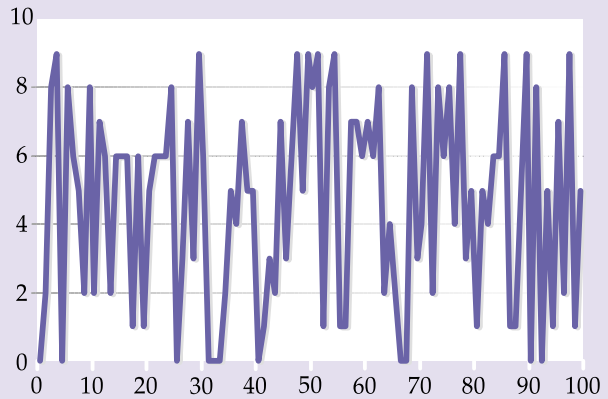
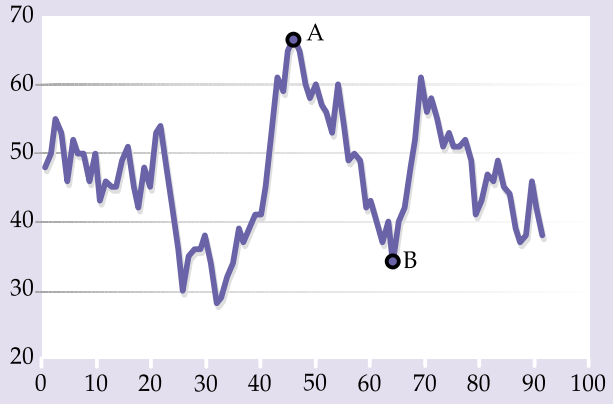


FIGURE 2
Ten-Item Moving Sum of Random Numbers Displayed in Figure 1



[2]Priority of discovery is attributed to the British statistician G. Udny Yule, who made this point in the early 1920s. However, Slutzky went much further than Yule in showing how random shocks could lead to apparently cyclical movements in economic (and other) data.

ure 2). While widely separated members of the series may be quite different in value, such as members A and B, the movement from A to B must be gradual because adjacent members of the series cannot be too different from each other. To persuade his readers that random numbers may underlie business-cycle movements, Slutzky compared a segment of his 10-item moving-sum series to an index of English business cycles. As we can see in Figure 3, the similarity is indeed remarkable!

Following Slutzky's pioneering work, mathematicians further developed the statistical theory of random waves. This development revealed that Slutzky's random-number-based explanation of irregular cyclical patterns was, in fact, the most compelling explanation of such patterns. This discovery persuaded business-cycle theorists to seek an explanation of business cycles in the cumulative effects of various random shocks hitting the economic system.

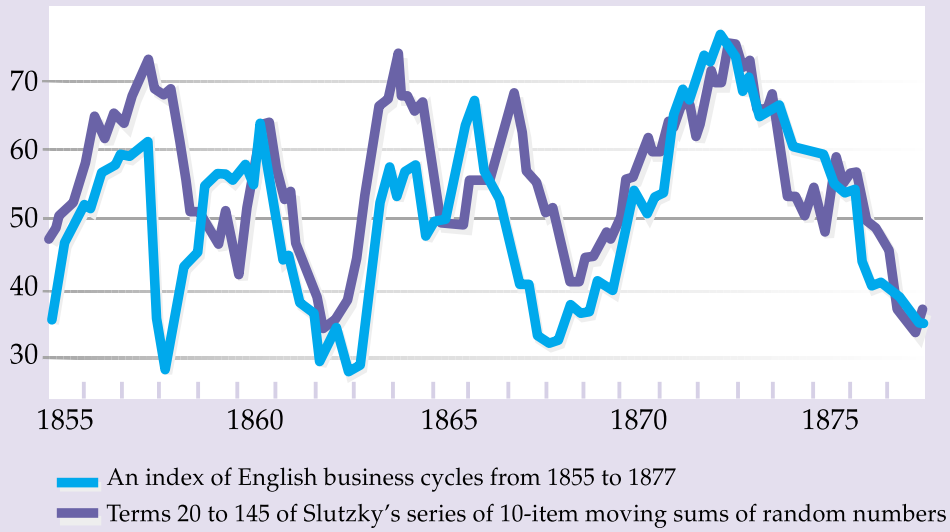
THE GENESIS OF SHOCK-BASED BUSINESS-CYCLE THEORY

Although Slutzky showed that moving sums of random numbers could display business-cycle-like patterns, he didn't provide any *economic* theory as to why macroeconomic variables might behave like moving sums of random numbers. However, he did point to examples of mechanical systems, such as a pendulum, whose motion under the influence of random shocks was, mathematically, a moving (weighted) sum of random numbers.

