The productivity of the banking sector: integrating financial and production approaches to measuring financial service output

DENNIS FIXLER Bureau of Labor Statistics
KIMBERLY ZIESCHANG International Monetary Fund

1. Introduction

Measurement of output for services in general, and for financial services in particular, is a challenge. In the context of the national accounts, there is a significant component of financial services output for which payment is made implicitly through the spread between the asset interest earned and liability interest paid by financial institutions. Although it is reasonably clear that the total value of output of financial institutions includes the net interest income on financial asset and liability products (such as loans and deposits for banks) plus explicit service charges, there are unsettled issues concerning the correct allocation of the net interest component across business (intermediate consumers) versus households, government, and the rest of the world (final consumers).

Recent revisions in national accounting rules for banking, together with the developments since the late 1970s in the microeconomic theory of financial firms and of household consumption of financial asset services (Diewert 1974, Barnett 1978, Donovan 1978, Hancock 1985) represent important developments in our understanding of the economics of and measurement possibilities for the banking sector. Central to, and an important contribution of, this last line of literature has been the characterization of the prices of individual service products in terms of the Barnett (1978)-Donovan (1978) user cost of money. These user cost prices are simple functions of items, such as interest rates, that can be measured in financial market transactions. The principal practical economic measurement issues these developments have illuminated are twofold:

- How the total value of output of financial business should be allocated between intermediate and final consuming sectors of the economy; and,
- How movement in the total value of output of financial business should be divided into price and volume components.

By and large, the input side of financial services business is straightforward, characterized by purchases of primary factor services of labour and capital

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and purchases of produced goods and services. The exception to this is the consumption of financial services for own use, or by other establishments in the same sector, which is subject to the same measurement issues as output.

Fixler and Zieschang (1991) discussed these issues in detail, and provided background on the historical treatment of financial business in the national accounts. More recently, a consortium comprising the United Nations, the World Bank, the International Monetary Fund, the Organization for Economic Cooperation and Development, and the European Statistical Agency issued an updated international standard system of national accounts. The *System of National Accounts 1993* (*SNA93*) recommends the calculation of imputed sectoral uses of financial services—termed Financial Intermediation Services Indirectly Measured or *FISIM*—according to a user cost principle.

Concomitant with solving, at least in principle, the two major measurement issues above, a unified measurement framework for financial services can be based on the following equalities:

The monetary and asset aggregate = the real gross product of financial services = the volume component of total output value; and,

The output price index (producer price index) of financial services = the price component of total output value.

Fixler and Zieschang (1992a) and Fixler (1993) applied an user cost based financial framework to the measurement of output and the construction of output price indexes. Fixler and Zieschang (1997) assessed the implications of the above equalities for constructing a consistent system of financial sector statistics that illuminates the transmission mechanism of central bank monetary policy actions, such as open market operations, from the financial to the real sectors.

Productivity, of course, tracks output divided by input, and the implications for financial services productivity measurement of the above developments are immediate. Fixler and Zieschang (1992b) provided a methodology, based on the exact index number results of Caves, Christensen, and Diewert (1982), for financial services productivity measurement within this new framework. A key feature of the framework is the endogenous assignment of financial output-input status to the various products provided by a financial firm. Historically, the treatment of deposit products has been the subject of considerable debate. Should they be treated as inputs because the attending funds are inputs to loan-making, or should they be treated as output because of the transaction, recordkeeping and safekeeping services that they provide? In the user cost framework the sign of the user cost provides the answer: a negative sign indicates an output status and a positive sign indicates input status. The assigned status is data driven, as changes in interest rates can alter the status of a particular deposit product. However, for deposits as a whole, experience with the data shows they are consistently outputs under the user cost approach.

Fixler and Zieschang also provided for the incorporation of additional information on the characteristics of financial services into productivity (and, by implication, price and quantity) measures, based on earlier work (Zieschang 1985, 1989). This leads to another issue:

Since the nature of the financial services sale transaction expresses the prices of financial services as rates per unit of currency on account in a particular financial product, such as a deposit account, in what sense is the dual volume measure 'real,' since it indicates movements in nominal currency values held or owed by product?

Standard practice in the literature characterizing the price of financial product services in terms of the user cost of money has been to find a commodity price index to further deflate the volume component to obtain a 'real' output indicator. By implication, therefore, the result from deflating financial institution sales by a user cost price index has been taken by user cost analysts not to be a volume index. Fixler and Zieschang (1991; 1992a,b) departed from this practice. Our reasoning rests on the nature of the sale transaction between the bank and its customers, which (other than those services having separate, explicit charges) characterizes the purchase price as a dimensionless rate on an amount owed or on deposit measured in currency units. However, we believe equally strongly that accounting for movements in services characteristics associated with these service purchase transactions is critical to obtaining a defensible banking services volume measure. These characteristics would include the usual items such as number of accounts of each type serviced by type and details as well as the less obvious average account size, which is generally inversely associated with the user cost price of both asset and liability service products. This latter 'quantity discount' characteristic of financial services pricing will offset output growth that is accompanied by an increase in average account size. Since average account size is directly related to the rate of increase in goods and services prices generally, this 'quality' modifier will have a similar effect to the commonly-applied econometric practice of deflating nominal account values by a general price index.

