The Effect of Pricing on Demand and Revenue in Federal Reserve ACH Payment Processing

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The automated clearinghouse (ACH) is an electronic payments system typically used for small recurring payments between consumers and businesses. In the absence of ACH, most of those payments would be handled with paper check. The unit cost of an ACH transaction has been found to be significantly below the unit cost of checks.[1] One of the key objectives of the Federal Reserve System in its payments activities is to maximize economic efficiency. While economic efficiency can take on different meanings, lowering the social cost of payment processing is certainly one way of improving efficiency.[2] Although there is some evidence that marketing can be an effective tool in ACH promotion, there have been no empirical analyses of whether lower prices have significant effects on the demand for ACH processing services.

The Federal Reserve processes ACH payments for financial institutions, who in turn sell their ACH services to businesses and individuals. Interviews with large financial institutions indicate that ACH users are sensitive to prices, but no quantitative analysis has been done to estimate likely market responses to reducing ACH fees. Since the Federal Reserve is trying to raise the volume of ACH, it is important to know the effect of lowering ACH fees on the volume.

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[1] According to Humphrey and Berger (1990) and Wells (1996), the average social cost of processing an ACH item is only about one-third to one-half as much as for a check.

[2] Since no studies have compared social benefits of paper check and ACH, we can only discuss cost effectiveness and not net benefits of switching from one payments method to the other. Depending on the relative position of the marginal cost curves for check and ACH, the optimal volume of ACH and the optimal number of paper checks may vary.

That is, we need to estimate the price elasticity of demand for ACH, the percentage change in quantity demanded associated with a one percent change in price.[3] Estimates of demand elasticities allow us to predict how much lowering the fees would increase demand. Such estimates can also be combined with an estimate of cost elasticity to predict the effect of lower fees on net revenue from ACH.

Although the literature on the cost of various electronic payments methods dates back to Humphrey (1981, 1982, 1984, 1985) and includes more recent studies by Bauer and Hancock (1995a, 1995b) and Bauer and Ferrier (1996), there have been no studies of the demand side. The present analysis uses monthly data on the ACH per-item prices charged by the Federal Reserve and the volumes of ACH processed by the twelve Regional Federal Reserve Banks from 1984 to 1996 to estimate the price elasticities.

After describing the ACH service in Section I, we discuss several plausible models that we estimate to obtain demand elasticities (Section II) and the data available for estimating them (Section III). After presenting our results (Section IV), we consider implications of our demand elasticity estimates for unit cost and net revenue from the ACH service (Section V), and we present some conclusions (Section VI).

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[3]The price elasticity of demand (often called demand elasticity) at price P and quantity Y is the percentage change in Y divided by the percentage change in P, or: $(\Delta Y/Y) \div (\Delta P/P) = (P/Y)(\Delta Y/\Delta P)$. More precisely, the price elasticity, ε_{yp}, is defined as $(P/Y)(\partial Y/\partial P)$. If demand is elastic ($\varepsilon_{yp} < -1$), then a quantity increase will be greater than a price decrease, but if demand is inelastic ($\varepsilon_{yp} > -1$), then a quantity increase will be smaller than a price decrease in percentage terms.

I Automated Clearinghouse Services

The ACH system is an electronic funds transfer system which can be used to make either credit transfers or debit transfers. With credit transfers (for example, direct payroll deposits), the payor's bank typically initiates the transfer and funds flow from the payor's bank to the payee's bank. With debit transfers (such as mortgage or utility payments), the payee's bank initiates the transfer and receives funds from the payor's bank. The "originator" is the party that initiates the transaction, which could be either a debit or a credit transaction. The other end party is called the recipient. We would expect the demand of originators to be more elastic than the demand of receivers because the former presumably choose how the payment is being made.

The split also gives us our only glimpse into how demand elasticities vary by the size of institutions. Originations tend to be predominantly generated by a few large institutions within each district, whereas receipts are sown much more broadly. For example, based on the monthly data collected between January and June of 1996, the top originator provided 8 percent of the total commercial ACH origination volume and the top 100 originators provided 77.5 percent of the total commercial ACH origination volume. At the same time, the top receiver represented only 1.5 percent of the total commercial receipts and the top 100 receivers represented only 26.6 percent of the total commercial ACH receipt volume. Differences in demand elasticities among the various customer groups could be helpful in designing a more efficient ACH pricing system by applying the inverse elasticity (Ramsey pricing) rule.[4]

The five principal participants in ACH transactions are the payor, the payee, the payor's

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[4]The concept was developed in Ramsey (1927).

bank, the payee's bank, and the provider of the ACH service. The Federal Reserve handled about 80 percent of the roughly 2.5 billion commercial and government ACH transactions processed in 1994. The remaining share of the market is handled by private sector ACH providers: Visa, New York Automated Clearinghouse, and Arizona Clearing House.

ACH transactions offer several key advantages over paper instruments. First, in most cases, payors know exactly when the funds will be removed from their accounts, and payees know exactly when the funds will be deposited to their accounts. Second, ACH transactions may be more convenient, particularly for recurring payments, because the payor need not remember to write and deliver a paper check, and the payee need not cash or deposit it. Third, the total costs to all parties are lower for ACH transactions than for paper checks. Finally, accounting efficiencies may exist for business payors and payees that have implemented financial electronic data interchange to facilitate communications with trading partners.[5] Given these clear benefits, the Federal Reserve wants to promote as widespread use of ACH as possible. Marketing efforts have been successful in at least some instances. For example, a six-week long marketing campaign to increase direct deposit among New York teachers raised the use of ACH by that market segment from 0 to 40 percent. We test whether pricing is an effective instrument in achieving that goal.

