Who Uses Electronic Check Products: A Look at Depository Institutions

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Approximately 42 billion checks were written and collected in the United States in 2000.[1] The vast majority of noncash transactions continue to be settled with paper checks, which despite gains in efficiency and speed, still require costly and time-consuming sorting and transportation. An alternative—electronic check presentment—could save time and money. Yet, electronic services have been slow to take off, possibly because of the way the Federal Reserve prices them. If the pricing structure were revised, there might be more demand from banks[2] for electronic services, and a higher level of efficiency, theoretically, might be obtained.

This paper uses data on purchases of the Federal Reserve's electronic check services by individual banks and tests whether demand for these services varies among depository institutions. We find that small and large banks use the services differently—large commercial banks are more likely to use MICR Information and Image than are small or medium banks, but the opposite is true for the other electronic check services. Demand elasticities may vary as well, although few of our estimated elasticities are statistically significant, suggesting that demand for the Federal Reserve's electronic check services does not adjust with price shifts, probably because other factors (besides the Federal Reserve's prices) can influence banks' decisions on how much to buy. We find that small and medium banks have more elastic demand for MICR Information than the large banks. However, data matching limited our sample and prevented us from drawing definite conclusions. Our results presented in this article are not conclusive enough to make policy recommendations, and should not be construed as such. Instead, this article is intended to raise the issue of differentiated pricing for electronic check products.

The paper is organized as follows: The next section briefly describes the check collection process and outlines the types of electronic check services that the Federal Reserve offers. Section II explains some features of the demand for these services. Section III focuses on the relationship between bank size and demand for the various products. Section IV describes the data used in this article. Section V shows the actual use of each electronic check service by depository institutions. Section VI specifies the econometric models used to estimate the use of the Federal Reserve's electronic check products, and Section VII presents the results of that estimation. Section VIII concludes.

I. Types of Electronic Check Services

Background

For most checks, the collection process occurs roughly as follows: The person to whom the check is made out (the payee) deposits it in her bank (the bank of first deposit or the depositary bank). If the account of the check writer (the payor) is in the same bank, the check is "on-us," and it stays at that bank. Otherwise, the physical check then travels, often via a financial intermediary, to the payor's bank (the paying bank), and finally, on a monthly basis, to the payor. An interbank transit check can be handled by multiple institutions, with several processing steps at each point. Legal presentment takes place when the check is delivered to the paying institution or its designated processor. If the paper check is stopped at any time before it reaches the check writer, the process is called check truncation.[3]

During check sorting, paper checks can be processed such that information encoded in the magnetic image character recognition line can be collected and sent in electronic files.

Technology can expedite the collection process. During check sorting, paper checks can be processed such that information encoded in the magnetic image character recognition (MICR) line can be collected and sent in electronic files. This information is gathered when a check passes through a reader-sorter. Because at least one pass through a reader-sorter is typically required during the forward collection process, MICR information is a valuable byproduct of check processing that is created at very low or even zero incremental cost.

The MICR information can then be electronically delivered to the paying bank, and, with minimal change in the routine collection process, the paying bank can use this information in a variety of ways. For instance, MICR information can be used to verify that accounts hold sufficient funds before paper checks arrive. The bank can go a step further and clear the checks based on information contained in an electronic file, treating the electronic delivery of information as the presentment of the check, in which case the process is called electronic check presentment, or ECP.

The electronic process is intended to improve on the traditional method of paper check presentment. Using ECP could reduce not only time, but also cost—indeed, some forms of ECP may be less expensive than paper checks.[4] The number of electronic checks processed by the Federal Reserve Banks has been growing, and such checks now constitute over 20 percent of their total processed checks. However, usage of ECP services currently is not high, possibly because of how the Federal Reserve prices them.

Fed Services and Pricing

All electronic check services offered by Federal Reserve Banks to payor institutions involve the capture of MICR information from paper checks.[5] Federal Reserve Banks charge paying banks for receiving electronic check data with fees that vary, depending on

[1] See Gerdes and Walton (2002).

[2] Throughout this paper the term "bank" refers to all types of depository institutions and includes credit unions, savings and loan institutions, and thrifts.

[3] According to the Federal Reserve Board's web site, "Check truncation refers to any of a number of arrangements in which the original paper checks are removed from the collection or return process before reaching either paying or depositary banks, respectively, or reaching their customers. Currently under typical check truncation arrangements, electronic information about the truncated checks is presented to paying banks instead of the original paper checks themselves" (http://www.federalreserve.gov/paymentsystems/truncation/proposed.htm). Most truncation in the United States occurs at the nation's largest banks that do the truncation themselves, in-house, after the checks have arrived. Some banks, however, outsource their truncation to the Federal Reserve, and it is on this form of truncating that we focus.

[4] See Stavins (1997).

[5] See the box on page 5 for a list of electronic check services offered by the Federal Reserve Bank.

Main Electronic Check Services Offered by the Federal Reserve

MICR Information—As the check passes through a sorter, the MICR line data are captured and stored in an electronic data file, which is then transferred electronically, but legal presentment is said to have occurred only when the physical items are delivered to the paying institution or its designated processor.

MICR Presentment—The paying bank may decide to debit the amount on the check based on the electronic presentment. In that case, legal presentment is said to have occurred when the MICR file arrives at the paying bank. The depositing bank is automatically debited for the amount of this electronic file that same day. The debiting occurs whether or not the paper checks were delivered to the customer or its designated presentment point successfully that day.

