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The Working Paper Series is made possible by a generous grant from the Alfred P. Sloan Foundation

Do Consumers Pay for One-Stop Banking?
Evidence from a Non-Standard Revenue Function [1]

August 1993

Abstract: Synergies in providing financial services can reduce costs due to joint production (cost economies of scope) or raise revenues due to joint consumption (revenue economies of scope). Cost economies of scope between bank deposits and loans were found to be small elsewhere. Revenue economies of scope are investigated here for the first time and found to be nonexistent over 1978-1990 for both small and large banks and for those on or off the revenue-efficient frontier. The lack of synergies between deposits and loans-where benefits are most likely to occur-suggests few synergies from an expansion of banking powers.

JEL: G21, L89, D20

Keywords: bank, revenue, scope economies, deposits

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I. Introduction.

Much has been made of the presumed advantages associated with the joint production and joint consumption of various financial services. For example, the gains believed to be associated with the joint provision of bank deposits and loans constitute a primary argument for expanding banking powers to new activities such as underwriting, insurance, and real estate. To date, only banking synergies on the production side—cost economies of scope—have been investigated, typically using a multiproduct cost function. Reductions in bank costs due to supplying deposit and loan services jointly, however, have been found to be small. In this paper, we focus on the gains from consuming financial services jointly and attempt to answer the question of whether or not consumers pay for one-stop banking. Using a specialized revenue function, we estimate revenue economies of scope and determine whether banks providing a broad mix of services are able to capitalize on the potential savings in transaction costs afforded their customers.

Banks have long argued that production and consumption synergies form the basis for their providing retail customers with transactions and savings services on the deposit side jointly with installment, mortgage, and credit card financing on the loan side. For corporate customers, transaction, payroll, cash management, and foreign exchange services are provided jointly with working capital credit, commercial loans, and leasing. Production economies lower unit costs by spreading fixed expenses over a broader output mix and exploiting production complementarities, while consumption economies lower consumer expenses, which consumers are presumably willing to pay for through higher prices. Both bank production costs and consumer consumption expenses are thought to be reduced through such “relationship banking” or “one-stop shopping” for financial services.

The belief in synergies is so strong that in the early 1980s, thrift institutions and credit unions lobbied for and obtained the power to expand their product mix and become more like banks, offering consumer transaction accounts and broader mixes of consumer and business loans to supplement their historic focus on savings deposits and mortgage loans. Synergies were also the justification for the formation of so-called financial supermarkets, where savings, installment and credit-card loan, insurance, real estate, and securities services were all offered jointly by retail firms (e.g., Sears).

Production synergies correspond to cost economies of scope and have been found to vary considerably for banks and thrifts, ranging from large economies to large diseconomies.[1] These diverse results are, unfortunately, most likely associated with the limitations of the translog functional form previously used to estimate scope economies and with the sparseness of the data regarding specialized production (Röller, 1990; Pulley and Braunstein, 1992).

The functional form problem has been addressed in banking by Pulley and Humphrey (1993). Using a better-behaved functional form—a composite form—they found only small cost economies of scope between deposits and loans of 4 to 5 percent.[2] Other researchers have shown how some of the limitations of bank data can be overcome by measuring the cost effects of producing a different product mix across different sized financial firms along the industry's expansion path (expansion path subadditivity), instead of focusing on joint versus completely specialized production. Although these points of evaluation are well within the range of the data, the product mix effects found were small and uneven; typical estimates were 3 percent or less (Berger, Hanweck, and Humphrey, 1987; Hunter, Timme, and Yang, 1990). Finally, using a linear programming approach in which no functional form is specified, significant diseconomies from banking output diversification are found (Ferrier, Grosskopf, Hayes, and Yaisawarng, 1993). In sum, if cost economies of scope exist, they are expected to be small.

The extent of complementarities in the consumption of bank services remains to be examined and is potentially as important for bank profitability as complementarities in production. Consumption complementarities arise from reductions in user transaction and search costs associated with consuming

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[1]See the studies surveyed in Mester (1987) and Clark (1988) and the recent scope analyses of Berger and Humphrey (1991) and Mester (1993).

[2]The 4 to 5 percent estimate also measures the potential cost of narrow banking proposals, which would eliminate the joint provision of insured deposits and risky loans.

financial services jointly from the same bank provider, often at the same location, rather than consuming these services separately from different providers at different locations. While actual user benefits cannot be observed, users should be willing—at the margin—to reward joint production up to the amount of savings they obtain from joint consumption. If benefits from joint consumption are strong, consumers should be willing to pay for them through higher prices at banks that provide services jointly, adding to bank revenues. Thus banks may increase revenues by supplying financial services jointly rather than separately. Just as bank cost economies of scope measure the benefits from joint production, bank revenue economies of scope can be used to approximate extracted gains from joint consumption. This is done through use of a non-standard revenue function. The economic importance of joint consumption for banks has, to our knowledge, never been determined.[3]

Section II describes how a revenue function can be used to model the value (as captured by banks) of joint consumption of banking services. A measure of revenue economies of scope is developed that allows us to estimate revenue complementarities separately from the effects of fixed revenues associated with specialized production. This decomposition is not possible with the translog functional form (or its Box-Cox variants); instead, we use the composite functional form of Pulley and Braunstein (1992). As bank suppliers of financial services may face customers with different preferences for joint consumption and/or may fail to set prices to maximize revenues, we perform separate (as well as pooled) analyses for small and large banks both on and off a revenue-efficient frontier. Model estimation and data issues are noted in Section III, and empirical results are presented in Section IV.

Summarizing our results, we find no evidence of statistically significant revenue complementarities or fixed revenue effects among banks over 1978-1990. In other words, revenues are

[3]While the existence of jointness in financial services has been tested statistically in a profit function context (and found to be significant—Hancock, 1992; Berger, Hancock, and Humphrey, 1993), this result can be due to either cost scope economies, revenue scope economies, or both. Profits can be higher with joint provision of financial services either from lower costs or higher revenues.

no larger when deposits and loans are provided jointly rather than separately and consumers do not pay for one-stop banking. This holds for the average small or large bank as well as those on and off the revenue-efficient frontier. While these results strictly apply only to existing bank services, they may be indicative of the sorts of gains (or non-gains) that may occur with an expansion of banking powers. Deposits and loans are currently the most natural combination to exhibit cost and revenue scope benefits and, if little or no gains are found, we should not be optimistic regarding benefits from joint provision of banking with other financial services. A more detailed set of conclusions is in Section V.