II Model

We are interested in estimating the effect of ACH price on its volume. However, demand

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[5]See Knudson, Walton, and Young (1994) for a discussion of the potential benefits of financial electronic data interchange (a combination of electronic remittance data and electronic funds transfers) for business payments.

for ACH is also likely to be affected by the level of economic activity and population in the area For a given price of ACH, areas with higher levels of economic activity are expected to have higher volumes of ACH We measure those factors with the level of employment, per-capita income, and population in each district at the time Other district-level factors that may affect volume include local inertia (people may be less willing to switch away from paper in some regions than in others) and local marketing efforts carried out by regional banks Since we cannot measure those effects directly, district dummies are included in the equation as well

Besides the variables included in the model, other variables might affect demand for ACH They include other costs of ACH besides the Federal Reserve fees. The higher the other ACH costs, the less responsive demand is likely to be to the Federal Reserve's prices However, since we have no information on any other costs of ACH processing that are incurred by banks, that variable could not be included in the estimation Prices of substitutes for the Federal Reserve ACH processing may be relevant as well The lower the prices of substitutes, the lower the demand for the Federal Reserve ACH processing services, everything else constant

The substitutes may include other payments methods as well as private market providers of ACH. Payments processed with ACH were typically paid by check in the past However, banks that process ACH do not consider the price of check processing to be relevant in determining demand for ACH The cost of check processing has not changed significantly over time and the difference in per-unit cost between check and ACH is small relative to the fixed cost of implementing ACH. The only relevant substitutes for Federal Reserve ACH processing are either direct exchange among banks or private market ACH processors A higher fraction of "on-us" payments, increased direct exchanges among financial institutions, and competition from private market processors could all reduce the demand for Federal Reserve's ACH services. For example, due to a higher rate of bank consolidation, financial institutions are more likely to omit an intermediary and use direct exchange. That could lower the volume of Federal Reserve's ACH processing.

The impact of these substitutes is incorporated in the elasticity measure. When the Federal Reserve lowers its ACH fees, financial institutions raise their demand for the Federal Reserve services. That increase in demand could occur either because the banks increase their overall ACH volume, or because they divert their existing volume away from private market processors. Similarly, for a given drop in the Federal Reserve ACH processing fees, demand increases by less than it would increase were it not for the competition from private sector providers. Thus we measure the price elasticity of demand for the *Federal Reserve's* ACH processing, not the total ACH processing in the U.S.

To determine whether competition from private sector processors affects demand for the Federal Reserve's ACH processing, we looked at the private sector processing more closely. There are three private sector ACH processors: Visa, New York Automated Clearinghouse, and Arizona Clearinghouse. The only national-scale private provider of ACH payments processing is Visa, who has competed with the Federal Reserve on the national scale only since 1994. Other private sector providers have focused on their local markets. Even though the fees charged by Visa may be important determinants of current or future demand for the Federal Reserve ACH processing, Visa was not a significant market player during the earlier years of the sample. Therefore data on Visa's fee structure would not be relevant. Table 1 shows annual rates of growth in the Federal Reserve ACH volume. The data does not indicate that Visa's presence in the ACH market affected the Federal Reserve's interregional volume growth

A Model I

The following demand equation regresses the volume of ACH processed in district i in period t (y_{it}) on the price of ACH in period t (p_t) and on exogenous factors that may affect the demand for ACH employment (EMP_{it}), population (POP_{it}), and per-capita income (INC_{it}) in district i in period t. District dummies (β_i) control for district-specific factors that are not captured by the above variables. It is common to use the double-log specification to estimate price elasticities of demand, since the price coefficient (β_1) can then be directly interpreted as the demand elasticity. The double-log specification also allows for nonlinear effects of the regressors.

$$\ln y_{it} = \beta_0 + \beta_1 \ln p_t + \beta_2 \ln EMP_{it} + \beta_3 \ln POP_{it} + \beta_4 \ln INC_{it} + \beta_i + \epsilon_{it} \qquad (1)$$

The above equation can be estimated using the standard ordinary least-squares regression (OLS) if the price of ACH is exogenous relative to the volume of ACH. In the case of most goods and services supplied in the private market, this assumption would be false, because prices and volumes are typically determined jointly, and a system of simultaneous equations would need to be estimated. For example, if one was trying to estimate demand for grain, Equation (1) would not be sufficient, because an increase in demand for grain would likely prompt the producer to raise its prices. In the case of ACH processing, however, prices are set in advance for the following year and do not change in response to changes in demand. Equation (1) can therefore be estimated using OLS.

B Model II

Although prices do not change in response to changes in the *current* volume, Equation (1) assumes that volume is independent of the *past* volume as well (except for any indirect effect of past volume on prices). This assumption may be too stringent.

To determine whether and how past ACH volumes affect current volumes, we analyzed more closely how the expectations about future volumes are made. There are several factors that influence each district's volume predictions. During the past two years, each district provided an explanation as to how its predictions of the following year's ACH volume were derived.[6] Based on those explanations, it seems that most districts relied on their current year's rate of growth and assumed that their ACH volume would continue growing at the same rate during the following year. We therefore adopted that assumption in our model. The equation below shows that each district's expected volume in period t (y_{it}^e) is determined as the district's last year's volume ($y_{i,t-1}$) increased at a rate of growth g_i.

$$y_{it}^e = y_{i,t-1} \times g_i \tag{2}$$

where g_i is the rate of growth of volume in district i from year t-2 to year t-1:

$$g_i = \frac{y_{i,t-1}}{y_{i,t-2}} \tag{3}$$

In other words, we assume that each district expects that its volume will grow between period t-1