MICR Presentment Plus—The MICR line data are captured and delivered, and the delivery of the electronic file constitutes legal presentment. This service adds a return service, where checks are held at the Reserve Bank awaiting information about return items (usually because of insufficient funds) from the paying bank. The Reserve Bank sends returned checks to the collecting bank and forwards the remaining checks to the paying bank.

Truncation—The MICR line data are captured and delivered, and the delivery of the electronic file constitutes legal presentment, but the paper checks are stopped at the Reserve Bank. The checks or their images (digital or microfilm) are stored at the Reserve Bank.

Image—Digital images of checks are captured and archived by the Reserve Bank. Images can then be delivered to the depository institution, or the institution can view and download selected images. MICR data are used to identify checks.

whether the banks use the data for information purposes only or as a basis for payment settlement.

During the past few years, the Federal Reserve's pricing of its financial services has become more responsive to market conditions. In 1997, the Board of Governors approved criteria that can be used to determine whether volume-based prices may be adopted for a Federal Reserve electronic payment service.[6] One of the criteria is that "demand characteristics differ across end users." Although five years have passed since the criteria were established, little is known about any differences in demand among paying banks receiving electronic check services. As a result, even though ECP services are priced differently across Federal Reserve Districts, the Federal Reserve does not currently offer volume discounts for per-item fees.

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The Monetary Control Act of 1980 requires only that the Federal Reserve recover the costs it incurs in supplying its payments services.[7] But how the costs are recovered affects both customers' demand and economic efficiency. Costs that can be ascribed to providing the good or service to a particular customer (also called attributable costs) should be charged to that customer, whether the costs are fixed or variable. If a customer is charged less than the cost of adding him to the service, his purchases may impose costs that exceed the benefits generated by his participation. Because total costs must be recovered, others would have to cross-subsidize his participation in the service, in turn affecting their decisions as to whether or not to purchase the service. Cross-subsidies lower efficiency and thus should be avoided, not just across different

[6] Board of Governors of the Federal Reserve System, Docket No. R-0967, March 19, 1997.

[7] Regarding cost recovery, the Federal Reserve Board's web site states, "Over the long run, fees shall be established on the basis of all direct and indirect costs actually incurred in providing the Federal Reserve services priced, including interest on items credited prior to actual collection, overhead, and an allocation of imputed costs which takes into account the taxes that would have been paid and the return on capital that would have been provided had the services been furnished by a private business firm.…" (http://www.federalreserve.gov/paymentsystems/pricing/pricingpol.htm).

types of payments (for example, between check and automated clearinghouse, or ACH), but across customers as well.

To promote economic efficiency, common costs that cannot be attributed to specific customers may be distributed based on differences in customers' willingness to pay for the service. If some depository institutions value the service more and are willing to pay more, charging them a higher price could increase efficiency.[8] Institutions that value the service less might not buy the product at all at the higher price. However, if they are offered a sufficiently low price, they might buy the product, thereby increasing revenues without raising total costs, as most of the costs are shared with other banks.[9]

II. Demand for Electronic Checks

The overall demand for electronic checks comes from corporations and households, as well as from their depository institutions. While households are not typically aware whether their banks use electronic check services (except for truncation, when they do not receive their checks back with their monthly statement), corporate customers use MICR information to obtain daily totals on which they can base their daily borrowing or investment activities. Depository institutions use MICR information as input into cash management services that they sell to their downstream corporate customers. Large banks with a great deal of activity with corporate clients are especially involved in float or cash management. MICR information gives banks advance information about incoming checks before the original paper items arrive, enabling banks to streamline their accounting. Thus, the Federal Reserve's MICR Information service can generate additional revenues without raising banks' costs.

In contrast, the electronic presentment services (MICR Presentment, MICR Presentment Plus, and Truncation) may impose additional operating costs on payor institutions, because they require substantial changes in the way depository institutions run their operations. The services that are designed to save banks money by eliminating transportation costs may in fact be raising their costs.

There are advantages to ECP, however. For example, ECP can speed up check collection. Depending on the type of service, the collecting bank can obtain its funds faster, while the paying bank can verify that the customer has sufficient funds for withdrawal and then deduct the funds from the customer's account before the paper check arrives. While the benefits can accrue for both institutions, the paying bank is responsible for paying for the Federal Reserve's ECP services under current law.[10] Most of the savings from truncation (whether it is done by an intermediary or by the bank) occur at the paying bank, as the paying bank does not have to mail cancelled checks to its account holders. The cost of check transport, on the other hand, is borne by the collecting bank.

Prices charged by Federal Reserve Banks for electronic check services reflect both their production costs and demand by depository institutions. Because both MICR Information and MICR Presentment involve capturing and sending the same electronically coded data, the costs of the two products are similar. Reserve Banks want to encourage banks to shift from MICR Information to MICR Presentment by creating a price differential between the two (as discussed further in Section III). On the other hand, MICR Presentment Plus, a very small service, carries slightly higher costs, because the checks have to be stored until the information about returns is available. Checks to be returned are pulled out, although banks pay separately for the return process. Of the four electronic check processes, Truncation is the most expensive, because physical checks have to be stored and later destroyed, while the microfilm or images of the checks are stored for several years. (The length of time that checks are stored is not uniform across Reserve Banks.)

Reserve Banks want to encourage banks to shift from MICR Information to MICR Presentment by creating a price differential between the two services.

[8] Varian (1995, 1996, 2000) shows that when consumers value products or services with high common costs differently, charging different prices to different consumers increases efficiency.

[9] See Lacker and Weinberg (1998) for a more detailed discussion.

[10] Cost sharing between banks may then be negotiated as part of a bilateral check exchange agreement.