Aside from national income and product account concerns, there are some particular reasons for examining the productivity of the providers of financial services. First, as shown in Fixler and Zieschang (1992b), from measures of the relative productivity (efficiency) of individual institutions, inferences can be drawn about the distribution and central tendency of the relative efficiency of institutions in the financial services industry for given time intervals. Second, temporal movements in the productivity of institutions have implications for aggregate technological change and capital accumulation over time. Both of these dimensions are important from the perspective of examining the money transmission story. An unmeasured change in either the distribution of individual institution productivities or in the prevailing transactions technology (i.e., e-cash, Automatic Teller Machines, etc.) will affect the money multiplier relating a change in reserves to its *effective* monetary services impact.

The relationship between the output and performance of the financial services sector and monetary policy is also linked to the measurement of the monetary aggregate at a given state of technology. In fact, the best developed area of application of the user cost principle to financial services is in the measurement of monetary aggregates that was pioneered by Barnett (1978, 1980). A preponderance of results favour the use of user-cost-weighted indexes of monetary components over the simple sum aggregates that have traditionally measured monetary stocks. In general, the broad 'Divisia' user cost weighted aggregates have a more intuitive and reliable relationship with the associated aggregate user cost prices, and greater explanatory power in models of the demand and supply of money and its relationship to aggregate production and consumption. See Anderson et al. (1996) for a review of this now substantial literature.

The remainder of the paper is organized in the following way. We briefly revisit the conceptual framework for a financial firm considered in Hancock (1985) and Barnett (1987). We consider the price of financial services, the *SNA93* accounting framework for gross value of output, and output and price measurement in the financial firm context. We construct benchmark rates for the 1993-1996 period using data from the Federal Deposit Insurance Corporation (FDIC) on the maturity structure of assets and liabilities of commercial banks, and data on Treasury security interest rates. We discuss their use in constructing an output index for commercial banking. We then examine the implications for the financial services output measure implied by the Divisia/FISIM framework of accounting for some measurable or potentially measurable service characteristics. In this vein, we focus specially on the treatment and impact of average account size and number of accounts on the volume measure, providing some empirical evidence from the FDIC data on the sizes of these impacts on the user cost price and their probable effects on components of the services volume measure. Where possible, we examine the empirical issues raised under each topic by reference to the available data.

2. Conceptual framework

2.1 Flows of income and expense and stocks of assets and liabilities: financial products within the accounting structure of a U.S. banking firm.

A financial firm is viewed as transforming nonfinancial inputs x into financial service products y. The collection of products y is measured in monetary units as the amounts in various asset and liability accounts.[1] We write $y = (y_A, y_L)$ to indicate the asset and liability components of the financial product vector. There are some 30 products, elements of our output vector y, that can be identified in the principal U.S. bank regulatory data set, the quarterly Reports of Condition and Income (Call Reports) collected by the Federal Deposit Insurance Corporation, the Comptroller of the Currency, and the Board of Governors of the Federal Reserve System. Data are available on these items for both interest/noninterest income/expense flows and the size of the stock of funds in the associated account.[2] They include the following principal categories of assets and liabilities:

Liabilities	Assets
Deposits	Loans and leases
Borrowed money and limited-life preferred stock	Securities Currency and balances due from depository institutions
Mortgages and capitalized leases (secured debt) Common and perpetual preferred stock (equity)	Premises and fixed assets Other real estate owned Investments in unconsolidated subsidiaries and associated companies Intangible assets Other assets

In this paper, we include liability and asset items in the output vector y down to the narrow solid line shown in this T-account as productive of intermediation services. We are concerned here and elsewhere with the linkage between the monetary and credit aggregates that are the focus of monetary policy, and the real sector of the economy. We therefore take a broad view of the aggregates of money and credit yielding financial intermediation services, in line with the trend in the monetary aggregation literature. At this writing, and in line with our treatment of banks in the national accounts in an earlier paper (Fixler and Zieschang 1991), the prevailing view among national accounts experts is to adopt a narrower view of service-yielding aggregates, including only deposit liabilities and loan and lease assets in y, the items shown above the dotted line in the T-account. For a comprehensive discussion of these asset and liability scope questions, as well as other issues in applying the *SNA93* reference rate methodology, see Begg, Bournay, Weale, and Wright (1996). Our scope preferences for commercial bank products in this paper are most similar to those attributed to Bournay (1993) in the aforementioned reference.