II. Modeling the Revenue Function and Estimating Revenue Economies of Scope.

A. A Non-Standard Revenue Function Approach. The benefits banks derive from offering their customers a broad mix of financial services can be measured by the variations in bank revenues associated with the joint provision of bank deposit and loan services. However, the indirect revenue function derived in the usual way cannot be used for this purpose since revenues are specified as being a function of exogenous output prices and input quantities. In such a framework, there can be no revenue scope economies. For banks to obtain greater revenues from the joint provision of deposit and loan services, output prices have to vary with different output mixes. This can occur if banks have some market power to vary prices with their assessment of the value of the product mix offered to consumers or consumers value different mixes of services and bid up prices when these services are offered jointly in a competitive market. In either case, there will be a relationship between the relative levels of output quantities provided and the revenues received.

More formally, the standard indirect revenue function will not explicitly reflect the relationship between joint production and revenues because firms are assumed to maximize revenue (R) in a competitive environment for given output prices (p) and input quantities (x) by varying output quantities (y). Thus firms solve:

$$\max_{\underline{y}} R = \underline{p}'\underline{y}, \qquad \text{s.t. } h(\underline{y},\underline{x})$$

where $h(\underline{y},\underline{x})$ is a production transformation from input quantities, $\underline{x}$, into output quantities, $\underline{y}$. The Lagrangian yields the optimal choice of output $\underline{y} = y(\underline{p},\underline{x})$. Then, since total revenue, R, is the product of output prices and output quantities, $\underline{p}'\underline{y}$, the indirect revenue function is given by:

$$R = \underline{p}'y(\underline{p},\underline{x}) = R(\underline{p},\underline{x}).$$

Our specification for the revenue function differs from the usual approach. Banks, through either local market power, quality differences, or the degree of jointness in the services provided, are assumed to determine output prices rather than take them as exogenous. Output price exogeneity certainly applies to nationally-traded assets such as government securities and federal funds sold and likely applies for commercial loans to low-risk, large corporate borrowers. However, output price exogeneity is likely not met for other deposit and loan services. Deposit fees, minimum balance requirements, rates on consumer installment and credit card loans, as well as rates charged on agricultural and middle market corporate loans are more likely endogenously—rather than exogenously—determined. For these products, banks have the ability to set output prices differentially among customer groups, across geographic areas, and over time. This conclusion is supported by studies that have tested for bank price-taking versus price-setting behavior, most often finding the latter (Hancock, 1986; Hannan and Liang, 1990; and English and Hayes, 1991).[4]

On the deposit side, the ability of customers to turn deposits into cash at low cost and at convenient times, as well as the need for local acceptability of checks for everyday use, virtually ensures that deposit fees and minimum balance requirements are determined locally rather than nationally,

[4]For example, Hancock (1986) rejected price-taking behavior for bank loan and demand deposit outputs but accepted it for labor and purchased funds (plus time deposit) inputs.

suggesting that they are not exogenous for banks with significant market shares.[5] On the loan side, the need for specific information regarding local business conditions to value collateral and assess credit risk properly gives banks some degree of control over loan rates charged to local consumers, small businesses, and middle-market corporate borrowers. Banks also generate private information about loan customers which is costly to duplicate by other lenders (Diamond, 1984; Boyd and Prescott, 1986) and the relationship between borrower and lender tends to grow stronger over time, tying the customer even more tightly to a given bank (Diamond, 1991; Berger and Udell, 1993). The structure-conduct-performance literature in banking is consistent with these arguments. Banks in markets with greater local concentration pay lower rates to small depositors (Berger and Hannan, 1989) and charge higher rates to small borrowers (Hannan, 1991).

It is true that most banks price their loans based on an essentially nationally-determined prime loan rate. But the positive and negative spreads from that rate, along with the size of required average idle compensating deposit balances, collateral, and loan commitment fees, differ both within and across borrower groups and geographic areas and are affected by local demand conditions. Only for loans to large, low-credit-risk corporate borrowers is there a truly national loan rate, a rate determined by the opportunity cost of issuing commercial paper or borrowing from nonbank financial firms, both of which are strong substitutes for these types of bank loans (as evidenced by a declining bank market share).

Using this approximate division of banking services into price-taking versus price-setting behavior implies that perhaps one-third of banking revenues are associated with services where price-taking is expected while two-thirds are associated with services where price-setting behavior is most likely. Securities and other investment income comprise 26% of total bank revenues while commercial and other

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[5] While Money Market Mutual Funds offer transaction services in competition with banks, the actual use of these transaction services by consumers is so slight (averaging two transactions per account per month) that regulatory agencies have classified these funds as savings substitutes rather than transactions balances in the money supply definitions. The average family writes 16 checks per month on their main checking account (Avery, Elliehausen, Kennickell, and Spindt, 1986).

loans contribute 25%. Since loans to low risk, large corporate borrowers account for perhaps one-fourth of the revenue from commercial and other loans, these types of loans may contribute 6% of bank revenues. Together, these revenue sources—which are most likely to reflect price-taking behavior—account for around one third of bank revenues.[6] In contrast, real estate loans, installment and credit card loans, and commercial and other loans to small business and middle market corporate customers generate, respectively, 21%, 21%, and 19% of total bank revenues. As well, 3% of revenues are generated by direct fees on deposits while 4% are contributed by safe deposit, trust, and data processing services.[7] Thus, about two-thirds of total bank revenues are associated with services that reflect price-setting behavior.