Truncation of checks outside of the paying bank is relatively rare.[11] Under the Uniform Commercial Code, the transfer of funds from the check writer's bank to the payee's bank takes place only after the physical check is presented at the check writer's bank, unless that bank agrees otherwise. Therefore, check truncation requires individual agreements with each paying bank. Because the paying bank is responsible for delivering the original check to the check writer on demand unless the customer agrees otherwise, most paying banks avoid truncation elsewhere and instead keep the cancelled checks at their own locations, thereby making them easily accessible if needed. For checks processed by Reserve Banks, paying banks must agree to receive and pay for any electronic check services. In contrast, paper check collection is paid by the collecting banks. That discourages the paying banks from buying electronic check products.

III. Bank Size and the Use of Electronic Check Products

Because they serve different types of customers, large and small depository institutions are likely to have different demands for electronic check products. We expect large depository institutions to value MICR Information more than small banks, because the customers of the former are more likely to use MICR Information for their cash management services. The value of electronic presentment, however, may be higher for small institutions because of differences in the structure of their operations and in the types of services they offer to their customers, as explained below.

Because check volumes are highly correlated with an institution's overall deposits, small depository institutions typically receive fewer checks than do larger institutions, and they receive checks from fewer sources, with a substantial proportion coming from a single source (such as Reserve Banks). Electronic presentment may allow a small bank to make the necessary investment in software and staff because it can use MICR data for uniform accounting and more easily reconcile accounts after paper checks arrive. By contrast, large depository institutions typically receive check presentments from multiple sources. For those banks, electronic presentment creates the need for dual processes—accounting for both paper and electronic checks, resulting in higher fixed costs. Dual processes also generate processing problems, such as a need to separate ECP and non-ECP presentments.[12]

Banks' customers differ as well. Large corporate customers typically seek larger depository institutions because of the scope of products such customers require (for example, lines of credit, cash management, and foreign exchange). Large corporate customers also tend to write checks for greater amounts, and those must be examined more closely because of the higher potential losses stemming from fraud.[13] As long as their customers want to receive paper checks, depository institutions must be able to process both types.[14] Small banks that service households and small businesses face lower levels of risk exposure from posting accounts from the electronic check file. In addition, small banks are more likely to know their customers, which also lowers their risk.

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As a result of the differences in costs and in potential savings from ECP, large banks may be less willing to pay for electronic check presentment, but more willing to pay for MICR Information than small banks. The current uniform pricing to banks of all sizes could lead to social inefficiency if some banks are not willing to pay the uniform price, but instead would be willing to pay a lower price that would still cover the incremental cost of serving them. In that case, the volume of electronic checks purchased would be lower than is socially optimal. One way to eliminate such a distortion is to distribute common costs of electronic checks in such a way that a larger proportion of those costs is recovered from small banks, while large banks are charged a lower share. Provided that each institution pays at least the incremental cost of

[11] Safekeeping, or in-house truncation by the paying bank, is more common, however. For example, Bank of America reports that over 50 percent of its accounts are truncated.

[12] See, for example, Lunt (1995) and Marlin (1997).

[13] According to Gerdes and Walton (2002), 64 percent of checks written by households in 2000 were under $100, compared to only 25 percent of corporate checks.

[14] Massachusetts state law requires paying banks to return paper checks to their customers. In most other states, check return is not required by law, but is a common practice.

the services it receives, common costs do not have to be distributed uniformly among customers to ensure an efficient outcome. On the contrary, distributing common costs in inverse proportion to elasticities of demand can increase efficiency. Volume could possibly be boosted, while maintaining cost recovery, by adopting "Ramsey pricing," where the price-cost markup over marginal cost charged to a given group of customers is inversely proportional to the price elasticity of demand for that group.[15]

Table 1
Electronic Check Pricing by Federal Reserve District (2000)

Federal Reserve District [a]	MICR Information		MICR Presentment		MICR Present-ment Plus		Truncation	
	(dollars)							
	Fixed	Variable	Fixed	Variable	Fixed	Variable	Fixed	Variable
1 Boston	5	.0040	2	.0020	2	.0060	7	.0140
2 New York	10	.0050	10	.0010	2	.0030	n.a.	n.a.
3 Philadelphia	2	.0013	2	.0010	2	.0040	2	.0150
4 Cleveland	10	.0050	10	.0020	10	.0060	5	.0100
5 Richmond	10	.0030	8	.0012	8	.0030	0	.0130
6 Atlanta	11	.0030	11	.0020	5	.0035	5	.0130
7 Chicago	5	.0050	3	.0020	3	.0030	2	.0070
8 St. Louis								
810	10	.0050	3.5	.0020	3.5	.0040	3.5	.0100
820	3	.0040	3	.0020	2	.0040	2	.0060
830	5	.0060	3	.0010	3	.0030	3	.0060
840	15	.0040	5	.0020	5	.0060	5	.0100
9 Minneapolis								
910	13	.0060	5	.0020	6	.0060	n.a.	n.a.
920	5	.0050	0	.0020	0	.0040	0	.0080
10 Kansas City	15	.0060	10	.0040	10	.0040	n.a.	n.a.
11 Dallas								
1110	8	.0040	2	.0020	3	.0030	2	.0060
1120	8	.0040	2	.0030	2	.0040	2	.0070
1130	8	.0030	3	.0030	0	.0030	3	.0060
1140	8	.0040	2	.0030	4	.0030	2	.0070
12 San Francisco	15	.0060	2	.0020	2	.0030	n.a.	n.a.

[a] Districts 8, 9, and 11 have different prices for each of their branches.
n.a. = Not applicable.