[6] There is no indication that prices were based on districts' volume predictions prior to that.

and t at the same rate it grew from t-2 to t-1 (g_t) The expected volume in period t is therefore determined by the volume in t-1 and by the rate of growth from t-2 to t-1 After setting their volume predictions, districts adjust their marketing efforts to try to meet those predictions As a result, the true volume in period t (y_{it}) may be a function of g_t, the rate of growth of volume between period t-2 and t-1 Taking the predictions into account, the new model to be estimated is:[7]

$$\ln y_{it} = \gamma_0 + \gamma_1 \ln p_t + \gamma_2 \ln EMP_{it} + \gamma_3 \ln POP_{it} + \gamma_4 \ln INC_{it} + \gamma_5 \ln (g_t) + \gamma_t + \eta_{it} \quad (4)$$

From Equation (3) it follows that:

$$\ln (g_t) = \ln (y_{i,t-1}) - \ln (y_{i,t-2})$$

Therefore Equation (4) becomes:

$$\ln y_{it} = \gamma_0 + \gamma_1 \ln p_t + \gamma_2 \ln EMP_{it} + \gamma_3 \ln POP_{it} + \gamma_4 \ln INC_{it} + \gamma_5 (\ln (y_{i,t-1}) - \ln (y_{i,t-2})) + \gamma_t + \eta_{it} \quad (5)$$

Equation (5) includes lagged dependent variables on the right hand side The equation can be estimated using OLS only if there is no serial correlation To test for serial correlation in the

[7]Although the data is compiled monthly and the subscript t denotes month throughout the paper, the volume growth rates are annual and are computed based on the previous two *years*, since each district estimates its annual growth rates

presence of lagged dependent variables, we used the Durbin h statistic.[8]

C. Model III

Above we explained why prices and volume of ACH are not determined simultaneously. However, when ACH prices are determined, volume expectations are taken into account. We applied a two-stage least squares (2SLS) estimation to test whether the results would significantly vary from the OLS results in Model I. In the first stage, the per-item fees for ACH in period t (p_{it}) were regressed on the unit cost of ACH processing in district i in period t-1 ($c_{i,t-1}$) and on the expected volume of ACH in district i in period t (y_{it}^e). The first stage of the estimation is therefore as follows:

$$p_{it} = \alpha_0 + \alpha_1 c_{i,t-1} + \alpha_2 y_{it}^e + \upsilon_{it}$$

From equation (2) it follows that:

$$p_{it} = \alpha_0 + \alpha_1 c_{i,t-1} + \alpha_2 y_{i,t-1} g_i + \upsilon_{it} \tag{6}$$

where g_i is defined as in Equation (3). The second stage uses predicted prices from Equation (6):

$$\ln y_{it} = \delta_0 + \delta_1 \ln \hat{p}_t + \delta_2 \ln EMP_{it} + \delta_3 \ln POP_{it} + \delta_4 \ln INC_{it} + \delta_i + \epsilon_{it} \tag{7}$$

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[8]For details on the Durbin h statistic, see, e.g., Johnston (1984).

III Data

The ACH price and volume data for the 1984-1996 period are from the CORE data set We included commercial volume only.[9] The Federal Reserve can process ACH payments for financial institutions that serve as originators or recipients, and of credit or debit payments The CORE data set distinguishes among those four types of transactions The data also separates intraregional payments (i e , within a Federal Reserve district) and interregional payments (i e , across Federal Reserve districts) Table 1 shows annual volume growth rates for the various types of interregional ACH service Figures 1 and 2 show monthly ACH volume for the Federal Reserve System in the 1984-96 period Figure 1 shows Total Interregional Origination Volume and Figure 2 shows Total Interregional Receipt Volume Figure 3 shows the Federal Reserve per-item interregional ACH fees over the same time period Throughout the period, volume increased while prices declined The econometric analysis used in this study isolates the effect of price decline from other factors affecting the volume growth

Monthly employment, per-capita income, and population data were aggregated from county to district level The employment data is from the Bureau of Labor Statistics, the per-capita income is from the Bureau of Economic Analysis, while the population data is from the U S Department of Commerce and the Bureau of the Census

In addition, conversations with representatives of financial institutions provided information about the nature of the ACH market, including the types of transactions ACH is currently used for, the most likely source of future volume growth, the way changes in the Federal

[9]While the data on government ACH volume is available as well, other (non-price) factors are likely to dominate the government demand.

Reserve fees are passed onto their customers, effects of customer resistance on volume growth, alternatives to the Federal Reserve ACH processing that they consider viable, and sectors that are likely to grow in response to ACH price changes.

IV Estimation Results

Equations (1) and (5) were estimated using OLS, and Equation (7) was estimated using 2SLS. Separate equations were estimated for each type of ACH processing service for which volume and price data were available.

a. interregional debit origination volume,
b. interregional credit origination volume,
c. total interregional origination volume (a. plus b.),
d. interregional debit receipt volume,
e. interregional credit receipt volume, and
f. total interregional receipt volume (d. plus e.).

Intraregional demand equations could not be estimated, since the intraregional processing fee has been constant since 1985. Since no price changes were observed, the data would not allow for estimation of what happens when the price rises or falls. Although no data was available by customer size, we expect the demand of originators to be more elastic than the demand of receivers (see Section I for explanation). Since originators tend to be predominantly large institutions, they are more likely to have some bargaining power with private sector providers.