As a result, we feel justified in altering the standard (indirect) revenue function specification where total revenues (R) are a function of exogenous output prices ($\underline{p}$) and input quantities ($\underline{x}$)--R($\underline{p}$,$\underline{x}$)--to a specification where banks are price takers only in the input market so that revenues are a function of exogenous output quantities ($\underline{y}$) and input prices ($\underline{r}$).[8] Here banks are assumed to maximize revenue for given output quantities and input prices by exercising their ability to chose output prices. The appropriate

[6]These data are from the large bank subsample of the Federal Reserve's Functional Cost Analysis annual survey, but also accord well with the less detailed revenue data from the Call Report, which covers all banks.

[7]Although only 3% of direct revenues are from fees on deposits, compensating balance requirements associated with loans, "due to" balances from other banks to pay for clearing services, and minimum balance requirements on deposit accounts generate indirect revenues which are not shown on a bank's income statement. In addition, the assignment of interest revenues to loans is arbitrary since loans could not be made without having deposits or purchased funds. In the case of interbank purchased funds, deposits sold to other banks generate direct revenues but deposits "sold" internally do not. Thus direct revenues attributed to deposits considerably understates the actual contribution of deposits to revenue.

[8]The alternative of an output distance function has been used by English, Grosskopf, Hayes, and Yaisawarng (1993) to investigate output allocative and technical efficiency for banks during 1982. The production relationships embodied in the output distance function, maximized over exogenous output levels, can alternatively be expressed in a revenue function. But since the revenue function dual to the distance function presumes price-taking behavior (Shephard, 1970; Färe, 1988), this approach will not permit the measurement of revenues associated with different mixes and levels of banking output quantities, which is what we require.

indirect revenue function is derived as the solution to the problem:

$$\max_{\underline{p}} \; R = \underline{p}'\underline{y} \qquad \text{s.t. } g(\underline{p},\underline{y},\underline{r})$$

where $g(\underline{p},\underline{y},\underline{r})$ is a transformation from output quantities ($\underline{y}$) and input prices ($\underline{r}$) into output prices ($\underline{p}$) that depends on production technology, market position, and demand conditions. Analogous to the production transformation h(•) above, the transformation g(•) represents the bank's pricing opportunity set and reflects the bank's assessment of its competitive position as well as its assessment of the willingness of its customers to absorb banking costs. Since customers may be willing to pay more for the opportunity to consume many different services at a single bank, we allow output prices to depend explicitly on a bank's output mix. Input prices will have a direct effect on output prices to the extent that banks price loans by marking-up the cost associated with purchased funds or core deposits. Input prices also serve as a source of information: the relatively low wages and low rental rates on capital paid by banks in particular geographic areas provide signals about customer income levels and price expectations in these areas, thus serving to constrain the available pricing options. The associated indirect revenue function is derived by solving the Lagrangian for the optimal choice for prices $\underline{p} = p(\underline{y},\underline{r})$. Since total revenues are given by output prices times output quantities, $\underline{p}'\underline{y}$, the indirect revenue function is given by:

$$R = \underline{p}'\underline{y} = p(\underline{y},\underline{r})'\underline{y} = R(\underline{y},\underline{r}).$$

Although our non-standard revenue function is seen to be supported theoretically and empirically, our main goal with the specification $R=R(\underline{y},\underline{r})$ is to use it as a practical method to determine the association of bank revenues with differences in the deposit/loan output mix.

The standard indirect revenue function, $R=R(\underline{p},\underline{x})$, is homogeneous of degree one in output prices: if we double output prices, holding input quantities constant, production will be unchanged and revenues will simply double. In contrast, our non-standard revenue function, $R=R(\underline{y},\underline{r})$, need not be homogeneous of degree one in output quantities. If output quantities, $\underline{y}$, doubled with input prices, $\underline{r}$, unchanged, output prices may change because they are determined in part from output quantities, reflecting consumer preferences to have more or less output provided in a single location. Thus there may be revenue scale economies as well as revenue scope economies.

We justify this characteristic of our revenue model in the following way. In practice, banking output first expands by raising the level of deposits and loans at each of one or a few original offices until the total banking firm reaches around $150 million in assets. After this, further expansion of the banking firm essentially proceeds by obtaining deposits and loans from new offices in new market areas, so the average size of a branch office remains relatively stable. Consequently, for all but the smallest banks, output expands by adding new offices rather than by adding more output to existing offices (see Benston, Hanweck, and Humphrey, 1982, for an empirical demonstration). Because bank customers obtain greater branch and ATM convenience at larger banks, expanding banks may be able to extract higher charges with the result that a doubling of output can lead to a more than doubling of revenue.[9] Thus we permit the data to indicate decreasing, constant, or increasing revenue economies of scale.

B. Choosing a Functional Form for the Revenue Function. Estimates of cost economies of scope have been found to be sensitive to the functional form specified and to the fact that data on specialized production in banking are difficult to obtain. In particular, scope estimation using the standard translog form, or its Box-Cox variants, compares poorly with the composite form developed by Pulley and Braunstein (1992). As similar difficulties would be expected in the estimation of revenue economies of scope, the composite form is also used here.

The composite model is described in detail in Pulley and Braunstein (1992) and Pulley and Humphrey (1993). It combines a quadratic structure for multiple outputs with a log-quadratic (translog) structure for input prices, linked through price-output interaction terms so that separability is not imposed.

[9] In addition, when customers move they are less likely to have to establish new relationships at a different bank if their current bank is large and geographically dispersed.

The general composite model for the revenue function is given by:

(1) $$R^{(\phi)} = \{[\alpha_0 + \Sigma\alpha_i y_i + \tfrac{1}{2}\Sigma\Sigma\alpha_{ij} y_i y_j + \Sigma\Sigma\delta_{ik} y_i \ln r_k] \cdot \exp[\Sigma\beta_k \ln r_k + \tfrac{1}{2}\Sigma\Sigma\beta_{kl} \ln r_k \ln r_l]\}^{(\phi)} + u$$
$$= \{F(\underline{y},\underline{\ln r}) \cdot \exp[G(\underline{\ln r})]\}^{(\phi)} + u,$$

where the superscript (ϕ) refers to the Box-Cox transformation $[(\bullet)^{\phi}/(1-\phi)]$ and represents an application of the "transform-both-sides" approach of Carroll and Ruppert (1984, 1988) to increase the flexibility of the model. When $\phi = 1$, the general composite model (1) reduces to $R = F(\underline{y},\underline{\ln r}) \cdot \exp[G(\underline{\ln r})] + u$ and when ϕ approaches 0, it reduces to $\ln R = \ln[F(\underline{y},\underline{\ln r})] + G(\underline{\ln r}) + u$. The application of the Box-Cox transformation to the dependent variable and to the entire right-hand side of the revenue function (excluding the error term) preserves the composite structure. This differs from the common practice of applying Box-Cox transformations to the individual right-hand-side variables. Since the underlying composite structure is not altered by the transformation, the results are easy to interpret.