IV. Data

The primary database used in this study is the Financial Services Information System (FSIS) data collected by the Federal Reserve. The data record monthly purchases of electronic check products by individual depository institutions in the United States. We use the data for the last three quarters of 2000 and all four quarters of 2001. Although the FSIS data have been collected since 1996, product codes were not unified across Reserve Banks until April 2000, and, therefore, the earlier data could not be pooled across Districts.

Services were grouped into the following categories: MICR Information, MICR Presentment, MICR Presentment Plus, Truncation, and Image. For each service, we obtained prices charged by each Federal Reserve Bank. Each depository institution was assigned to a single Reserve Bank that provided all or most financial services to that institution. In cases when a bank purchased its electronic check services from more than one Reserve Bank, the actual prices paid by that bank were used. Thus, we would use Boston's price for MICR Information and New York's price for MICR Presentment, if a bank purchased its services in this way.

Table 1 shows prices charged by Reserve Banks for electronic check products in 2000. Most Reserve Banks charged a fixed fee to cover the cost of each transaction (regardless of the number of checks) and a variable fee for each check. We note several points about the data. First, there is significant variation in the price of each product across Districts. For instance, the fee for MICR Information varies from a $2 fixed fee plus $0.0013 per item at Philadelphia to a $15 fixed fee plus $0.0060 per item at Kansas City and San Francisco. Second, the price of MICR Presentment is always lower than that of MICR Information, even though the cost of providing the two services is approximately the same.[16] For New York, the price ratio is 20 percent ($0.0010 compared to $0.0050), while in Philadelphia it is almost 100 percent. Third, the price of MICR Presentment Plus is always higher than that of MICR Presentment, but in only three cases less expensive than MICR Information. Fourth, Truncation has the highest per-item fee in all Districts. Note that prices vary across Districts but not across banks within Districts.

Although some Districts changed their electronic check prices between 2000 and 2001, most prices

[15] See Ramsey (1927).
[16] Based on discussions with Retail Product Office staff.

remained constant. Out of 340 different product prices that existed in 2000, only 80 changed the following year. In contrast, 317 out of 447 changed in April 2000. Several products were also dropped at the time, explaining the difference in the number of different services offered. The 2000-2001 price changes were not concentrated in product groups, but in Districts. Boston, Dallas, and Richmond had several price changes, while New York, Philadelphia, Kansas City, and San Francisco had very few. Prices moved in both directions.

A price structure for ECP must include a decision about how pricing should be administered: at the Federal Reserve branch, the Federal Reserve District, or at the national level. Currently, services are typically priced at the Federal Reserve District Banks, but in some cases at the Federal Reserve Branches. Localized pricing, better reflecting differences in cost and demand across banks, may be the most efficient. However, given that the financial services industry is increasingly dominated by fewer large firms operating simultaneously in several Federal Reserve Districts (and those users account for the majority of electronic check volumes), national pricing may simplify accounting for those interdistrict institutions.

To obtain data on each institution's assets, deposits, loans, and the number of accounts, we merged the FSIS data with the quarterly Consolidated Report of Condition and Income (Call Report) database.[17] In total, out of the 4,335 distinct American Banking Association (ABA) numbers in the FSIS data, 3,708 were matched with either Call Report or credit union records.[18] Because the Call Report data are quarterly, we combined three-month sets of FSIS data to create quarterly observations.

Finally, using zip codes provided in the Call Report data, we created a variable measuring each institution's distance from the Reserve Bank, branch, or processing center it used for its financial services.[19] For observations without an assigned Reserve Bank, we used the closest branch office based on the distance data. At the end, 116 observations still lacked distance to the nearest Reserve Bank. Those observations had either "0" listed instead of a zip code or were located in U.S. territories. Our final dataset has 20,173 observations for 3,708 institutions with distinct ABA numbers that used Federal Reserve electronic check services.

V. Who Uses Federal Reserve Electronic Check Products?

In this section we take a look at who uses each of the Federal Reserve's electronic check products. We calculate the percentages of banks by asset size category that purchase each electronic check product. An institution is deemed to use a given service if its volume is greater than 0 in any month in the sample.

Table 2 shows the penetration for Reserve Bank customers included in the FSIS sample only—the use of Federal Reserve services among all depository institutions is substantially lower. Some banks buy electronic check products from other sources or use their own processing. Including all depository institutions in our analysis would bias the results, as we have no information about their use of non-Fed electronic check services. To avoid a bias, we limit our analysis to the Federal Reserve customers included in the FSIS sample to test whether demand for electronic check services varies by type or size of institution. While the magnitude of use is likely to be overestimated, we focus on relative differences among the institutions.

MICR Presentment is the most common electronic check service among commercial banks, while Truncation is the greatest among credit unions.

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[17] In order to match the two datasets, we aggregated the volumes for banks with multiple ABA numbers, and then we linked each bank's primary ABA number used in the Federal Reserve data with the FDIC certificate number used in the Call Report data. Many of the ABA numbers were not in the Call Report database. Most of the ABA numbers that did not match were credit unions. We used credit union data for the entities we could match.

[18] The institutions that could not be matched represent only 5 percent of the volume, suggesting that we may omit a larger fraction of small banks even though we capture most of the volume. Almost all the credit unions were matched successfully. MICR Presentment Plus and Image had relatively high fractions of their volume that could not be matched (20 percent and 14 percent, respectively).

[19] We used mapblast.com to get each Reserve Bank's location. We obtained distances for each zip code based on the latitude and longitude of a given point using the MABLE/Geocorr Geographic Correspondence Engine provided by the Office of Social and Economic Data Analysis at the University of Missouri <http://oseda.missouri.edu:80/plue/geocorr/>. In cases where zip codes were missing, we used the U.S. postal web site <www.usps.com> to find the closest zip code.