2.2 The price of financial services

The Barnett/Donovan value or user cost price per currency unit of monetary services for output y_i is given by

$$p_i = \begin{cases} p_{Ai} = h_i - \tilde{n}, & \text{if the item is an asset} \\ p_{Li} = \tilde{n} - h_i\,, & \text{if the item is a liability} \end{cases} \tag{1}$$

where

$$h_i = \begin{cases} h_{Ai} = r_i + s_i + \check{\partial}_i - d, & \text{if the item is an asset} \\ h_i = r_i - s_i\,, & \text{if the item is a liability.} \end{cases}$$

The *asset* holding income rate *h* is the sum of the interest rate received on the item *r* plus the directly levied service charge rate *s* and the expected appreciation rate ð, minus the rate *d* at which loan losses are taken. The *liability* holding cost rate is the sum of the interest rate paid r-- principally on deposit accounts--net of the directly-levied service charge rate *s*.[3] The scalar variable ñ is the Barnett *benchmark rate*, also known as the Hancock *opportunity cost rate of money*, and the *SNA93*'s *reference rate*.

2.3 The gross value of financial services output

The value of sales for the firm at user cost prices is

$$\begin{aligned} S &= p'y = p_A' y_A + p_L' y_L \\ &= (r_A + s_A - d - ñ1)'y_A + (ñ1 + s_L - r_L)'y_L + ð'y_A \\ &= [(r_A + s_A)'y_A - (r_L - s_L)'y_L] - ñ(1'y_A - 1'y_L) + (ð - d)'y_A \\ &= [(r_A' y_A - r_L' y_L] + [s_A' y_A + s_L' y_L] - ñ(1'y_A - 1'y_L) + (ð - d)'y_A \qquad (2) \end{aligned}$$

where the notation l′*y* refers to the sum over the elements of *y* by premultiplying by a vector of ones of appropriate dimension.

In the *SNA93* framework, the value of financial services production is given by the first three terms in equation (2), the first of these being net interest, and the second being explicit service charge income. The third term vanishes if assets and liabilities balance, which is identically true if all assets and liabilities are considered, but will not necessarily be true if services are thought to be associated with selected asset and liability items, as we have described above. Financial services *indirectly* measured, or FISIM, are the sum of terms one and three.[4,5] The fourth term $(ð - d)'y_A$, representing asset appreciation less losses, is accounted for in the *SNA93*'s *Other Changes in Assets* accounts and is not included in the value of financial services output; a long-held national accounting convention regarding output valuation for all industries.[6] Although it is arguable from a conceptual point of view within the user cost framework, we will adopt the *SNA* convention for present purposes and exclude *Other Changes in Assets* items from the value of financial services output.

2.4 The production function and multifactor productivity

The joint production function of financial services in output distance function form is given by

$$D(x,y_A y_L) = D(x,y) = [sup_è\{è:èy \text{ is feasible for inputs } x\}]^{-1}.$$

The output distance function also can be interpreted as the output efficiency function following Shephard (1970) and the economics and operations research literature on efficiency and productivity measurement.[7] Following Caves, Christensen, and Diewert (CCD, 1982), the index of multifactor productivity can be defined in an output-homogeneous form as a ratio of distance functions:

$$p^{i-1,t} = \frac{D(x^t, y^t)}{D(x^{t-1}, y^{t-1})}.$$

3. Implications of the financial firm model for economic statistics and productivity

3.1 Monetary and credit aggregates=output

Financial services output within the financial firm framework is dealt with in Hancock (1985), Barnett, Hinich, and Weber (1986), and Barnett (1987). Bank output is multidimensional. In this case, it is a vector whose elements are an institution's holdings of financial assets, such as loans and securities, and liabilities such as deposits. The inputs are the usual primary factors of labour and capital, as well as purchases of items produced by other industrial sectors.

The output quantity index of financial services is determined according to Malmquist (1953) and Moorsteen (1961) as

$$Q^{t-1,t} = \frac{D(x, y^t)}{D(x, y^{t-1})}, \tag{3}$$

which is the ratio of output distance or efficiency functions comparing two output vectors while holding inputs constant at a reference level. If the distance function is translog, as

$$\begin{aligned}\ln D'(x, y_A, y_L) &= \ln D'(x, y) \\ &= \acute{a}_0^t + (\acute{a}_x^t)'\ln x + (\acute{a}_p^t)'\ln y + \ln x'\ddot{E}_{xy}\ln y + \ln x'\ddot{E}_{xx}\ln x + \ln y\ddot{E}_{yy}\ln y\end{aligned}$$

which is a second order approximation at a point to any twice differentiable D, then the output quantity index is exactly[8]

$$Q^{t-1,t} = \exp\left[\frac{1}{2}\left(w_A^{t-1} + w_A^t\right)'\left(\ln y_A^t - \ln y_A^{t-1}\right) + \frac{1}{2}\left(w_L^{t-1} + w_L^t\right)'\left(\ln y_L^t - \ln y_L^{t-1}\right)\right] \tag{4}$$

where

$$w_{Aj}^t = \frac{p_{Aj}^t y_{Aj}^t}{(p_A^t)' y_A^t + (p_L^t)' y_L^t} \text{ and } w_{Lk}^t = \frac{p_{Lk}^t y_{lk}^t}{(p_A^t)' y_A^t + (p_L^t)' y_L^t}.$$