The results of Model I, Model II, and Model III are included in Tables 2 through 7. Each table corresponds to a different volume category (a. through f.). Below are the estimates of own price elasticities of demand for the three models for each volume category. The values are expressed as the percentage change in volume caused by a 1 percent increase in price:

ACH Service	Estimates of Own Price Elasticity of Demand		
	Model I	Model II	Model III
Inter Debit Origination	-0.36	0.15	1.20*
Inter Credit Origination	-1.45*	-1.18*	-2.69*
Total Inter Origination	-0.95*	-0.62*	0.22
Inter Debit Receipt	-0.37*	-0.53*	0.02
Inter Credit Receipt	-1.00*	0.06	-1.64*
Total Inter Receipt	-0.63*	-0.80*	-0.47*

Estimates marked with * were significant at the 1 percent level. Most of the results are qualitatively similar across the three models. In particular, results of the estimation with the previous year's rate of volume growth (Model II) seem to be very close to the OLS estimates (Model I). While most estimates are statistically significant, credit origination and credit receipt are the only volume categories facing elastic demand. In other words, a 1 percent drop in credit origination or receipt price leads to a more than 1 percent increase in volume. At the same time, a 1 percent drop in debit origination or debit receipt price leads to a less than 1 percent increase in volume. Most of the estimates show that a decrease in ACH price leads to an increase in all the volumes and most of the results are statistically significant.

Origination seems to be somewhat more sensitive to price changes than receipt, confirming our prior belief that originators, who tend to be large, could more easily switch either to direct exchange or to private market processors. Smaller institutions typically have fewer options However, the biggest difference in demand elasticity estimates is between ACH credit and ACH debit. The difference is likely caused by consumer resistance to debit transactions (such as automated bill payment), or by a relatively low number of companies offering automatic deduction, or both. Consumer surveys show that a large fraction of the population prefers writing checks to having their payments be automatically deducted from their bank accounts.[10] Consumer resistance is less likely to occur in the case of credit, such as direct payroll deposit, leading employers to be responsive to price incentives from their banks.

The effect of other variables on the volume of ACH was as follows:

Population	negative and significant effect; possibly picks up some the effect of the other economic indicators.
Per-capita income	positive and highly significant, with values slightly higher for origination than for receipt.
Employment	positive effect on credit, negative effect on debit; higher employment levels raise demand for direct deposit, raising demand for ACH credit.

V Implications for Unit Cost

Previous studies have found significant scale economies in ACH processing (see Bauer and Ferrier (1996), Bauer and Hancock (1993), and Humphrey (1982, 1984, 1985)). The estimates of cost elasticities for ACH have generally ranged from 0.5 to 0.75. In other words, a 1

[10]NACHA Electronic Check Council, March 7, 1996.

percent increase in ACH volume leads to only a 0.5 to 0.75 percent increase in the total cost of ACH. Based on those estimates, a 1 percent increase in ACH volume leads to a 0.5 to 0.25 decrease in the unit cost.[11]

Given the scale economies that have been found in Federal Reserve ACH processing, it is important to consider the effect that changes in prices may have on production costs. To calculate the effect of a 1 percent decline in price on the unit cost, the effect of a price decline on volume (measured by demand elasticity) can be combined with the effect of an increase in volume on unit cost (measured by cost elasticity)

$$\frac{\partial \ln(\frac{C(y)}{y})}{\partial \ln p} = (\frac{\partial \ln C}{\partial \ln y} - 1)\frac{\partial \ln y}{\partial \ln p} \tag{8}$$

where the first term on the right hand side is the cost elasticity minus one and the second term is the price elasticity of demand. As long as the demand elasticity is negative and the cost elasticity is less than one (i.e., scale economies exist), the unit cost will decline with a reduction in price. Also notice that if the demand elasticity is greater than $1/(1-\partial \ln C/\partial \ln y)$, the percentage decline in unit cost will be greater than the percentage decline in price, so that the price reduction would be "self-financing" (see Appendix for the derivation of the effect of price reduction on net revenue from ACH).

While the results of the above studies are fairly robust, all the cost elasticity estimates

[11]The effect of a 1 percent increase in volume on the unit cost can be derived from cost elasticity as follows.

$$\frac{\partial \ln(\frac{C}{y})}{\partial \ln y} = \frac{\partial(\ln C - \ln y)}{\partial \ln y} = \frac{\partial \ln C}{\partial \ln y} - 1 = \varepsilon_{cy} - 1$$

referenced above were derived before the full implementation of the FRAS consolidation. Some adjustments should therefore be made to obtain the best estimate of the cost elasticity that can be applied in the Federal Reserve System's current circumstances. Beginning with Humphrey (1982), single equation estimates of ACH cost elasticities have been around 0.75, even though the volume of ACH has grown significantly since then. One approach is therefore to assume that the estimates will remain around 0.75. Another approach is to use the most recent estimate (Bauer and Ferrier (1996)) and extrapolate it out to the current consolidated volume levels to estimate the current cost elasticity.[12] Extrapolating it out to the current system-wide volume level yields a cost elasticity estimate of 0.6.[13]

Consequently, we employ two separate estimates of the cost elasticities (0.75 and 0.60) to demonstrate the range of likely outcomes. If, in fact, the cost elasticity is equal to 1 (i.e., there are constant returns to scale), then it can be seen from the above equation that changing prices will have no effect on unit costs.

As can be seen in Tables 8 and 9, the percentage change in unit cost is smaller than the percentage change in prices, other things held constant. This suggests that although lowering the price of ACH will increase demand, the resulting increase in volume alone will not lower the unit

[12] Bauer and Ferrier (1996) employed a standard translog and an extended translog (with Fourier terms added). The former is a second order approximation to the cost function, but only about the sample mean. Extrapolating it out to the current system-wide volume level yields a cost elasticity estimate of 0.6. The latter functional form can fit the cost function over a wider interval, but cannot be reliably extrapolated beyond the observed range of the data.