Imagine tapping with a hammer a pendulum whose motion is hampered by friction. If the hammer strokes vary randomly in strength, they'll cause the pendulum to swing about in an irregular way. A time-plot of the displacement of the pendulum from its (vertical) resting position (with displacement to the right measured as positive numbers and to the left as negative numbers) will show an irregular wavy line. The key

FIGURE 3

English Business Cycles and Slutzky's Random Series



Adapted from Slutzky, Eugen, *Econometrica*, 5 (1937).

point is that mathematically (and experimentally!), the displacement of the pendulum at any given point in time is a weighted moving sum of random numbers, the random numbers being the strength of each hammer stroke up to that point in time.

In an article published in 1933, the Norwegian economist and Nobel laureate Ragnar Frisch described a simple macroeconomic model in which the evolution of output, investment, and consumer spending resembled the motion of a swinging pendulum. Frisch's model implied that if some transient random event raised output above the economy's normal level, all macroeconomic variables (output, investment, and consumer spending) returned to normal in a *cyclical* fashion. In other words, the initial periods of above-normal economic activity (analogous to displacements of the pendulum to the right) were followed by periods of below-normal economic activity (analogous to displacements to the left). These swings in economic activity gradually diminished in strength and eventually died.

Frisch didn't work out the behavior of his model economy for a sequence of random shocks, but the analogy to the swinging pendulum suggested that the resulting behavior would resemble that of business cycles. In any event, by adopting the swinging pendulum as an analogy for the evolution of a capitalistic economy, Frisch took a step back from the prevailing view that business cycles were self-sustaining. Recall that without the hammer strokes, the force of friction brings the pendulum eventually to rest. And so it is, claimed Frisch, with an economic system: without shocks, there are no cycles.

Still, by basing his economic model of business cycles on an analogy to a swinging pendulum, Frisch gave inherently cyclical behavior (i.e., pendulum-like movements) a prominent place in business-cycle theory. However, the influence of the pendulum in business-cycle theory received a severe setback when Irma and Frank Adelman published an article in 1959 showing that shocks, rather than pendulum-like movements, lie at the center of cyclical volatility.

THE DEMISE OF THE PENDULUM AND THE RISE OF SHOCKS

By the mid-1950s, advances in econometrics (the use of statistical methods to determine quantitative economic relationships from economic data) had progressed to the point where equations describing various sectors of the economy could be inferred from economic data. The Klein-Goldberger model of the U.S. economy was one such model.[3] It contained 25 equations describing the evolution of 25 macroeconomic variables for the U.S. economy and was much more detailed than the simple economic model used by Frisch.

The question that the Adelmans asked was whether the Klein-Goldberger model could generate business cycles. First, they simulated the model on a computer to see if it displayed inherently cyclical behavior. They found that the model did *not* display appreciable pendulum-like movements. If some small to moderate transient shock temporarily raised economic activity, most economic variables simply returned to normal *without* experiencing any periods of below-normal activity.[4]

Next, the Adelmans turned to assessing the role of shocks in cyclical fluctuations. The first type of shock they considered was one affecting observable causal factors. In the Klein-Goldberger model, the list of observable causal factors included changes in short-term and long-

[3]The model was developed by Lawrence Klein and Arthur Goldberger, two well-respected econometricians (Klein received the Nobel Prize in economics in 1980). The model is described in their book published in 1955.

[4]In their simulations of the Klein-Goldberger model, the Adelmans did find pendulum-like behavior for very large shocks to the economic system. But these shocks were much larger than those actually observed for the U.S. economy.

term interest rates, an index of hours worked by those employed, government employee compensation and government expenditures, agricultural exports and agricultural subsidies, and population and labor-force variables. The Adelmans noted that these causal factors didn't evolve steadily but tended to jump around their respective trend paths "more or less erratically." The Adelmans treated these erratic movements in causal factors as random shocks and simulated the Klein-Goldberger model to see how macroeconomic variables behaved in response to such shocks. They found that these shocks didn't "produce the sort of cyclical behavior observed in the actual economy." Thus, shocks to observable causal factors did not seem to be responsible for business cycles, either.