Examination of equation (4) reveals that the quantity index is the product of a *broad Divisia financial asset aggregate* and a *broad Divisia monetary (financial liability) aggregate*.[9] There is a large literature on the use of these aggregates and various subaggregates for monetary policy, beginning with Barnett's seminal 1980 article. Even though both aggregates are relevant to the question of how monetary policy is transmitted into the real sector of the economy, the greatest focus in recent years has been on the liability (deposit) products, plus currency in circulation.

3.2 Financial product aggregates and multifactor productivity

Under the assumption of the translog form for the output distance function, CCD (1982) derived the following exact index number result:

$$P_F^{t-1,t} = \left[\frac{D^{t-1}(y^t, x^t)}{D^{t-1}(y^{t-1}, x^{t-1})} - \frac{D^t(y^t, x^t)}{D^t(y^{t-1}, x^{t-1})} \right]^{\frac{1}{2}} = \frac{Q}{X}$$

where Q is the Törnqvist output index in equation (3) and X is a Törnqvist-type input index with exponential weights depending on the elasticity of scale in addition to the input cost shares.[10]

The available input data on banks from the Call Reports include: Premises and fixed assets, Full time equivalent employees, and Other noninterest expense (see Fixler and Zieschang 1992b). Clearly, there is work to do in the first and last categories. Capital is measured at book value, a less than optimal quantity measure for that input, and there are no specific deflators for Other noninterest expense to obtain a volume measure for that set of inputs. Nevertheless, the greatest challenge for this sector lies in the output aggregate Q, both in productivity measurement, and in the linkage between the real accounts and the monetary accounts. We therefore direct our attention in the remainder of this paper to output measurement.

4. Implementing the output measurement framework for commercial banks

4.1 The reference rate

Clearly, the linchpin of an integrated approach to macroeconomic measurement of financial services built around the Barnett/Donovan rental price of money concept is the opportunity cost rate/benchmark rate/reference rate ñ. Practical considerations require that this benchmark be readily measurable from observed deposit, money market, security, and asset rates. United States GDP data currently include a type of FISIM imputation which effectively takes the benchmark rate as the average rate earned on all financial assets of financial institutions (Fixler and Zieschang 1991), and improperly includes returns on risky assets.

Barnett (1978) focused on the measurement of the transaction services demanded by households and supplied by the deposit liability items also appearing in the financial firm production model above, as well as currency in circulation. He proposed that the benchmark rate be computed in effect as the maximum of a set of rates including treasury securities and the Baa corporate bond rate. The position taken by the *SNA93* (paragraph 6.128) on determining the reference rate is that:

> "The reference rate to be used represents the pure cost of borrowing funds--that is, a rate from which the risk premium has been eliminated to the greatest extent possible and which does not include any intermediation services. The type of rate chosen as the reference rate may differ from country to country but the inter-bank lending rate would be a suitable choice when available; alternatively, the central bank lending rate could be used."

The *SNA93* thus takes a less sharply framed view of determining the benchmark rate, the test being that the corresponding asset be essentially credit risk free and offer no intermediation services. Clearly, some consensus will need to be reached on how the benchmark rate is to be determined between the statistical offices usually responsible for prices and national accounts on the one hand, and, on the other hand, the central bank which usually compiles interest and monetary stock data.

Our suggestion would compile the reference rate(s) for FISIM from a single source of interest rate data--the rates on U.S. Treasury securities of various maturities--in concert with data on the maturity structure of bank portfolios of loans and deposits, to arrive at (1) a national average reference rate, and (2) if possible, reference rates specific to the maturity structures of the asset and liability positions of banks with each consuming sector. Some of the data for compiling these statistics exist for the United States. See table 1 in Fixler and Zieschang (1998) for a brief description of the available maturity data for the most recent five years.

Aside from its being operational with available data, we believe this approach to the reference rate integrates with the conceptual framework. The reference rate so calculated would have no risk premium built-in, but would reflect the maturity structure of bank asset portfolios. It would be an estimate of the rate of return should the current asset portfolio of the system be converted entirely to government securities, as if all banks operated as narrow banks, facilitating transactions, but not originating loans.