C. Revenue Economies of Scope. The more familiar concept of cost economies of scope measures cost savings that result from producing a mix of outputs jointly relative to producing each output separately in a specialized firm. Cost economies of scope can arise from either spreading fixed costs over an expanded product mix or cost complementarities among output categories in production. Here we measure revenue economies of scope, which we take as an estimate of banks' ability to capture the benefit to customers of joint consumption of deposit and loan services.

Unlike cost functions, revenue functions are more likely to go through the origin, i.e., there is little reason to expect "fixed" revenues since revenues are likely to be zero when no output is produced/sold. Put differently, customers are not subject to nonlinear or two-part pricing at banks (Oi, 1971; Humphrey, 1984); there is no fixed charge or "entry fee"—designed to cover fixed costs, plus a unit price tied to variable expenses.[10] Typically, a single and separate price is assessed for each service used, although it can differ depending on volume and the customer's "relationship" with the bank in other service areas (reflecting a decision to cross-subsidize services). As a result, revenue economies of scope are expected to arise only from revenue complementarities associated with the joint provision of financial services. Revenue complementarities would be expected to exist to the extent that (1) consumers value the joint provision of financial services, i.e., they benefit from "one-stop" banking, (2) banks offering a broad mix of financial services are able to extract some of this added value to consumers through higher prices, and (3) competition among banks is not sufficient to eliminate the potential revenue gains.

Consumers value the joint provision of financial services when transportation and transaction costs involved in consuming, say, transaction account services, can also cover the consumption of a savings or loan service with the same supplier at the same time. A common example is overdraft protection, whether for business or consumers, as when a loan is automatically extended to a depositor who, because of checks written on a transaction account, would otherwise be in overdraft. Even personal record keeping is simplified when banks consolidate all deposit and loan transactions into a single monthly statement for depositors. In addition, for businesses provided cash management services, "sweep accounts" can be set up where idle demand deposit balances can be automatically drawn down and used, to reduce working capital loans. Further value arises to the extent that the transfer of funds between checking, savings, and loan accounts occurs at the same bank, permitting same-day crediting and debiting of accounts rather than the delayed availability of funds that results when monies are transferred between

[10]Some potential "fixed" revenues in banking include minimum balance requirements on deposit accounts and account maintenance fees payable regardless of the volume of account transactions, or commitment fees on loans whether or not a loan is taken down. But the size of these "fixed" revenues is dependent on the number of customers a bank has. Smaller banks have fewer customers and therefore generate a smaller total value of minimum balances, a lower level of account maintenance fee income, and a reduced amount of commitment fees. Consequently, what is a fixed revenue per customer is not a fixed revenue for the bank because the number of customers changes as the size of the bank changes.

accounts at different banks.[11] Banks that offer a broad mix of financial services should be able to capture some of this value from customers in higher fees or through increased revenues associated with higher account balances. In fact, to attract customers with larger (and more profitable) deposit balances, banks frequently give such customers preferential treatment in securing other banking services, such as personal and other loans, investment advice, and cash management. By these actions banks themselves contribute to the value derived from joint consumption of banking services.

Overall revenue economies of scope are defined analogously to cost economies of scope and are measured as the percentage increase in revenue received by banks when all financial services are provided jointly as opposed to when each service is produced and provided separately:[12]

$$\text{(2)} \quad RSCOPE = [R(y_1,y_2,\ldots,y_m;\underline{r}) - R(y_1,0,\ldots,0;\underline{r}) - R(0,y_2,0,\ldots,0;\underline{r}) - \ldots - R(0,\ldots,0,y_m;\underline{r})]/R(y_1,y_2,\ldots,y_m;\underline{r})$$

where R(•) refers to the composite specification of the revenue function in (1) above. In contrast to cost economies of scope, which exist if the costs of joint production are less than the combined costs of specialized production of each output, revenue economies of scope exist when the revenues associated with joint production <u>exceed</u> the revenues associated with specialized production of each output. Therefore, revenues from separate production are subtracted from revenues from joint production so that RSCOPE is positive when revenue economies of scope occur.

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[11]While wire transfers over the Federal Reserve's Fedwire funds transfer network will achieve same-day availability for funds transferred between accounts at different banks, this electronic network is not economical to use unless very large amounts of funds are being transferred.

[12]With the data at hand, it is necessary to assume that greater joint production of financial services by banks also reflects greater joint consumption by users of these services. This accords well with observed behavior but may attribute joint consumption to a few users who separately consume each financial service at a different bank.

Like cost scope economies, revenue economies of scope are based on extrapolated values of the revenue function corresponding to zero values of the outputs, for which there is little empirical support. We simply do not see banks that only produce commercial loans and have no deposits or have deposits but make no loans. Indeed, the legal definition of a bank is an institution that produces both demand deposits and commercial loans. To assess the sensitivity of our results to this problem, the RSCOPE formula is extended to include points of "quasi-specialized" provision of financial services where specialized firms also produce the proportion ϵ of the other outputs (Pulley and Humphrey, 1993). Consumption of the specialized banking service is also adjusted downward so that the total amount provided through all the quasi-specialized firms together equals the amount provided by the non-specializing firm jointly. Thus the firm specializing in the 1st output produces the output vector $\{1-(m-1)\epsilon\}y_1, \epsilon y_2, \ldots, \epsilon y_m$. The measure of "quasi" revenue scope economies is then computed as:

$$(3)\ QRSCOPE = [R(y_1,y_2,\ldots,y_m;r) - R(\{1-(m-1)\epsilon\}y_1,\epsilon y_2,\ldots,\epsilon y_m;r) - R(\epsilon y_1,\{1-(m-1)\epsilon\}y_2,\ldots,\epsilon y_m;r) - \ldots - R(\epsilon y_1,\epsilon y_2,\ldots,\{1-(m-1)\epsilon\}y_m;r)]/R(y_1,y_2,\ldots,y_m;r).$$