[13] These numbers should be used cautiously. Not only are the cost elasticity estimates based on pre-consolidation data, they are also based on the PACS database which measures interregional ACH items twice (since some processing occurred in both districts), in contrast to the CORE database (used to estimate the demand elasticities) that counts each item only once. Depending on the real resource costs of interregional processing prior to consolidation, the bias in the above calculation could go either way.

cost sufficiently to compensate for lost revenues [14] A price decline might hurt cost recovery efforts

A more general formula for the effect of an ACH price reduction on net revenue is included in the Appendix. The result shows that with the cost elasticity equal to 0.75, the demand elasticity must be greater than 4 in absolute value for net revenue to increase as a result of a price decline. None of our estimates reach that level. For example, the demand elasticity for interregional credit origination estimated in Model I equals -1.45. The effect of a 1 percent price decline on net revenue equals:

$$\frac{\partial NR}{\partial p} = \frac{py}{C}\left(\frac{1}{-1.45}+1\right) - 0.75$$

Assuming that revenue was equal to cost prior to the price decline (i.e., py = C),

$$\frac{\partial NR}{\partial p} = -0.44$$

Thus even for the market segment with elastic demand, a price decline will lower net revenue

VI Conclusion

Automated clearinghouse has been found to be a more efficient payments mechanism than paper check. The Federal Reserve has been promoting a more widespread use of ACH through marketing and through lowering ACH processing fees, but until now there has been no evidence of whether lowering ACH fees has had an effect on volume. Our results show that the volume of

[14]Volume increase is not the only source of unit cost decline. Bauer and Ferrier (1996) found that technological change leads to a reduction in unit cost of 11 percent a year.

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The above inequality shows a relationship between the cost elasticity (ε_{cy}) and the price elasticity of demand (ε_{yp}) that must be met for net revenue to increase as a result of a price decrease. If revenue equal cost ($py = C$), the first part of the above expression equals 1. In that case, the condition becomes:

$$\frac{1}{\varepsilon_{yp}} + 1 > \varepsilon_{cy} \quad \Rightarrow \quad \varepsilon_{yp} < \frac{1}{\varepsilon_{cy} - 1}$$

For a cost elasticity of 0.75, the demand elasticity has to be less than -4 (or greater than 4 in absolute value) for net revenue to increase as a result of a price decrease.

Table 2: Interregional Debit Origination Volume

	Model I		Model II		Model III	
Variables	Coefficient	t-Stat	Coefficient	t-Stat.	Coefficient	t-Stat
Intercept	23.37	3.93	19.79	3.01	25.72	3.72
log (Growth Rate)	---	---	0.31	7.47	---	---
log (Price)	-0.36	-1.22	0.15	0.52	1.20	4.16
log (Population)	-1.97	-3.15	-0.72	-1.03	-0.67	-0.96
log (Per-Capita Income)	6.27	27.27	6.66	27.10	6.84	33.91
log (Employment)	-0.83	-2.49	-1.74	-5.40	-1.99	-6.16
District Dummies?	Yes		Yes		Yes	
N	1583		1331		1331	
R^2	0.892		0.895		0.892	
F	858		696		720	

Table 1 Annual Growth Rates in Interregional Origination and Receipt Volumes
(percent)

	Interregional Credit Origination	Interregional Debit Origination	Total Interregional Origination	Interregional Credit Receipt	Interregional Debit Receipt	Total Interregional Receipt
1984-1985	86.69	66.29	73.40	85.23	64.83	70.24
1985-1986	38.53	38.84	38.73	37.49	30.86	32.78
1986-1987	37.41	35.73	36.36	41.93	32.75	35.56
1987-1988	29.70	30.35	30.11	30.06	24.01	25.90
1988-1989	28.97	20.44	23.65	29.85	24.67	26.35
1989-1990	28.57	52.88	43.33	27.84	14.58	18.99
1990-1991	33.63	16.00	22.21	31.12	13.37	19.72
1991-1992	28.98	16.49	21.30	30.64	17.61	22.71
1992-1993	26.59	15.22	19.88	26.40	14.77	19.62
1993-1994	22.17	13.41	17.20	22.96	13.91	17.89
1994-1995	23.09	16.83	19.65	22.53	16.76	19.41
1995-1996	24.57	16.51	20.24	21.03	15.72	18.22
Average Annual Growth Rate	34.07	28.25	30.51	33.92	23.65	27.28

ACH items processed by the Federal Reserve does respond to changes in per-item fees. Our estimated demand elasticities are negative and mostly statistically significant. Interestingly, we find that demand for credit is elastic while demand for debit is inelastic. The difference most likely arises from high customer resistance to automatic payment deduction and from low market penetration of that service among companies. Demand for origination was found to be somewhat more elastic than demand for receipt. The differences in elasticities could be used in a more efficient fee schedule by adopting prices proportional to the inverse of elasticities (i.e., Ramsey pricing)

The demand elasticity estimates were combined with cost elasticities estimated in previous studies. To outweigh revenues lost as a result of a price decline, ACH volume would have to increase by more than our estimates indicate. A decline in per-item ACH fees would likely lead to lower net revenues from the service. Before further price decreases are adopted (beyond those justified by technological changes), it is important to state clearly the Federal Reserve System's objectives and constraints. If the objective is to raise the Federal Reserve's ACH processing volume, a price decline will clearly help accomplish that goal. But, if maintaining current net revenues is a constraint, a price decrease will likely be problematic.

Appendix

This Appendix derives the effect of a reduction in price for ACH service on net revenue from ACH, and shows the condition that must be met for net revenue to increase as a result of a price decline.