4.2 Some empirical evidence

Table 1 depicts the construction of the reference rate. The first three panels give the portfolio percentages by maturity for total produced assets, as well as for the loan and security components. These panels show a rather stable maturity composition of bank assets at this high level of aggregation, with the greatest concentration in the shortest, zero to three month maturity, followed by the middle, one to five year category. A set of treasury security rates of approximately similar maturities to the asset breakdowns in the Call Reports are shown in the fourth panel. The fifth panel shows the reference rate overall, and for loans and securities individually, calculated as a maturity-weighted average of riskless security rates. The next line of the table provides the one year Treasury bond rate, used in Fixler and Zieschang (FZ 1997), for comparison purposes. Finally, the sixth and last panel of table 1 shows average interest rates and user cost prices for three products--deposits in domestic offices, commercial and industrial loans, and loans to farmers--that we will revisit in our discussion of quality effects below. Of interest is that all three have consistently positive user cost prices, and hence output status, over the four years.

Also of note is the fact that the preferred overall reference rate is higher than the 1 year bond rate for all four years. On the other hand, the benchmark rate for loan and lease products is lower than the overall rate and almost the same as the 1 year bond rate, reflecting their relatively short maturity structure.

4.3 Gross output quantity and price indexes

FZ (1997) compute Törnqvist asset and liability product index subcomponents and then take the product of them to obtain a Törnqvist financial service output quantity index as in equation (4). An implicit price is derived by dividing the quantity index into a normalized series for aggregate bank service charge and net interest income. The study examines the movement in output and prices for financial services without considering service characteristics for the historical period from 1961 to 1994. The data come from the Flow of Funds compiled by the Federal Reserve and the Reports of Income and Condition compiled by the Federal Deposit Insurance Corporation (FDIC). The banking sector defined there consists of US chartered commercial banks. For this sector the majority of the Flow of Funds data come from changes in the levels of the FDIC data.

Six financial service products are identifiable in the Flow of Funds. The four asset products are: Cash and Balances Due from Depository Institutions, Loans, Securities and Federal Funds Sold and Securities Purchased. The two liability products are: Deposits and Federal Funds Purchased and Securities sold.

To construct the user cost prices for each of these products a benchmark rate must be specified along with unit value interest rates for each of the products.[11] FZ (1997) use the one year constant maturity Treasury bond rate.[12] This was selected because it is considered riskless and represents an opportunity cost for

TABLE 1 Determining the benchmark rate bank portfolio maturity weights by financial product

Description	**Effective Treasury security maturity**	**199306**	**199406**	**199506**	**199606**
Percentages: overall loan and security portfolio					
Assets with maturity of at most 3 months		38.86%	38.55%	40.86%	40.23%
Assets with maturity of greater than 3 months and less than 1 year		15.90%	16.17%	15.98%	16.11%
Assets with maturity of greater than 1 year but less than five years		27.01%	27.08%	26.10%	25.52%
Assets with maturity greater than five years		18.23%	18.20%	17.06%	18.14%
Percentages: loan portfolio					
Assets with maturity of at most 3 months		48.64%	48.08%	49.17%	47.94%
Assets with maturity of greater than 3 months and less than 1 year		16.24%	16.20%	15.65%	16.32%
Assets with maturity of greater than 1 year but less than five years		23.62%	23.58%	23.56%	23.36%
Assets with maturity greater than five years		11.50%	12.14%	11.62%	12.37%
Percentages: security portfolio					
Assets with maturity of at most 3 months		14.02%	13.52%	14.75%	14.06%
Assets with maturity of greater than 3 months and less than 1 year		15.03%	16.09%	17.05%	15.42%
Assets with maturity of greater than 1 year but less than five years		35.63%	36.28%	34.06%	32.82%
Assets with maturity greater than five years		35.31%	34.11%	34.14%	37.70%
Treasury security interest rates					
Assets with maturity of at most 3 months	3 month	3.03	4.10	5.78	5.16
Assets with maturity of greater than 3 months and at most 1 year	6-12 mo avg	3.28	4.86	6.01	5.51
Assets with maturity of greater than 1 year and at most 5 years	2-3-5yr avg	4.53	6.23	6.27	6.30
Assets with maturity greater than five years	7-10-20-30 yr avg	6.16	7.21	6.77	6.85
Overall reference rate: Treasury rates averaged by maturities in FDIC portfolio		4.05	5.36	6.11	5.81
Loan reference rate: Treasury rates averaged by loan portfolio maturity weights		3.79	5.10	6.04	5.69
Security reference rate: Treasury rates averaged by security portfolio maturity weights		4.71	6.05	6.32	6.23
1-year Treasury bond rate		3.38	5.13	5.97	5.66
Unit value interest rates and user cost prices					
Annualized unit value rate: Deposit service charges		0.79	0.80	0.83	0.81
Annualized unit value rate: Deposit interest		1.96	1.69	2.46	2.46
Annualized unit value rate: Commercial and industrial loan interest		8.39	7.96	10.30	9.83
Annualized unit value rate: Loans to farmers interest		8.83	8.76	13.67	11.23
Estimated user cost price: Deposits		2.87	4.47	4.48	4.16
Estimated user cost price: Commercial & industrial loans		4.60	2.86	4.26	4.14
Estimated user cost price: Loans to farmers		5.05	3.66	7.63	5.54