When $\epsilon=0$, QRSCOPE yields the RSCOPE measure. As ϵ rises from 0 to 1/m, we move from complete specialization ($\epsilon=0$), where each of m hypothetical banks produces the total amount of one of the m outputs, to the case where specialization is exhausted ($\epsilon=1/m$), and each bank produces 1/mth of all the m outputs jointly. In the empirical application below, there are 2 outputs—deposits and loans—evaluated at their sample medians. Thus as ϵ rises from 0 to 1/2, we move from complete specialization, where one bank produces only the median value of deposits and another produces only the median value of loans, to the case where specialization is exhausted and each bank jointly produces half of the median value of both deposits and loans.

Thus it is seen that at the limit of $\epsilon=1/m$, QRSCOPE compares the revenues from a hypothetical large bank producing all outputs jointly with the revenues from m smaller banks each producing $1/m^{th}$ of each output level of the larger bank. Since all of these banks have the same product mix, QRSCOPE at $\epsilon = 1/m$ becomes a measure of ray revenue scale economies for a banking firm. In our $m=2$ case, the large bank produces the median value of both deposits and loans while the two smaller banks each produce half of the median value of these outputs jointly. To illustrate the effects on our QRSCOPE measure as ϵ increases from 0 to 1/m, QRSCOPE is evaluated for eight values of ϵ (0.0, .0001, .001, .01, .1, .2, .35, .5). At the extreme values of 0.0 and .5, QRSCOPE represents pure scope and pure scale effects, respectively.

Applying the composite specification for the revenue function from (1) above to the RSCOPE measure in (2), we can decompose revenue economies of scope (RSCOPE) into fixed-revenue (RFIXED) and revenue-complementarity (RCOMP) components. These are measured by:

$$\text{(4)} \qquad \begin{aligned} \text{RSCOPE} &= -[(m-1)\alpha_0 - \tfrac{1}{2}\Sigma_i\Sigma_{i\neq j}\alpha_{ij}y_iy_j]/F(\underline{y},\underline{\ln r}) \\ &= [-(m-1)\alpha_0/F(\underline{y},\underline{\ln r})] + [\tfrac{1}{2}\Sigma_i\Sigma_{i\neq j}\alpha_{ij}y_iy_j/F(\underline{y},\underline{\ln r})] \\ &= \text{RFIXED} + \text{RCOMP} \end{aligned}$$

where $F(\bullet)$ is defined in (1). Fixed revenues are captured in the first term in (4) while revenue complementarities are included in the second.

When the α_0 term in (4) is positive, fixed revenues exist and RFIXED is negative, reducing revenue scope economies. The expansion of product mix away from complete specialization will reduce unit revenues since fixed revenue will now be spread over a broader output mix. Note that fixed revenue has the opposite effect on the scope economy measure from fixed cost in the measurement of cost scope economies.[13]

When the α_{ij} terms in (4) are positive, revenue complementarities exist and RCOMP is positive, contributing positively to revenue scope economies. Here marginal revenue from output i will rise as more of output j is produced, indicating that unit revenues rise with joint production. Again, this contrasts with cost scope economies where cost complementarities are derived from negative coefficients on the output interaction terms (indicating a reduction in the marginal cost of product i as more of product j is produced).

As discussed above, we expect RFIXED to be close to zero because pricing is typically not set to recoup separately the fixed and variable expenses associated with producing banking outputs. Revenues arise only from the provision of some positive level of financial services so α_0, the intercept of the revenue function and the primary determinant of RFIXED, should be relatively small or zero.[14] Revenue scope economies, if they exist, should therefore be due to revenue complementarities (RCOMP), not fixed revenue effects. A similar decomposition into fixed and complementarity effects is possible with the quasi-revenue scope economy measure QRSCOPE, with the same formula for QRFIXED and a more involved expression for QRCOMP.

III. Data and Estimation Issues.

As described above, we model revenues as a function of the output quantities and input prices.

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[13]For cost scope economies, the larger is fixed cost with specialized production, the greater the benefits from joint production as this fixed cost is spread over a broader output mix, lowering average cost. In contrast, the larger are fixed revenues from specialized production, the smaller will be the benefits from joint consumption as unit revenues fall as output mix is expanded, lowering measured revenue scope economies.

[14]As is reported below, a total of 36 different revenue models were estimated involving banks of different sizes, data from different time periods, two different measures of revenue, and banks on or off a revenue-efficient frontier. RFIXED was .01 or smaller in 20 of the models; never exceeded .06 in magnitude; and was statistically significant 10 times, 8 of which were negative values (a spurious result).

In the interests of parsimony in specification, banks are considered to produce two categories of financial services: payment, liquidity, and safekeeping services (y_1)—measured by the value of demand deposits plus savings and small denomination time deposits—and intermediation and loan services (y_2)—measured by the sum of the values of real estate loans, commercial and industrial loans, and installment loans including credit card loans).[15] While it would have been interesting to attempt to determine the value to consumers of joint consumption of transaction and time and savings deposits, the high correlation between these deposit categories makes this difficult. Disaggregation of the intermediation and loan services variable into its three subcategories was also not attempted because loan services are not usually jointly demanded. If there are synergies in joint consumption of banking services it is most likely to be evident between deposits and loans, rather than among the different types of loans that can be observed.

Using aggregate deposits and aggregate loans as our measures of the revenue-producing financial services of banks, we determine whether any reductions in user transactions costs associated with consuming these two services jointly translate into increased revenues for banks. However, we must include in our revenue function specification other sources of revenue differences among banks that do not reflect financial services provided to bank customers. A measure of "other assets"—securities, investments, vault cash—held by banks is included in our revenue function (with no interaction terms with the two output categories). Three input prices are specified: physical capital, labor, and funds (composed of core deposits plus purchased funds).[16]

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[15]Although off-balance-sheet activities are a growing category of bank assets, and are included in our revenue measure, they could not be included as a separate output category in the earlier data, since such information was not collected until recently. In any event, the most important off-balance-sheet component—loan commitments—is already proxied in our data on outstanding loans as over 70% of all commercial loans are made under a loan commitment. Thus growth in outstanding loans will also reflect the growth in revenues from loan commitments. Loan commitments and standby letters of credit are believed to account for the vast majority of the revenues from off-balance-sheet activities.