Table 2
Fraction of Depository Institutions That Used Each Federal Reserve Electronic Check Product, by Size and Type of Institution

	MICR	MICR Presentment	MICR Presentment Plus	Truncation	Image	Number of Observations[a]
	(percent)					
Commercial banks	19.01	66.29	13.53	2.17	12.18	2,898
≤$100 million	16.24	66.05	17.82	25.30	10.07	1,897
$100 million to $1 billion	22.94	70.62	5.31	1.47	12.43	885
>$1 billion	34.48	37.07	6.03	1.72	44.83	116
Credit unions	1.23	4.44	6.91	31.85	17.16	810
≤$100 million	1.09	3.27	7.01	33.96	13.55	642
$100 million to $1 billion	1.83	9.15	6.10	23.78	30.49	164
>$1 billion	0.00	0.00	25.00	25.00	50.00	4
All	15.13	52.78	12.08	8.66	13.27	3,708
≤$100 million	12.41	50.18	15.08	10.48	10.95	2,539
$100 million to $1 billion	19.64	61.01	5.43	4.96	15.25	1,049
>$1 billion	33.33	35.83	6.67	2.50	45.00	120

[a] Denotes institutions with distinct entity numbers.
Note: Data for second quarter 2002.
Source: Author's calculations based on FSIS data.

Overall, the highest fraction of depository institutions purchase MICR Presentment, followed by MICR Information, Image, and MICR Presentment Plus, with the smallest fraction using check Truncation (under 9 percent). MICR Information, MICR Presentment, and MICR Presentment Plus are used by a higher fraction of commercial banks than credit unions. Truncation and Image are more common among credit unions because credit unions as a rule do not return cancelled checks to their customers. This gives them a customer base that readily accepts truncation.

Large commercial banks are more likely to use MICR Information and Image than are small or medium banks, but the opposite is true for the other electronic check services. The difference is consistent with the distinction between the customers of large and small banks discussed in Section III—customers of large banks are more likely to use MICR Information than are customers of small banks, while small banks' customers are more likely to buy Truncation than are large banks' customers.

Table 3 shows average quarterly volumes purchased by each type and size of institution. Volume differences between commercial banks and credit unions are consistent with the differences displayed as fractions in Table 2. Except for Truncation, average volumes increase with the size of the institution. We also computed the average number of items per transaction for each service by bank size and found that in the cases of MICR Information, MICR Presentment, and Image, large banks process large transactions. The relationship does not hold in the case of MICR Presentment Plus or Truncation, however (see Table 4).

VI. Econometric Model

We begin by testing which characteristics affect whether a bank uses each type of electronic check service. We estimate the following model using logit regression:

$$ECP_{ikj} = \beta_0 + \beta_k + \beta_j X_i + \epsilon_{ij} \quad (1)$$

where ECP_{ikj} is a dummy variable indicating whether bank i located in Federal Reserve District k purchased product j; β_0 is a constant; β_k is a vector of dummy variables equal to 1 if bank i is located in District k; X_i is a vector of bank i's attributes—bank size (measured by assets or deposits), number of accounts, loan composition (fraction of loans that are credit card loans or commercial and industrial—C&I—loans), deposits-to-assets ratio, and the bank's distance from a Federal Reserve Bank; β_j are coefficients on those attributes for product j; and ϵ_{ij} is an error term.

As discussed in Section III, depending on the type of product, bank size can increase or decrease the probability of electronic check services adoption. We expect banks with a higher fraction of C&I loans to be more likely to purchase MICR Information, because their corporate clients can use it for their internal accounting purposes. In contrast, we expect that banks geared towards serving households, such as those with higher fractions of consumer loans (such as credit card loans) or with higher ratios of deposits to assets, are less likely to buy MICR Information, but more like-

Table 3
Average Volumes of Electronic Check Products, by Size and Type of Institution and by Total Volumes

	MICR Information	MICR Presentment	MICR Presentment Plus	Truncation	Image
	(thousand items per bank per quarter)				
Commercial banks	74.1	138.3	12.2	2.7	26.9
≤$100 million	18.9	68.2	11.6	2.1	15.7
$100 million to $1 billion	73.9	214.4	11.2	3.7	30.5
>$1billion	874.8	586.3	28.1	4.2	162.6
Credit unions	.7	20.0	7.6	55.1	48.3
≤$100 million	.7	2.5	2.5	26.6	10.4
$100 million to $1 billion	.7	61.1	19.8	119.2	123.0
>$1billion	4.1	16.3	.02	148.5	538.8
All	66.6	135.3	15.1	11.1	41.9
≤$100 million	15.4	55.5	9.9	6.8	14.7
$100 million to $1 billion	61.8	189.0	12.6	22.8	45.8
>$1billion	194.8	262.3	30.6	7.2	102.6
	(total volume in sample in millions)				
All institutions	2029.0	4122.0	460.9	338.1	1277.4

Source: Author's calculations based on FSIS data.

ly to purchase MICR Presentment. The farther away from a Federal Reserve Bank the bank is located, the more time-consuming the transport of physical checks becomes and the more valuable electronic presentment becomes; thus, the distant bank is more likely to adopt ECP, especially in the case of Truncation. Alternatively, each institution's physical isolation could be measured with a dummy variable indicating whether the bank is located in an urban area. Banks located in urban areas are less likely to use ECP products, all else constant.