The total cost of ACH processing is a function of the total volume of ACH processed by the Federal Reserve, C(y). Net revenue from ACH equals

$$NR = py - C(y)$$

The effect of price change on net revenue

$$\frac{\partial NR}{\partial p} = (y + p\frac{\partial y}{\partial p}) - (\frac{\partial C}{\partial y}\frac{\partial y}{\partial p})$$

Net revenue increases if

$$\frac{\partial NR}{\partial p} > 0 \;\rightarrow\; y + p\frac{\partial y}{\partial p} > \frac{\partial C}{\partial y}\frac{\partial y}{\partial p}$$

or

$$(\frac{y}{C})\,(\frac{y}{\frac{\partial y}{\partial p}} + p) > \frac{\partial C}{\partial y}\frac{y}{C}$$

Expressing the above inequality in terms of elasticities:

$$\frac{py}{C}(\frac{1}{\varepsilon_{yp}} + 1) > \varepsilon_{cy}$$

Table 3: Interregional Credit Origination Volume

	Model I		Model II		Model III	
Variables	Coefficient	t-Stat.	Coefficient	t-Stat.	Coefficient	t-Stat.
Intercept	-4.00	-1.00	5.09	1.15	-7.13	-1.61
log (Growth Rate)	---	---	0.40	9.16	---	---
log (Price)	-1.45	-7.36	-1.18	-6.17	-2.69	-13.55
log (Population)	-3.68	-8.78	-3.77	-8.07	-2.83	-6.32
log (Per-Capita Income)	4.11	26.67	4.75	29.31	4.12	32.04
log (Employment)	4.00	17.86	3.08	14.29	2.87	13.82
District Dummies?	Yes		Yes		Yes	
N	1582		1330		1330	
R^2	0.929		0.930		0.933	
F	1367		1089		1212	

Table 4: Total Interregional Origination Volume

	Model I		Model II		Model III	
Variables	Coefficient	t-Stat.	Coefficient	t-Stat.	Coefficient	t-Stat.
Intercept	0.97	0.30	1.89	0.54	1.84	0.50
log (Growth Rate)	---	---	0.25	6.32	---	---
log (Price)	-0.95	-5.95	-0.62	-4.07	0.22	1.33
log (Population)	-2.03	-5.99	-1.22	-3.30	-0.76	-2.05
log (Per-Capita Income)	4.64	37.18	5.00	37.55	5.33	48.46
log (Employment)	1.82	10.04	0.87	5.08	0.64	3.65
District Dummies[a]	Yes		Yes		Yes	
N	1583		1331		1331	
R^2	0.954		0.957		0.955	
F	2157		1804		1837	

Table 5: Interregional Debit Receipt Volume

	Model I		Model II		Model III	
Variables	Coefficient	t-Stat.	Coefficient	t-Stat.	Coefficient	t-Stat.
Intercept	-5.37	-2.87	-4.87	-2.35	-5.50	-2.57
log (Growth Rate)	---	---	-0.39	-8.28	---	---
log (Price)	-0.37	-3.96	-0.53	-5.87	0.02	0.19
log (Population)	1.01	5.12	1.36	6.21	1.56	6.88
log (Per-Capita Income)	3.54	48.76	2.86	33.31	3.51	56.14
log (Employment)	-0.21	-1.97	-0.50	-4.93	-0.62	-6.03
District Dummies?	Yes		Yes		Yes	
N	1584		1332		1332	
R^2	0.970		0.971		0.969	
F	3391		2730		2714	

Table 6: Interregional Credit Receipt Volume

	Model I		Model II		Model III	
Variables	Coefficient	t-Stat.	Coefficient	t-Stat	Coefficient	t-Stat
Intercept	-7.67	-4.06	-7.35	-3.72	-8.82	-4.07
log (Growth Rate)	---	---	0.43	18.51	---	---
log (Price)	-1.00	-10.71	0.06	0.58	-1.64	-13.10
log (Population)	0.64	3.21	0.64	3.02	0.83	3.46
log (Per-Capita Income)	4.90	67.02	3.22	30.57	4.76	77.41
log (Employment)	-0.29	-2.71	-0.14	-1.35	-0.62	-5.92
District Dummies?	Yes		Yes		Yes	
N	1584		1332		1332	
R^2	0.981		0.983		0.980	
F	5376		4811		4272	

Table 7: Total Interregional Receipt Volume

	Model I		Model II		Model III	
Variables	Coefficient	t-Stat.	Coefficient	t-Stat.	Coefficient	t-Stat
Intercept	-8.61	-4.66	-11.36	-5.61	-10.12	-4.70
log (Growth Rate)	---	---	-0.46	-10.53	---	---
log (Price)	-0.63	-6.88	-0.80	-8.99	-0.47	-3.63
log (Population)	1.21	6.25	1.91	8.93	1.82	7.73
log (Per-Capita Income)	3.95	55.39	3.23	38.79	3.95	63.21
log (Employment)	-0.28	-2.74	-0.61	-6.17	-0.72	-6.92
District Dummies?	Yes		Yes		Yes	
N	1584		1332		1332	
R^2	0.974		0.974		0.971	
F	3921		3113		2961	

Table 8: Effect of a 1% Decline in Price on Unit Costs

($\partial \ln C/\partial \ln y=0.75$)