The Adelmans then turned to a second type of random shock: the random discrepancies between the predictions of the Klein-Goldberger model and the actual values of macroeconomic variables. These discrepancies arise for several reasons, the most important being that any macroeconomic model is likely to omit some relevant factors. For instance, the Klein-Goldberger equation for predicting consumer spending takes into account only the influence of income; the stock of liquid assets (cash as well as checking and savings accounts) held by people; population; and consumer spending from the previous year. It ignores any effects resulting from, say, shifts in the distribution of personal income. If a shift in the distribution of personal income is an important factor in some year, that shift will contribute to the discrepancy between the predictions of the model and the actual value of consumer spending for that year. Macroeconomists refer to such deviations of model-predicted values from actual values as *residuals.*

When the Adelmans treated the residuals of the Klein-Goldberger model as random shocks, they found that the behavior of macroeconomic variables in the Klein-Goldberger model closely resembled actual U.S. business cycles. In other words, they found that residuals were the prime source of cyclical volatility!

These results were counter to prevailing views about the role of shocks in cyclical volatility. Recall that Frisch and his contemporaries believed that business cycles resulted from observable shocks impinging on an economy prone to pendulum-like movements. But the Adelmans found that business cycles resulted from unexplained shocks (i.e., residuals) impinging on an economy that displayed no strong tendency toward pendulum-like movement.

Why does the Klein-Goldberger model generate business cycles even without any strong tendency to pendulum-like movement? The answer lies in the fact that in the Klein-Goldberger model, values of macroeconomic variables are determined, in part, by moving sums of random numbers. For instance, the Klein-Goldberger equation for consumer spending holds that the level of consumer spending during the previous year has a positive influence on consumer spending in the current year. Thus, if some shock raised consumer spending in the past year, that same shock will raise consumer spending during the current year as well, although not by as much. By the same logic, a shock that raised consumer spending two years ago will also have raised consumer spending during the past year (again, not by as much) and, therefore, will raise it during the current year as well. In other words, since consumer spending in any year is affected by consumer spending in the previous year, consumer spending in any year is determined, in part, by a weighted sum of random shocks affecting consumer spending in all previous years.

Now recall Slutzky's demonstration that a quantity that's a moving sum of random numbers will display wavelike movement. Thus, in the presence of random shocks, the link between consumer spending in consecutive years becomes a source of wavelike movements in consumer expenditures.

Most modern macroeconomic models incorporate links between consecutive values of macroeconomic variables. These links imply that

values of macroeconomic variables are determined, in part, by moving sums of random numbers, and those random numbers are past unexplained shocks to macroeconomic variables, i.e., past residuals.[5] Thus, while it's true that macroeconomists don't know *which* factors cause business cycles, they do understand *how* the changes brought about by those factors combine to generate cyclical fluctuations.[6]

Nevertheless, the fact that residuals cause business cycles is unsettling for business-cycle theory. Macroeconomists would prefer to explain business cycles in terms of observable shocks or, failing that, to develop theories that make minimal use of residuals.

THE POWER OF RESIDUALS

Since the 1960s, the evolution of business-cycle thought has been linked to theoretical developments in economics in general. In particular, advances in dynamic economic theory provided new and powerful tools for tackling problems in business-cycle research. Initially, these new ideas held out hope of reducing the importance of omitted factors in business-cycle models and correspondingly raising that of included factors. Consequently, professional attention turned to re-assessing the role of factors included in business-cycle models. A great deal of energy was spent in assessing the role of monetary shocks. As it turned out, this assessment failed to produce a compelling case for monetary shocks as an important factor in postwar U.S. business cycles. It also failed to produce compelling evidence in favor of other easily identifiable shocks.[7] Since the early 1980s, interest has again shifted to consideration of the role of residuals in cyclical fluctuations. Armed with the new advances in dynamic economic theory, Finn Kydland in collaboration with Edward Prescott developed a residual-driven business-cycle model called the real business cycle (RBC) model.[8]

Recall that a residual is the deviation of a macroeconomic variable from its model-predicted value. In RBC theory, the residual that generates business cycles is the quarterly deviation of labor productivity from its model-predicted value. The model of labor productivity used in RBC theory was developed by growth theorists in the 1940s and 1950s. This model holds that average labor productivity (output per worker) is positively related to the amount of capital per worker in the economy. The difference between growth in actual labor productivity and its model-predicted value is called the Solow residual, in honor of Nobel laureate Robert Solow, who developed this idea. A positive Solow residual, i.e., growth in labor productivity in excess of what can be explained by growth in capital per worker, indicates an improvement

[5]In principle, random shocks to observable causal factors can also be a source of wavelike movements. However, the shocks to observed causal factors are too small to generate realistic business-cycle fluctuations in the Klein-Goldberger model.