Next, we estimate the use of electronic check services. Because Federal Reserve prices of electronic check services are set in advance for next year and do not respond to changes in demand, they may be viewed as exogenous. We apply the following reduced-form model that regresses observed quantities on prices and on other variables:

$$Q_{ijt} = f(P_{jt}, Z_{it}), \qquad (2)$$

where Q_{ijt} is the volume of service j bought by bank i at time t, P_{jt} is the relevant Reserve Bank's price of product j at time t, and the matrix Z_{it} represents exogenous attributes of bank i at time t that may influence the demand for the four electronic check products, such as size and distance from a Federal Reserve Bank. Larger institutions process more transactions (conditional on adoption) and are more apt to service large corporate clients that demand cash management services. As a result, we expect assets to be positively related to the volume of MICR Information. Payor institutions that are closer to a Federal Reserve Bank are less likely to earn float income stemming from transportation delays, lowering their demand for electronic presentment. On the other hand, remote banks can get their check records sooner, which may raise their demand for electronic information. Therefore, the relationship between distance and demand for electronic check services is ambiguous and may vary by product.

Demand for electronic check products may be affected by local economic activity. For a given price, we expect that areas with higher levels of economic activity process more electronic checks, partly because of a higher number of payments overall, and partly because banks and corporations in those areas are likely to have installed more advanced information technology. Marketing efforts vary across the Reserve Banks, further differentiating the demand for Federal Reserve services. We applied fixed effects estimation to control for local bank effects. Other specifications included dummy variables for each state or Federal Reserve

Table 4
Average Number of Items per Transaction, by Bank Size

Bank Assets	MICR Information	MICR Presentment	MICR Presentment Plus	Truncation	Image
< $100 million	1,678	1,700	1,039	1,696	2,412
$100 million to $1 billion	5,901	4,754	4,611	7,883	6,956
>$1 billion	20,594	9,873	3,315	1,364	11,117

Source: Author's calculations based on FSIS data.

District or branch, but those performed worse than the selected specification. We also included a measure of state employment, which varies both over time and geographically.

Delays in presenting paper checks may result in float income to the paying bank and the check writer, and losses to the payee, the collecting institution, or the intermediary. Poor weather conditions or distribution errors, for example, may cause this to happen. Float is proportional to the opportunity cost of using those funds elsewhere. As a result, the volume of MICR Presentment should be negatively related to current interest rates. We use the 6-month Treasury bill interest rate for this purpose and test whether the variable performs better than time dummy variables for each quarter.

We estimate the following equation for each electronic check product:

Table 5A
Probability of Using Each Type of Electronic Check Services—Logit Regressions

	MICR Information	MICR Presentment	MICR Presentment Plus	Truncation	Image
Intercept	–1.649	1.454	6.388	–2.790	–2.006
	(–1.08)	(1.26)	(4.20)	(–3.75)	(–1.65)
log(assets)	.320	.013	–.455	–.422	.268
	(2.55)	(.13)	(–3.04)	(–1.94)	(2.36)
log(account)	–.122	.007	–.044	.325	.038
	(–1.10)	(.08)	(.31)	(1.47)	(.36)
log(ccfrac)	–.411	–.129	1.965	–1.516	–1.249
	(–.23)	(–.08)	(.91)	(–.45)	(–.74)
log(commfrac)	.711	–.315	–3.591	–.092	–1.218
	(.98)	(–.51)	(–2.85)	(–.05)	(–1.66)
log(depass)	–.549	2.693	.661	–5.910	–2.954
	(–.46)	(3.01)	(.50)	(–2.72)	(–2.92)
log(distance)	.242	.027	–.210	–.172	–.350
	(3.89)	(.62)	(–3.56)	(–1.96)	(–7.72)
Banktype	–2.978	–3.890	–1.846	4.289	.599
	(–7.35)	(–15.09)	(–6.21)	(9.68)	(2.61)
Federal Reserve Office dummies?	Yes	Yes	Yes	Yes	Yes
χ^2	830.32	1725.58	688.50	1027.66	490.27
N	3498	3658	2878	2022	3500

Note: Dependent variables: 0–1 dummy variables indicating whether a bank used the service at any time during the sample period. The t-statistics are in parentheses.
Source: Author's calculations.

$$\ln(Q_{ijkt}) = \beta_0 + \beta_i + \beta_k + \beta_{jP} \ln(P_{jkt}) + \beta_{-jP} \ln(P_{-jkt}) + \beta_1 \ln(ASSETS_{it}) + \beta_2 \ln(ACCOUNT_{it}) + \beta_3 \ln(CCFRAC_{it}) + \beta_4 \ln(COMFRAC_{it}) + \beta_5 \ln(DEPASS_{it}) + \beta_6 BANKTYPE_i + \beta_7 \ln(DISTANCE_i) + \beta_8 \ln(EMPLOYMENT_{kt}) + \beta_9 \ln(TBILL_t) + \epsilon_{ijkt}, \quad (3)$$

where Q_{ijkt} is the volume of service j purchased at time t by bank i located in the Federal Reserve office k territory, β_0 is a constant, β_i is a vector of dummy variables for each bank i, β_k is a vector of area dummy variables for each office, β_{jP} is the price elasticity of demand for product j, P_{jkt} is the price of service j charged by Federal Reserve office k at time t, β_{-jP} is the cross-price elasticity of demand between product j and –j, P_{-jkt} is the price of service –j, $ASSETS_{it}$ is assets of bank i, $ACCOUNT_{it}$ is the number of accounts, $CCFRAC_{it}$ and $COMFRAC_{it}$ measure the bank's loan composition (fraction of loans that are credit card loans and C&I loans, respectively), $DEPASS_{it}$ is the ratio of deposits to assets, $BANKTYPE_i$ equals 1 for a commercial bank and 2 for a credit union, $DISTANCE_i$ is the distance from bank i to the nearest Federal Reserve office, $EMPLOYMENT_{kt}$ is seasonally adjusted total nonfarm employment, $TBILL_t$ is the 6-month Treasury bill interest rate, and ϵ_{ijkt} is an error term.