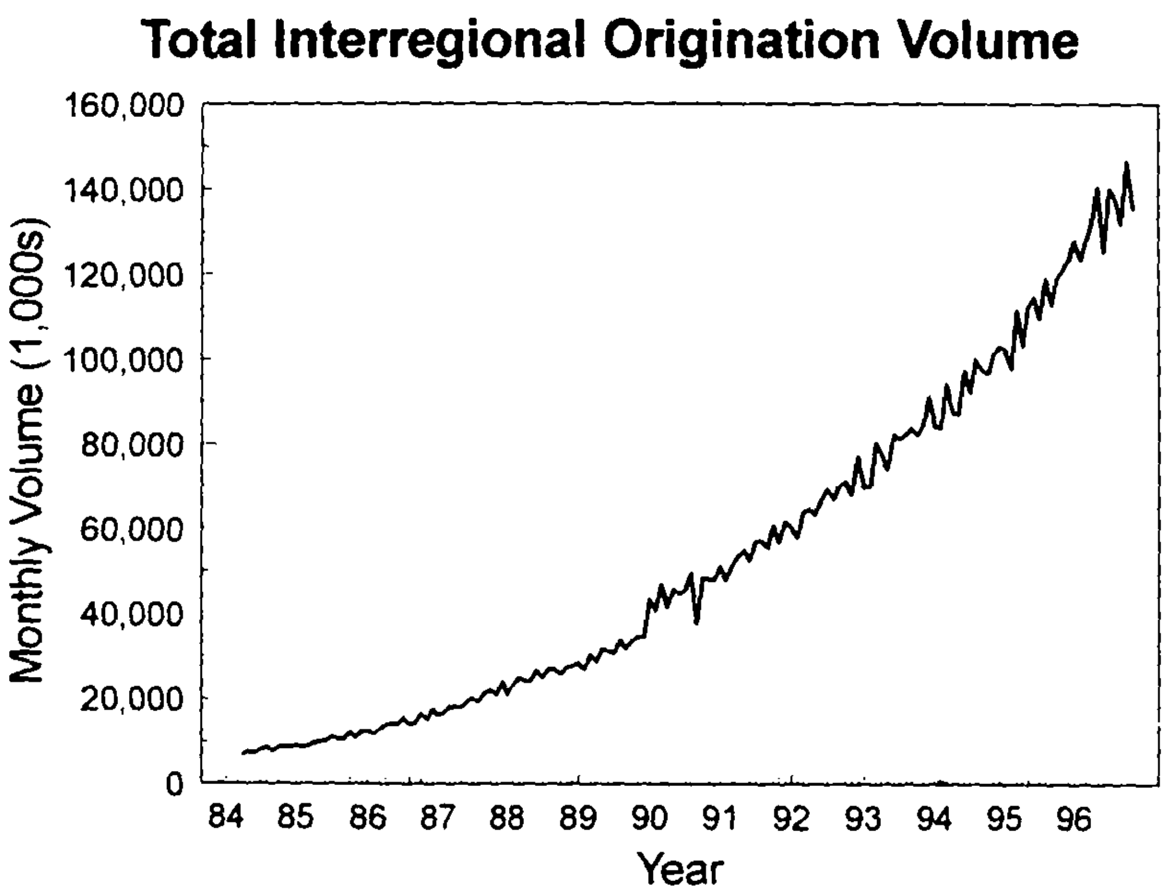
ACH Service	Model I	Model II	Model III
Inter Debit Origination	-0.09	0.04	0.30*
Inter Credit Origination	-0.36*	-0.30*	-0.67*
Total Inter Origination	-0.24*	-0.16*	0.06
Inter Debit Receipt	-0.09*	-0.13*	0.01
Inter Credit Receipt	-0.25*	0.02	-0.41*
Total Inter Receipt	-0.16*	-0.20*	-0.12*

Table 9: Effect of a 1% Decline in Price on Unit Costs

($\partial \ln C / \partial \ln y = 0.60$)

ACH Service	Model I	Model II	Model III
Inter Debit Origination	-0.14	0.06	0.48*
Inter Credit Origination	-0.58*	-0.47*	-1.08*
Total Inter Origination	-0.38*	-0.25*	0.09
Inter Debit Receipt	-0.15*	-0.21*	0.01
Inter Credit Receipt	-0.40*	0.02	-0.66*
Total Inter Receipt	-0.25*	-0.32*	-0.19*

Figure 1



Total Interregional Origination Volume
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
Monthly Volume (1,000s)
84
85
86
87
88
89
90
91
92
93
94
95
96
Year