SOURCE: Call reports for June quarter 1993-1996.

any of the potential uses of liabilities. As discussed in the previous section, the maturity weighted reference rate for loans and leases is about the same as the 1 year bond rate and thus there should be little effect from this benchmark rate calculation for these asset products over the 1993-96 period. The security reference rate is somewhat higher than the loan reference rate, and hence securities are slightly overweighted in that study. In any case, Fixler and Zieschang (1992a) show that temporal bank *gross* output indexes are fairly robust to the specified benchmark rate. The interest rates earned and paid on the various products are computed by dividing the yearly income and expense by the corresponding stock.

In table 2 we present the various quantity indexes and the overall implicit price index calculated by FZ (1997) for 1977-94. As shown in columns 3 and 5, the results of this calculation are remarkable in that most of the growth of bank gross output over the eighteen year period was in liability products--primarily deposit (monetary) products--rather than credit services. Monetary services have therefore driven most of the growth in aggregate financial services gross output, displayed in column 6 (which is the product of columns 3 and 5). As shown in column 7, the overall price index of financial services has trended slowly upward over the period, with declines in recessions. The last trough in the index occurred in 1990, recovering in 1991 and then trending upward on a somewhat volatile course to historically high values through 1994.

Although not presented here, FZ (1997) also construct an alternative nominal final sales figure under the user cost framework. We found that, for the period from 1951-1985, nominal final sales are generally understated with the current BEA FISIM method, which is effectively based on a reference rate equal to the average return on loans and securities (FZ 1991), as compared with our FZ (1997) method, which is based on the lower one year Treasury bond rate. After 1985, the nominal sales computed using the user cost method are lower, but the two almost converge again by 1993.

4.4 Measuring the quality of financial services

Series such as these presented in table 2 accurately measure trends in output only if adjustments for changes in product quality are made. The quality of deposit services can be characterized by service characteristics, such as volume of transactions per account, ATM sites and number of branches (convenience). The implications of increases in service quality in financial services, while having the usual interpretation as output augmenting, have a significant parallel interpretation for monetary policy, since financial services output volume is identical with broad financial stock aggregates that are the subjects of central bank influence and control. A rise in service quality augments the stock of monetary and financial assets. If this service quality effect is not taken into account, it is possible that the velocity with which a given unadjusted stock turns over could increase, while, quality adjusted, velocity may not have changed.

TABLE 2
Financial services quantity and price indexes.
(Reference rate set at one-year Treasury Bond rate)

Year	Asset Part of Financial Services Index (t, t-1)	Chained Asset Index	Liability Part of Financial Services Index (t, t-1)	Chained Liability Index	Chained Financial Service Output Index Q for Gross Output of Depository Institutions	Chained Implicit Price Index	Index for BEA Real Gross Domestic Product of Depository Institutions[1]
1977		100.00		100.00	***100.00***	100.00	***100.00***
1978	99.84	99.84	112.54	112.54	***112.37***	101.64	***105.83***
1979	94.95	94.80	117.28	131.99	***125.13***	100.78	***111.85***
1980	92.75	87.93	115.55	152.52	***134.11***	101.99	***116.17***
1981	99.26	87.27	114.09	174.00	***151.86***	94.52	***118.22***
1982	97.63	85.20	112.05	194.97	***166.12***	104.42	***117.92***
1983	100.40	85.54	108.05	210.66	***180.22***	105.33	***121.18***
1984	106.92	91.46	106.36	224.06	***204.94***	97.79	***127.24***
1985	101.40	92.74	106.87	239.46	***222.08***	105.39	***130.35***
1986	103.50	95.98	103.70	248.32	***238.36***	105.05	***130.47***
1987	104.16	99.97	100.92	250.61	***250.55***	102.80	***136.68***
1988	103.60	103.57	101.98	255.57	***264.70***	103.31	***135.93***
1989	104.22	107.95	102.16	261.09	***281.82***	101.06	***136.68***
1990	103.17	111.37	103.08	269.15	***299.73***	98.44	***136.19***
1991	99.24	110.52	100.56	270.66	***299.14***	109.51	***130.93***
1992	100.85	111.46	99.74	269.97	***300.91***	120.82	***126.82***
1993	106.39	118.58	99.19	267.79	***317.54***	122.78	***125.87***
1994	105.32	124.90	101.40	271.53	***339.12***	115.68	***124.85***

SOURCE: columns 2-7, Fixler and Zieschang (1997), column 8, Bureau of Economic Analysis (http://www.bea.doc.gov/bea/dn2.htm).