VII. Results

Probability of Using Electronic Check Services

The first set of regressions estimates the effect of bank attributes on the bank's probability of using each type of electronic check service: MICR Information, MICR Presentment, MICR Presentment Plus, Truncation, and Image. Because we use logit estimation,

Table 5B
Estimated Change in Probability of Using Electronic Check Services When a Right-Hand-Side Variable Doubles

	MICR Information	MICR Presentment	MICR Presentment Plus	Truncation	Image
Assets	.030	.002	–.041	–.039	.022
Account	–.011	.001	–.004	.030	.003
Ccfrac	–.038	–.022	.178	–.140	–.104
Commfrac	.066	–.054	–.326	–.008	–.102
Depass	–.051	.464	.060	–.546	–.247
Distance	.023	.005	–.019	–.016	–.029
Banktype	–.400	–.968	–.242	.571	.072

Source: Author's calculations.

the estimated coefficients on linear right-hand-side variables are interpreted according to the formula:[20]

$$\Delta \log \frac{P}{1-P} = \beta \Delta x, \qquad (4)$$

where P is the probability of using a given service, β is the estimated coefficient, and x is the variable whose effect we are trying to evaluate. Rewriting the above equation, the effect of an increase in x by 1 is:

$$\Delta P \approx \beta[P\,(1-P)]. \qquad (5)$$

When right-hand-side variables are in a log form, the following transformation is applied:

$$\Delta \log \frac{P}{1-P} = \beta \Delta \log x. \qquad (6)$$

When x doubles, the estimated change in probability becomes:

$$\Delta P \approx [P(1-P)]\,[\beta(\log 2x - \log x)] = [P(1-P)]\,\beta \log 2. \qquad (7)$$

The estimated coefficients, transformed using equations (5) and (7), are presented in Table 5A. The estimated change in the probability of using each service when a variable doubles is reported in Table 5B.

The estimated effect of bank size is consistent with our expectations. Larger banks were found to have a higher probability of using MICR Information and Image, and a lower probability of using MICR Presentment Plus and Truncation. Bank size was not statistically significant in the probability of using MICR Presentment. The effect is relatively small: A bank with twice the assets has a 3 percent higher probability of using MICR Information, and a 2 percent higher probability of using Image. The negative effect on the probability of using other services is somewhat bigger: A bank with twice the assets has a 4 percent lower probability of using MICR Presentment Plus, and a 4 percent lower probability of using Truncation. However, the differences become five times larger when comparing a $100 million asset community bank with a large bank that has $1 billion in assets.

When we include the number of accounts (account), loan structure (ccfrac and commfrac), and the deposit to asset ratio (depass) to control for banks' characteristics, banks with higher ratios of deposits to assets were found to have a higher likelihood of using MICR Presentment, but a lower probability of using Truncation or Image. The ratio of credit card loans to total loans (ccfrac) and the ratio of C&I loans to total loans (commfrac) are correlated with whether a bank tends to cater to businesses or to households. The variables turned out to be statistically insignificant in almost all of the regressions, indicating that bank size rather than its customer base affects its decisions whether or not to use electronic check products.

The bank's size rather than its customer base affects its decisions whether or not to use electronic check products.

Consistent with our expectations, credit unions were found to have a significantly higher probability of using Truncation and Image than were commercial banks, but a significantly lower probability of using MICR Information, MICR Presentment, or MICR Presentment Plus. A credit union had a 40 percent lower probability of using MICR Information, a 97 percent lower probability of using MICR Presentment,

[20] See Pindyck and Rubinfeld (1991) for details.

Table 6
Electronic Check Product Volume Regressions (fixed effects)

	MICR Information	MICR Presentment	MICR Presentment Plus	Truncation	Image
Intercept	–12.882	11.385	9.513	15.886	–17.687
	(–2.54)	(1.93)	(2.74)	(2.31)	(–3.51)
log(Price)	–1.528	–.021	.569	.550	–.010
	(–12.86)	(–.14)	(4.94)	(1.33)	(–.39)
log(assets)	.139	.311	.179	–.086	.303
	(1.57)	(3.04)	(2.97)	(–.71)	(3.36)
log(account)	.032	–.011	.003	–.009	–.005
	(8.13)	(–2.36)	(1.24)	(–1.81)	(–1.26)
log(ccfrac)	–.535	–.050	.086	–2.947	–.0482
	(–1.01)	(–.08)	(.24)	(–3.53)	(–.09)
log(comfrac)	.704	–.476	.135	–.945	.023
	(3.33)	(–1.96)	(.93)	(–3.69)	(.11)
log(depass)	–.030	.296	–.001	–.021	.012
	(–.28)	(2.36)	(–.01)	(–.08)	(.11)
log(distance)	.050	–.297	.014	.066	.418
	(.44)	(–2.23)	(.18)	(.22)	(3.61)
log(employ)	.493	–.854	–.926	–1.499	1.806
	(.78)	(–1.18)	(–2.17)	(–1.82)	(2.86)
log(tbill)	.226	–.260	.098	.412	–.093
	(9.80)	(–9.80)	(6.20)	(14.03)	(–3.93)
F	64.93	85.72	114.38	32.02	65.53
N	24392	24382	23680	14964	23537

Note: Dependent variables: log of quarterly volumes. The t-statistics are in parentheses.
Source: Author's calculations.

and a 57 percent higher probability of using Truncation.