[16]The contriversy in the literature over whether deposits are an input or an output is not an issue here as both aspects are incorporated in our model (see Berger and Humphrey, 1992). That is, we specify the dollars in deposit accounts as reflecting the service flow associated with deposits and the

Two measures of total revenue are used. The first is the measure of total gross revenue reported by banks. A second measure, referred to as net revenue, is likely more appropriate for our stated goal of estimating revenue complementarities associated with the joint provision of deposits and loans. Gross revenue is adjusted for taxes, loan loss provisions, and extraordinary items to give a net revenue measure that reflects better the revenues actually realized by banks and, if not adjusted for, could obscure the revenue signals we wish to measure. Net revenue is equivalent to net income (a common measure of profits) plus total interest and operating expense.[17]

To assess our measures of revenue complementarities over time, we conduct three separate estimations for the years 1978, 1984, and 1990. This corresponds to the ex ante, ex durante, ex post periods associated with the interest rate deregulation of the early 1980s. Data on a panel of 683 U.S. banks—located in states that had some form of within-state branching during the 1980s and having assets over $100 million in 1988 dollars—are used in 1978 and 1984.[18] The sample was extended to 1990 by including an overlapping group of 626 banks for this final period.[19] The banks examined in this study account for almost 45 percent of all U.S. bank assets and represent the future of banking since, today, all states allow some form of within-state bank branching and all but one state allows interstate banking using holding companies.

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interest paid on deposits as part of the price of the funds input. In any event, recent studies treating deposits first as an input then as an output have found that estimates of cost scale economies and subadditivity are little affected either way (Hunter, Timme, and Yang, 1990).

[17]While it could be argued that net income or profit might serve our purposes, this is not the case. Net income—total revenue minus total costs and the above noted adjustments—captures both revenue and cost complementarities, and it is our goal to measure the former and exclude the latter. Aside from this concern, net income is negative for some banks in some years and this presents estimation difficulties.

[18]Bank mergers are treated as an expansion of assets and deposits for the acquiring bank in the year the merger occurs and thereafter. This is the only way an acquired bank enters the data set. Call Report data were used.

[19]The data set is the same as that used in Pulley and Humphrey (1993) in order to allow a consistent comparison between bank cost and revenue scope and scale economy results.

IV. Estimates of Fixed Revenues and Revenue Complementarities in Banking

For each of the three years—1978, 1984, and 1990—we estimated the revenue function in (1) using the bank data described above.[20] Revenue functions were estimated and scope economies determined using both the gross and net measures of revenue as the dependent variable. To allow for structural differences in the revenue relationships that might be related to size, separate revenue functions were also estimated in each year for "small" banks with assets in the range of $100-$500 million and "large" banks with assets greater than $500 million.[21] Estimates of revenue economies of scope were derived by computing the quasi-scope formula in (3) for eight values of ϵ (0.0, .0001, .001, .01, .1, .2, .35, .5). This covers the RSCOPE measure when $\epsilon=0$ and a measure of ray scale economies when $\epsilon=1/m$. The QRSCOPE estimates are decomposed further into fixed-revenue (QRFIXED) and revenue-complementarity (QRCOMP) effects.

Estimates of fixed revenues are presented in Table 1 followed by revenue complementarities in Table 2. Results using gross revenue and net revenue as the dependent variable are both reported, although the latter are preferred since other, non-scope effects on revenues are better controlled. Rows designated as "pooled estimation" contain results derived from a single revenue regression in each year in which the small bank and large bank data are pooled and represents our preferred model. Rows designated as "separate estimation" contain results obtained when separate revenue functions are estimated for the small bank and large bank samples and illustrates an alternative approach to the data. All of these measures are computed using the variable medians for the respective samples and only the results for $\epsilon=0$

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[20]A standard nonlinear-least-squares routine was used to estimate the general composite model for the revenue function in (1). As mentioned above, the revenue specification in (1) is augmented with the "other assets" variable. The second-order price terms created difficulties in estimation and were deleted from the model. Estimation procedures are described in Pulley and Braunstein (1992) and Carroll and Ruppert (1988).

[21]There were 340 small banks and 343 large banks in the samples for 1978 and 1984. The corresponding figures for 1990 were 233 and 393, respectively.

are shown in these tables.

As seen in Table 1, RFIXED was significantly different from zero in 8 out of 24 possible cases. But in all 8 cases, fixed revenues were significantly negative — a spurious result since fixed revenues, if they exist at all, would have to be positive. This result suggests some inaccuracy in extrapolating outside of the data set and, in any event, confirms our expectation that fixed revenues are not important in banking.

What was not expected was the result that revenue complementarities were also insignificantly different from zero in Table 2. Only in 1 case out of 24 was RCOMP significantly different from zero—for small banks in 1978—and this case indicated negative complementarity or revenue scope diseconomies. Overall, revenue complementarities are not present for either small or large banks; neither do they appear to have existed in the past before or after the interest rate deregulation of the early 1980s.[22]

In addition to the 24 pooled and separate estimations using gross and net revenue measures, we also conducted an estimation based on an approximation to a "thick" revenue frontier (following Berger and Humphrey, 1991). Banks in the small bank and large bank samples were ranked separately by the ratio of net revenue to total assets. Then small and large banks with the largest values of net revenues per dollar of assets in the top two quartiles were selected. These banks represent the 50% of banks that are the most revenue efficient. Pooled and separate revenue functions were then estimated for the screened small bank and large bank samples, and RSCOPE values were derived using the variable medians for the screened samples. Results from this procedure are shown as estimates from a "Frontier

[22]In general, our results indicate considerably more bank-to-bank variability in revenue structures for small banks, giving us less confidence in the separate estimation results for small banks. The larger standard errors corroborate this finding. When revenue complementarities are computed for small banks from the pooled revenue regressions, these irregularities are attenuated. This holds for both the gross and net revenue regressions.