1 Indexes are linked over the 1987 revision of the national accounts, normalized to 1977=100. Data from 1977-87 are for Finance, Insurance, and Real Estate, as data for Depository institutions were not separately published until 1987. The BEA data are for real value added. Although a controversial concept, real value added as defined by Sato (1976) has a solid production foundation and can be bounded with so-called double deflation measures. The *SNA93* mentions first (among alternatives) the practice of double deflation to compute real value added in practice (paragraph 16.60). This effectively excludes from the volume of gross output the volume of intermediate purchases of goods and services by banks. The data for index Q to which the real GDP data are compared in this table cover gross output. It is, therefore, conceivable that some of the difference between the two could be attributed to fluctuations in intermediate input purchases by banks. However, real GDP was calculated above principally by extrapolating a base level of bank GDP forward using movements in banking employment. Although this is a commonly used 'single indicator' method for producing real value added, an indicator for output is preferable to one for input, and an assumption must be made about the stability of the share of intermediate input in total output to defend the estimates produced with these methods. The latter assumption is effectively violated by the differing rates of change in real gross output (Q) and real value added (GDP) in the above series.

FZ (1992b) provide a straightforward methodology for incorporating service characteristics into superlative quantity indexes such as the financial output aggregates defined in the previous section. We rely on knowledge of a hedonic relationship between the asset or liability holding cost rate and the service characteristics of the associated account as in

$$h = H(z,ä,\varepsilon)$$

where h is the holding cost, H is the hedonic function, z is a vector of service characteristics, $ä$ is a vector of other conditioning variables, and $å$ is a random error.

FZ (1992b) establish that within a Törnqvist index framework, an exact quality adjusted quantity index Q^* can be derived as

$$Q^* = ZQ$$

where the quality modifier Z to the quantity index Q is

$$Z = \prod_m \left[\prod_j \left(\frac{z^t_{ajm}}{z^{t-1}_{ajm}} \right)^{\frac{1}{2}\left(\hat{a}^{t-1}_{ajm} \frac{p^{t-1}_{aj} y^{t-1}_{aj}}{\sum_j p^{t-1}_{aj} y^{t-1}_{aj}} + \hat{a}^{t-1}_{ajm} \frac{p^{t-1}_{aj} y^{t-1}_{aj}}{\sum_j p^{t-1}_{aj} y^{t-1}_{aj}} \right)} \prod_k \left(\frac{z^t_{lkm}}{z^{t-1}_{lkm}} \right)^{\frac{1}{2}\left(\hat{a}^{t-1}_{lkm} \frac{p^{t-1}_{lk} y^{t-1}_{lk}}{\sum_k p^{t-1}_{lk} y^{t-1}_{lk}} + \hat{a}^{t-1}_{lkm} \frac{p^{t-1}_{lk} y^{t-1}_{lk}}{\sum_k p^{t-1}_{lk} y^{t-1}_{lk}} \right)} \right] \tag{5}$$

and where t indexes time, m indexes service characteristics, j indexes asset products, and k indexes liability products. The $\hat{a}$ terms are given by

$$\hat{a}^t_{qrs} = \frac{\partial \ln H^t_{qr}\left(z^t_{qr}, ä^t_{qr}\right)}{\partial \ln z^t_{qrs}}$$

and represent the proportional impact at time t on the holding cost of product r of type q (asset or liability) of a marginal change in the s^{th} service characteristic.

The data available on the service characteristics z of banking services in the U.S. include counts of six types of branches compiled in the Call Reports,[13] and number of sites for automatic teller machines (ATMs), as well as the transaction volumes for checks cleared and electronic funds transfers published by the Bank for International Settlements (BIS) for a significant subset of large banking institutions and ATM network providers.

The 1988 volume of transactions was 55490 million and the 1995 volume was 72663 million, indicating an average annual rate of growth of nearly 4%. The level of credit card activity has increased even more substantially: the 1988 volume of credit card payments was 8813 million and the 1995 volume of transactions was 14914 million, for an average annual growth of about 8%.

ATM services are increasingly priced with explicit transaction charges. Typical charges in the Washington, DC area are 25 to 50 cents per transaction on an ATM of the ‘home’ institution of the account accessed, and $1 to $2 on transactions from a 'foreign' ATM. However, offsets are often given when the deposit balances of an account holder exceed certain levels, and these services were often 'free' or implicitly priced only a few years ago. Clearly, ATM services are a source of sales revenue and would generally increase the user cost price charged on the associated deposit accounts, notwithstanding the possible offsets related to the size of the account balance (more about these below).[14] Examining our formula in equation (5), then, for a given distribution of account sizes, growth in ATM transactions would *augment* the growth in output measured by the unadjusted Divisia monetary and credit aggregate.