Price Elasticities of Demand

To estimate price elasticities of demand for electronic check products, we estimate equation (3) for each electronic check service using fixed effects. The results are shown in Table 6. In full sample regressions, price elasticity of demand for electronic check products was found not to be statistically significant, with the exception of MICR Information, where a 1 percent increase in price is associated with a 1.53 percent drop in volume, when controlling for bank fixed effects.[21] The results suggest that demand for Federal Reserve's electronic check services does not adjust with price shifts, probably because other factors (besides the Federal Reserve's prices) can influence banks' decisions on how much to buy.

In the case of MICR Presentment, MICR Presentment Plus, and Image, volume was higher the larger the bank, while in the case of MICR Information and Truncation, bank size was not statistically significant. Cross-price elasticities turned out to be insignificant, and were not included in the final specification, probably because the market segment that buys MICR Information, for example, is different from the market segment that buys MICR Presentment, and most depository institutions do not view the various services as substitutes in the short term. Banks with higher fractions of commercial loans had higher volumes of MICR Information, but lower volumes of MICR Presentment or Truncation.

As we expected, remote banks were found to request Image more often. However, distance was not significant in the other regressions with fixed effects. Only volumes of MICR Presentment and Image decreased with higher interest rates, while the other volumes were higher the higher the rate of interest.

Institution Size

To test whether demand elasticities vary by asset size of an institution, we estimated equation (3) separately for small, medium, and large banks, using the asset-size categories shown above (below $100 million, $100 million to $1 billion, and above $1 billion). The estimated price elasticities from the regressions by asset size are shown in Table 7. Small and medium banks' use of MICR Information is more sensitive to the price of the service than that of large institutions. This suggests that MICR Information could be used more efficiently if

[21] As mentioned above, data matching issues limited our sample, especially in the case of MICR Presentment Plus users. In addition, the sample used in the Truncation regression was reduced substantially because of missing price variables for many observations. Therefore, the positive price elasticities for the two services might have resulted from sample-selection issues.

Table 7
Price Elasticities of Demand for Electronic Check Products by Asset Size (fixed effects)

Bank Assets	MICR Information	MICR Presentment	MICR Presentment Plus	Truncation	Image
<$100 million	–1.9804	–.0477	.6966	1.1078	.0778
	(–12.50)	(–.24)	(4.87)	(1.40)	(1.78)
$100 million to $1 billion	–1.3672	–.4270	.6191	.3931	–.1669
	(–5.98)	(–1.50)	(3.04)	(.75)	(–4.57)
>$1 billion	.0809	.9554	.3299	1.1091	.4249
	(.41)	(1.39)	(.32)	(.81)	(3.08)

Source: Author's calculations.

differential pricing were introduced. We expected to find large banks' use of MICR Presentment to be more sensitive to price than that of small banks, but those results were not statistically significant.

Transaction Size

To the extent that there are fixed costs of processing a transaction, the total cost of processing electronic check services may vary with transaction size rather than with bank size. That is why electronic check prices have a fixed transaction fee as well as a unit fee.[22] We tested whether price elasticities varied with transaction size in the case of electronic check services. As demonstrated in Table 4, the number of items processed in each transaction for some of the services, but not for all, rises with the size of banks. We divided the sample into three size categories, defining small, medium, and large categories separately for each service by the number of items per transaction for each institution. Equation (3) was then estimated separately for those three size categories for each service. However, none of the estimated price elasticities turned out to be statistically significant because, in many cases, the number of transactions was not reported and thus a substantial number of observations had to be dropped. Such analysis should be done with better data on the number of transactions.

VIII. Conclusion

In the presence of common costs, uniform pricing across all consumers may lower efficiency compared to differentiated pricing. This happens if one consumer is willing to pay the incremental cost of the service, but not the full price. The price charged to each consumer should cover the incremental cost of providing the service, but differences in price elasticities of demand should be taken into account when common costs must be recovered.

We explore the issue of heterogeneous price elasticities in the case of Federal Reserve electronic check products. Using the Federal Reserve FSIS data on an individual depository institution's use of various types of electronic check services, we show that there may be differences in demand elasticities across depository institutions. In particular, we find that small and medium banks have more elastic demand for MICR Information than do large institutions. Because large banks have inelastic demand for MICR Information services, their fees could rise without significant detrimental effect on volume. If the Federal Reserve wants to encourage banks to buy MICR Presentment instead of MICR Information, the former prices could decline while the latter increase. Efficiency might increase if these differences were incorporated into prices.

Differences in price elasticities of demand should be taken into account when common costs must be recovered.

However, data limitations prevent us from making pricing recommendations at this time. Our estimates are based on a very short time series when few price changes took place. Before specific pricing recommendations can be made, a longer time series with more substantial price changes during that period would be necessary. A more detailed analysis

[22] In the case of ACH, a cost analysis demonstrated that the average per-item cost to process larger files was less than the per-item cost for smaller files, which led to the implementation of a two-tier pricing scheme in 1997 (Board of Governors of the Federal Reserve System, Docket No. R-0967, March 19, 1997).

of the cost of providing electronic check services should be conducted in order to determine whether the cost varies among depository institutions. More reliable data on the number of transactions would be needed to compare the cost per transaction across banks and to determine whether there are differences in demand elasticities among institutions processing various size transactions. Prices could vary by bank size or by transaction size, depending on which breakdown yields significant differences in cost and/or demand. Differentiating prices charged to different depository institutions could potentially increase efficiency and, therefore, should be explored further.

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