Model" in Tables 1 and 2.[23] Overall, the results for the screened samples consisting of the most revenue efficient banks are quite similar to the results obtained for all banks; the fixed revenue effect was statistically significant only in 1984 and no significant revenue complementarities were observed. In sum, for the total of 36 estimations shown in the tables, revenue economies of scope appear to be nonexistent.

Table 3 provides some results on revenue scale economies. Recall that as ϵ approaches $1/m$ (= .5 for our models since m, the number of outputs, is 2), the QRSCOPE formula in (3) compares the revenues associated with one bank's joint provision of the medians of both outputs with the revenues from two other banks, each jointly producing one half the median value of each output. If there are no revenue ray scale economies, the value of QRSCOPE for $\epsilon = .5$ would be zero. Values greater than (less than) zero indicate revenue scale economies (diseconomies). Estimates of revenue ray scale economies (using net revenue) are given in Table 3 for both the separate and pooled estimations using data from small and large banks. In the separate estimations, revenue ray scale economies are uniformly small and statistically insignificant. But in the pooled estimations, ray revenue economies of scale for 1978 and 1984 were 4 percent at small banks and 1 percent at large banks and significant. In 1990, these economies were reduced to 1 percent and zero, respectively, and were not significant. Thus if there are revenue ray scale economies, they apply primarily to small banks, a result similar to the results of most studies of cost ray-scale economies.

Table 4 presents an analysis of quasi-revenue scope economies for different values of the specialization parameter ϵ. In the upper portion of this table (again using net revenue) we report the revenue complementarity (RCOMP) estimates. The fixed revenue effect (RFIXED) does not change with different ϵ values and was reported earlier in Table 1. Although results are only shown for 1990, their pattern for the other years is quite similar. As epsilon increases, the product mix becomes less and less

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[23] The larger standard errors, particularly for the small banks, reflect the fact that the variability within samples is reduced by the screening procedure.

specialized; therefore, the measured revenue gains from specialization should diminish as well. And this is exactly the pattern we observe in Table 4. However, none of these revenue complementarity values is significantly different from zero.

Parameter results for our preferred (net revenue) model for the pooled estimation in 1990 are presented in the Appendix. Overall, the fit achieved using our composite revenue function is good—the values of R* are generally .95 or higher for all models in all years. For our purposes, however, a more telling measure of model adequacy is whether the marginal revenues associated with each of the two outputs are positive. In particular, our revenue complementarities, which are related to second derivatives, can only be trusted if the first derivatives—the marginal revenues—are of the theoretically correct (positive) sign. In the lower portion of Table 4 violations of this condition are reported for the 1990 net revenue measure as the percentage of bank observations for which marginal revenue is negative for at least one of the two outputs. The estimated revenue function for the pooled data satisfies this condition most effectively, (Similar patterns are observed for the other years with the exception that the 32.3% violation rate for large banks in 1990 for the separate estimation is by far the largest achieved by any model in any year). Virtually all of the violations occur for our deposit output variable, composed of demand deposits and time and small savings deposits. That this variable may be associated with violations is not altogether surprising since this output category directly accounts for only about 3.5% of total revenues although, as noted above, its indirect contribution—which cannot be determined from existing data—is much greater.

V. Conclusions.

In banking, synergies can arise from the joint provision of financial services in two ways. First, costs can be reduced through joint production (measured from cost economies of scope) or, second, revenues can be increased through joint consumption (measured from revenue economies of scope). The cost effects of joint production have been intensively investigated but, once the problems inherent in the data and in the translog functional form used earlier are addressed, only small cost economies of scope of from 4 to 5 percent of total costs were found to exist between bank deposits and loans.

In this paper, we investigate for the first time the synergies arising from joint consumption of deposit and loan services and quantify these effects using a measure of revenue economies of scope. Our purpose is to determine if bank revenues are larger when deposits and loans are provided jointly rather than separately, answering the question of whether or not consumers pay for one-stop banking. Such an analysis may also be indicative of the benefits we may expect from an expansion of banking powers into insurance, real estate, underwriting, etc. We find no evidence of statistically significant consumption synergies from fixed revenues or revenue complementarities among either small or large banks over 1978-1990. Nor do we find significant revenue scope economies among the set of revenue efficient banks that lie closest to a revenue frontier. Lastly, we find only weak evidence of significant revenue ray scale economies, and then primarily for small banks.

Combining the revenue scope results reported here with earlier cost scope findings suggests that synergies between bank deposits and loans are small and concentrated in joint production, rather than joint consumption. The common sense of this result is that consumers do not pay a premium to banks for the provision of retail transaction and savings account services jointly with bank mortgage, auto, installment, or credit card loans. Similarly, businesses do not pay a premium to consume transaction and cash management services jointly with working capital, commercial, real estate, and other loans. Apparently, the extra transactions and search costs involved for consumers and businesses in having their transaction, savings, and loan services met by bank, thrift, finance company, or nonbank financial institutions separately is not of great importance or the value of it has been competed away by banks and is captured by the users of banking services. That is, consumers may or may not value one-stop banking, but in either case they apparently do not have to pay for it. This result for the provision of current banking services—where benefits are most likely to occur if they occur at all—is suggestive of similarly small synergies from an expansion of banking powers into new service areas.