[6]For evidence on the importance of residuals for cyclical volatility in modern macroeconomic models, see John Cochrane's article. Can the omitted factors be discovered by relating residuals to observable historical events? Perhaps, but scholars are not sanguine about the prospects. To quote the eminent economic historian Peter Temin: "If the goal is to find events that can be represented by the residuals, it may be possible to find events to explain one set of residuals as easily as another. But the variety of models extant today makes that kind of exercise unrealistic as a way to identify causes of multiple cycles."

[7]Pre-WWII fluctuations are another matter. In that case, monetary shocks may well have been the decisive factor.

[8]Prescott's 1986 article contains an influential statement of the RBC model. The antecedents of this article appeared in an earlier 1982 publication by Finn Kydland and Edward Prescott. Two other authors, John Long and Charles Plosser, published a closely related article in 1983; they coined the term real business cycles.

in the economy's technological capability (brought on by new inventions). In the theory of economic growth, positive Solow residuals are seen as a major cause of economic growth; in RBC theory, *fluctuations* in the Solow residual are seen as a major cause of business cycles.[9]

Two properties of the Solow residual make it possible to base a business-cycle theory on it. First, when the Solow residual rises above its trend path, indicating better-than-average growth in the economy's technological capability, firms are motivated to invest in new plant and equipment at a faster-than-average rate. To meet the increased demand for investment goods, businesses hire more than the average number of workers. Above-average employment growth leads, in turn, to faster-than-average growth in consumer spending. Thus, a rise in the Solow residual above its trend path makes investment, employment, and consumer spending rise above their respective trend paths as well. This comovement of key macroeconomic variables is a central feature of business cycles.

Second, as was the case with consumer spending in the Klein-Goldberger model, there is a strong link between the value of the Solow residual in consecutive years. Therefore, the value of the residual in any given year is determined, in part, by a weighted sum of random shocks affecting the residual in past years. Thus, the observed movements of the Solow residual around its trend path resemble Slutzky's moving sums of random numbers. Since RBC theory predicts that macroeconomic variables will take on values that are almost proportional to the Solow residual, all macroeconomic variables in the RBC model behave like moving sums of random numbers as well. Thus, RBC theory can also explain the observed wavelike movement of macroeconomic variables.

RBC theory has had considerable success in explaining cyclical fluctuations. As shown in Charles Plosser's 1989 article, values predicted by RBC theory (given the observed movements in the Solow residual) are close to the actual values of key macroeconomic variables during the post-WWII period. For instance, as predicted by the theory, a decline in consumer expenditures, hours worked, investment, and output accompanied the decline in the Solow residual in 1970. More recently, the faster-than-average growth of the U.S. economy since 1995 has accompanied a faster-than-average growth in the Solow residual. Between 1995 and 1997 (the last year for which the residual can be calculated), the growth in the Solow residual exceeded its average growth rate since 1959 by more than 15 percent.

Still, a natural question to ask about the RBC model is whether it offers a more satisfactory explanation of business cycles than the one offered by the Adelmans using the Klein-Goldberger model. After all, given that both explanations are residual-based, are there any reasons to prefer one to the other?

Quantitatively, the RBC model explains cyclical fluctuations at least as well as the Klein-Goldberger model, as Robert King and Charles Plosser demonstrated in a 1994 article. However, many macroeconomists prefer the RBC explanation for two reasons. First, RBC theory relies on only one residual to generate business cycles whereas the Adelmans relied on a consumer spending residual, an investment residual, and other assorted residuals. Second, the RBC model is based on straightforward economic ideas whereas the theory underlying the Klein-Goldberger model is much more complex and subtle.

WHITHER BUSINESS-CYCLE THEORY?

The pioneers of RBC theory have steadfastly maintained that fluctuations in the Solow residual result from technological and institutional changes. Generally speaking, business-cycle theorists don't view their job as explaining

[9]For a detailed description of the RBC model and some of its implications, see my 1995 and 1999 articles.

changes in technology or institutions. So, if the omitted factors that cause fluctuations in the Solow residual are truly technological or institutional in nature, then in one important sense, RBC theory is complete. The phenomenon left unexplained, namely, fluctuations in the Solow residual, falls outside the scope of business-cycle theory and therefore doesn't need to be explained by it. The intellectual journey begun in 1927 on the pages of an obscure Russian journal has come to an end!