Figure 2

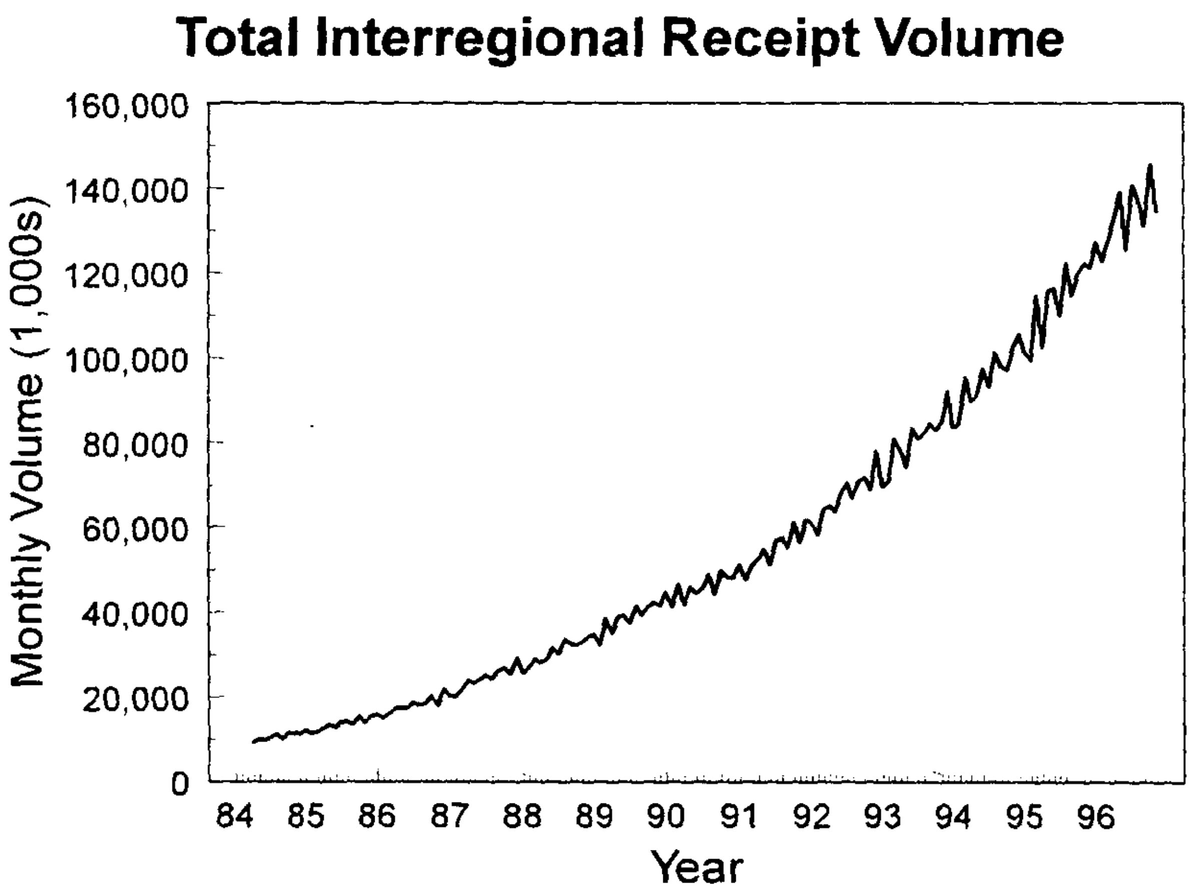
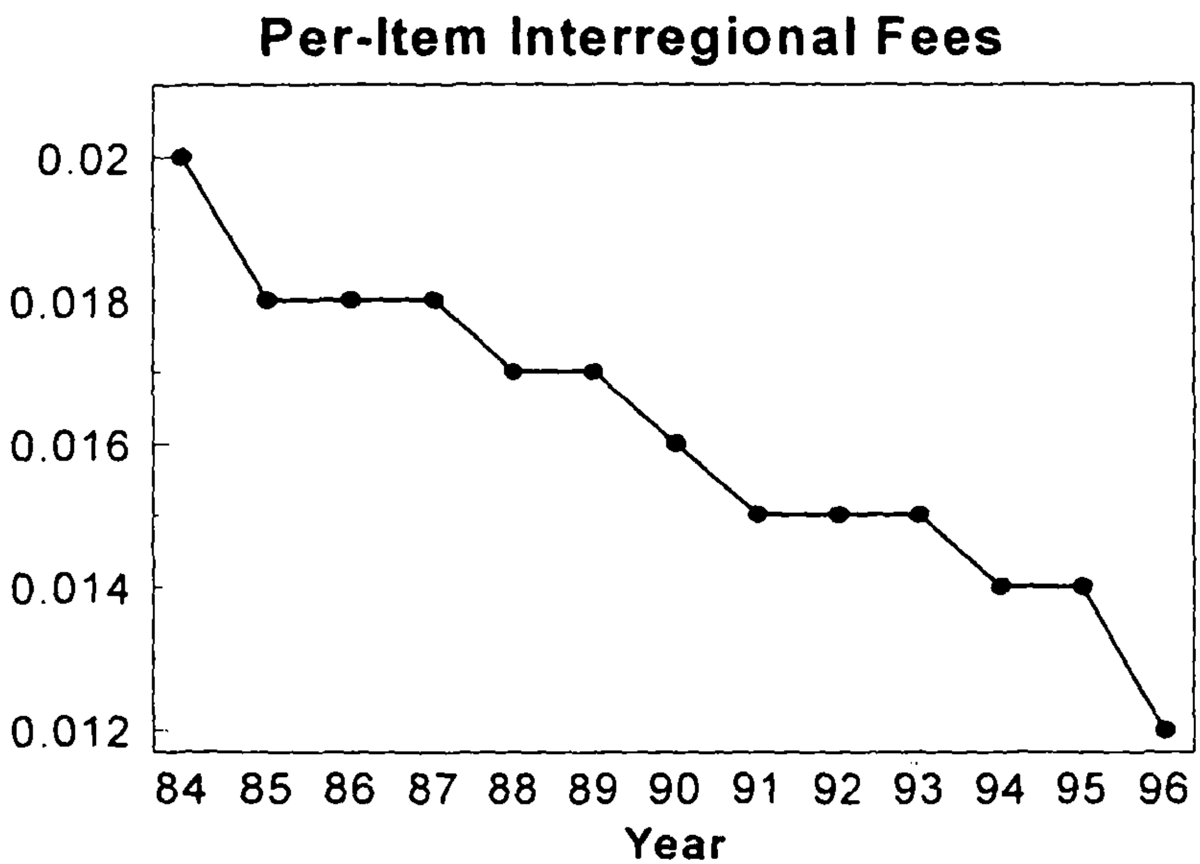

Total Interregional Receipt Volume
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
Monthly Volume (1,000s)
84
85
86
87
88
89
90
91
92
93
94
95
96
Year

Figure 3


Per-Item Interregional Fees
0.02
0.018
0.016
0.014
0.012
84 85 86 87 88 89 90 91 92 93 94 95 96
Year