Appendix: Table A1
Revenue Function Coefficient Estimates[a]
Net revenue specification, 1990 data (pooled)
(Asymptotic standard errors in parentheses)

Coefficient	Variable	Estimated Value
ϕ	Transformation Parameter	-.143* (.040)
α_0	Constant	54.29 (71.79)
α_{OA}	Other Assets	.011 (.908E-02)
α_1	Deposits	.022 (.016)
α_2	Loans	.103 (.082)
α_{11}	Deposits^2	-.777E-09 (.921E-09)
α_{22}	Loans^2	-.124E-09 (.291E-09)
α_{12}	Dep*Loans	.415E-09 (.553E-09)
δ_{11}	Dep*ln(P_{Labor})	-.161E-02 (.220E-02)
δ_{12}	Dep*ln($P_{Interest}$)	-.666E-02 (.835E-02)
δ_{13}	Dep*ln($P_{Capital}$)	-.663E-02 (.452E-02)
δ_{21}	Loans*ln(P_{Labor})	-.838E-02 (.667E-02)
δ_{22}	Loans*ln($P_{Interest}$)	.531E-02 (.613E-02)
δ_{23}	Loans*ln($P_{Capital}$)	-.011 (.865E-02)
β_1	ln(P_{Labor})	.423* (.106)
β_2	ln($P_{Interest}$)	.800* (.134)
β_3	ln($P_{Capital}$)	.572* (.165)

[a]As is frequently the case with second-order (quadratic or log-quadratic) output specifications, it is difficult to identify precisely individual first- and second-order output coefficients, as well as output and input price interaction terms. However, as our results indicate, functions of those coefficients--such as economies of scope--can be identified with greater precision since correlations among coefficients are explicitly taken into account in the formulas for (approximate) asymptotic standard errors.

*Statistically significant at the .05 level.

Table 1
Estimates of Fixed Revenues RFIXED
(Asymptotic Standard Errors in parentheses)

TOTAL REVENUE MEASURE

	Small Banks			Large Banks		
	1978	1984	1990	1978	1984	1990
Pooled Estimation of small and large banks[a]	-.05* (.01)	-.03* (.01)	-.01 (.01)	-.01* (.00)	-.01* (.00)	-.00 (.00)
Separate Estimation of small and large banks[a]	.02 (.05)	-.02 (.02)	.04 (.03)	.00 (.00)	-.03 (.02)	-.01 (.01)

NET REVENUE MEASURE

	Small Banks			Large Banks		
	1978	1984	1990	1978	1984	1990
Pooled Estimation of small and large banks[a]	-.04* (.01)	-.04* (.01)	.01 (.01)	-.01* (.00)	-.01* (.00)	.00 (.00)
Separate Estimation of small and large banks[a]	.06 (.06)	-.01 (.03)	.04 (.03)	.00 (.01)	-.03 (.02)	.01 (.01)
Frontier Model:[b]						
pooled estimation	.03 (.02)	.02* (.01)	-.01 (.01)	-.01 (.00)	.01* (.00)	-.00 (.00)
separate estimation	-.02 (.06)	.03 (.03)	.03 (.03)	-.01 (.01)	.01 (.02)	.01 (.01)

Table 2
Estimates of Revenue Complementarities RCOMP
(Asymptotic Standard Errors in parentheses)

TOTAL REVENUE MEASURE

	Small Banks			Large Banks		
	1978	1984	1990	1978	1984	1990
Pooled Estimation of small and large banks[a]	-.00 (.01)	.00 (.00)	.00 (.00)	-.00 (.03)	.00 (.01)	.00 (.01)
Separate Estimation of small and large banks[a]	-.45* (.15)	.05 (.09)	.06 (.17)	.00 (.00)	.00 (.01)	.00 (.00)

NET REVENUE MEASURE

	Small Banks			Large Banks		
	1978	1984	1990	1978	1984	1990
Pooled Estimation of small and large banks[a]	.01 (.01)	-.00 (.00)	.00 (.00)	.02 (.02)	-.00 (.01)	.02 (.02)
Separate Estimation of small and large banks[a]	-.25 (.15)	.14 (.10)	.27 (.20)	.01 (.00)	.00 (.01)	.00 (.00)
Frontier Model:[b]						
pooled estimation	.01 (.01)	-.00 (.01)	-.00 (.01)	.03 (.04)	-.01 (.03)	-.02 (.02)
separate estimation	-.55 (.33)	.15 (.14)	-.14 (.39)	.06 (.04)	-.01 (.03)	-.01 (.01)

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* Significantly different from zero at the .05 level.

a. Revenue complementarities are computed at respective pooled or separate bank sample medians.

b. Results based on first screening the small and large bank samples to include only the "revenue efficient" banks. Banks are ranked based on net revenue per dollar of assets, and half of the banks in each of the small and large bank samples—those with the smallest values of net revenue per dollar of assets—are excluded. Revenue complementarities are computed at respective pooled or separate bank medians for the screened samples.

Table 3
Revenue Scale Economies
(Ray-Scale estimates based on QRSCOPE evaluated at $\epsilon = .5$, standard errors in parentheses)[a]

NET REVENUE MEASURE

	1978	1984	1990
Pooled Estimation			
Small Banks	.04*	.04*	.01
	(.01)	(.01)	(.01)
Large Banks	.01*	.01*	-.00
	(.00)	(.00)	(.00)
Separate Estimation			
Small Banks	-.02	.02	-.01
	(.03)	(.02)	(.01)
Large Banks	-.00	.03	-.01
	(.00)	(.02)	(.01)

* Significantly different from zero at the .05 level.

[a] Positive (negative) values (when multiplied by 100) indicate the percentage amount of revenue ray scale economies (diseconomies).

Table 4
Values of (Quasi-) Revenue Complementarities (QRCOMP)
For Various Values of Epsilon (ϵ)
(Results for 1990)[a]

NET REVENUE MEASURE

	Pooled Estimation		Separate Estimation	
Values of ϵ	Small Banks	Large Banks	Small Banks	Large Banks
0.00	0.003	0.019	0.266	0.001
0.0001	0.003	0.019	0.266	0.001
0.001	0.003	0.019	0.265	0.001
0.01	0.003	0.018	0.257	0.001
0.10	0.002	0.011	0.179	0.001
0.20	0.001	0.005	0.112	0.000
0.35	-.000	-.000	0.046	0.000
0.50	-.001	-.002	0.025	0.000

[a] Fixed revenue effects (RFIXED) do not vary with ϵ values and were reported earlier in Table 1 (and were, respectively, -.04, -.01, .01, and -.00; none are significant).

Percentage of observations for which
the computed marginal revenue associated
with at least one of the outputs is negative

Pooled Estimation	2.4%
Separate Estimation	
Small Banks	16.3%
Large Banks	32.3%

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