But has it really? Economists, after all, are a curious lot. Confronted with a residual that can explain business cycles, they will want to dig deeper into its ultimate causes. One reason researchers are motivated to dig deeper is that some aspects of the Solow residual seem inconsistent with the assertion that only technological or institutional changes cause the residual to fluctuate. For instance, during recessions, the residual usually declines. The strict RBC interpretation would hold that some factor caused a decline in the productive potential of the economy and led to the recession. In some cases such an interpretation seems plausible (as it does for the decline in the Solow residual during the energy crisis in 1974). However, in other cases (for instance, in 1970) the reason for the decline is not clear. Most macroeconomists find declines in the Solow residual during recessions puzzling, although many now believe the declines are real and not simply the consequence of measurement error.

The future development of shock-based theories of business cycles is almost certainly going to be influenced, in part, by attempts to resolve such puzzles. Indeed, both critics and proponents of RBC theory have focused increasingly on the reasons why the Solow residual fluctuates.

For instance, critics of RBC theory have proposed models in which the Solow residual moves in response to cyclical fluctuations caused by unexplained shifts in investment or consumer spending. In these models, a higher rate of production enables businesses to produce at a lower unit cost, which implies that the Solow residual rises during booms and falls during recessions. These induced changes in the Solow residual magnify the effects of the initial change in investment or consumer spending and may lead to excessive cyclical volatility.[10]

On the other hand, proponents of RBC theory point to evidence from U.S. manufacturing plants that seems to indicate that technological change is an important determinant of fluctuations in the Solow residual. If new plants adopt technological improvements, RBC theory predicts that such improvements will induce old and obsolete plants to cease production. As the new technology comes into use, both the Solow residual and national output will rise. U.S. data show that, as theory predicts, plant closings precede increases in the Solow residual. Then, as the Solow residual rises, new plants open and national output increases.[11]

As research on RBC theory progresses, we may expect it to shed light on the questions that vex policymakers. Is there a policy trade-off between the rate of economic growth and its cyclical volatility? How can policy contribute to reducing cyclical volatility? What role do existing countercyclical policies play in promoting economic growth and reducing cyclical volatility? It is to the credit of shock-based business-cycle theories, and to the RBC theory in particular, that progress on these traditional policy concerns can now be made by learning about the factors that underlie fluctuations in the Solow residual.

SUMMARY

Early analysts of business cycles believed that cyclical fluctuations are self-sustaining. But in

[10]See, for instance, the article by Marianne Baxter and Robert King and the article by Roger Farmer and Jang-Ting Guo.

[11]This theory is described in Jeffrey Campbell's article.

the 1920s, statisticians and economists realized that business cycles could result from purely random causes. This discovery moved economists away from the self-sustaining view of business cycles and toward a shock-based view. The first shock-based business-cycle model gave prominence to both random shocks and inherently cyclical behavior as sources of business cycles. But later research demonstrated that shocks were the major source of cyclical fluctuations.

However, these shocks turned out to be peculiar in nature in that they couldn't easily be connected to observable real-world events. They appeared, instead, as deviations of macroeconomic variables from their model-predicted values (i.e., residuals). Then, in the early 1980s, a group of economists greatly refined shock-based (more precisely, residual-based) business-cycle theories by linking cyclical fluctuations to deviations in labor productivity, the so-called Solow residual. Using the advances made in dynamic economic theory in the 1960s and 1970s, these economists demonstrated that fluctuations in the Solow residual were powerful enough to generate fluctuations in output that closely resembled post-WWII U.S. business cycles. This remarkable demonstration strengthened the links between business-cycle theory and simple microeconomic principles and reduced the number of residuals from several to just one. For both reasons, RBC theory represents a significant improvement over first-generation shock-based theories.

Nevertheless, RBC theory doesn't settle the issue of the ultimate sources of cyclical volatility because the random shocks in the RBC model result from variations in unspecified factors that cause erratic movements in business-sector productivity. However, by focusing attention on the role of the Solow residual in cyclical fluctuations, RBC theory has laid a foundation for better understanding the causes of such fluctuations. As business-cycle researchers look for reasons why the Solow residual fluctuates, they may gain knowledge that will help policymakers fashion better macroeconomic policies.

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