Credit card transactions, on the other hand, are still generally only implicitly priced, often with no charge on accounts paid in full every month. The impact of credit card transactions is less clear, but we expect that, again, the credit card transactions will have a positive, although arguably quite small, impact on the holding income earned on credit card loans.[15] By implication, the robust growth in credit card transactions will have the (likely quite modest) effect of *augmenting* the growth of the unadjusted Divisia aggregate.

4.5 The 'quantity discount' and number of accounts effects on the volume index of financial services

As stated in the Introduction, the adjustment of the financial product output index to account for nominal changes unrelated to the production of services involves the relationship between the holding income/cost rates of products and the average account size. We suggest that effective service 'quantity discounts' on the nominal size of accounts will act to offset changes arising from essentially nominal sources in a manner similar to deflation, but using information solely from the way banking service transactions are defined. For deposit and other liability products, a quantity discount would be indicated by a direct relationship between the deposit holding cost rate and the amount deposited. For loans and other asset products, a quantity discount would be characterized by an inverse relationship between the holding income rate and loan amount. This is, in fact, a common pricing strategy in banking, with deposit service charge rates phased out as minimum balance requirements are satisfied, and with rates on 'jumbo' loans often discounted compared with those on smaller amounts.[16]

To adjust our volume index to account for this 'pricing policy' effect, we treat average account size as if it were a quality variable in our quality-adjusted formula. We posit the following 'hedonic' equation,

$$h = H(\bar{y}, z, \ddot{a}, \varepsilon), \tag{6}$$

treating average account size $\bar{y}$ in the same way as the service characteristics vector z. The factor adjusting output for average account size in a comparison between periods t and $t + 1$ would then be

$$V = \prod_j \left(\frac{\bar{y}_{aj}^{t}}{\bar{y}_{aj}^{t-1}} \right)^{\frac{1}{2}\left(\hat{a}_{aj}^{t-1} \frac{p_{aj}^{t-1} y_{aj}^{t-1}}{\sum_j p_{aj}^{t-1} y_{aj}^{t-1}} + \hat{a}_{ajm}^{t} \frac{p_{aj}^{t} y_{aj}^{t}}{\sum_j p_{aj}^{t} y_{aj}^{t}} \right)} \prod_k \left(\frac{\bar{y}_{lk}^{t}}{\bar{y}_{lk}^{t-1}} \right)^{\frac{1}{2}\left(\hat{a}_{lk}^{t-1} \frac{p_{lk}^{t-1} y_{lk}^{t-1}}{\sum_j p_{lk}^{t-1} y_{lk}^{t-1}} + \hat{a}_{lkm}^{t} \frac{p_{lk}^{t} y_{lk}^{t}}{\sum_j p_{lk}^{t} y_{lk}^{t}} \right)} \quad (7)$$

where j and k index, respectively, asset and liability account types, and

$$\hat{a}_{rs}^{t} = \frac{\partial \ln H_{rs}^{t}\left(\bar{y}_{rs}^{t}, z_{rs}^{t}, \ddot{a}_{rs}^{t}\right)}{\partial \ln \bar{y}_{rs}^{t}}.$$

In summary, then, our quality adjusted output index would be written as

$Q^{**} = VZQ.$

Clearly, if $\hat{a}_{rs}^{t} = 0$, then average account size has no effect on the essentially nominal output aggregate. However, we expect that in many cases this parameter is negative, in which case equation (7) implies an *attenuation* of growth in the unadjusted asset and monetary output aggregate as average account size increases. This is straightforwardly generalizable to the case in which the holding cost of one account depends on other average account sizes besides its own. This is a potentially useful approach to consider for handling the service bundles offered in retail banking, where for example the combined value of several types of accounts for a given customer determines the holding costs of each.

4.6 The available data on the 'quantity discount' effect

To provide some evidence on the quantity discount effect, we estimate equation (6) for a selection of loans and all deposits in domestic offices. Mid-year (June 30) data on interest income/expense, number of accounts, and aggregate value for commercial and industrial loans, loans to farmers, and domestic deposit accounts are available from 1993 in the Call Reports. The Call Reports measure income and expense items cumulatively through the year. Holding income/expense rates constructed as ratios of income/expense to associated account values therefore represent what the typical account of each type earned on average over the first half of the calendar year. Mid-year average account size can also be constructed as the ratio of aggregate account value with number of accounts for those categories of products having count information. The problem with these data for estimating the relationship we seek is that there are differences in the reference periods of the holding income/expense flows, which are cumulative, with the stocks, which are point in time at the end of the second quarter. 'Unit' holding income and cost rates can be noisy and can assume rather extreme values. We therefore estimate a double log model of the form

$$\ln R = \acute{a} + \tilde{a}\ln \bar{y} + \grave{u}\ln \ddot{a} + \varepsilon \qquad (8)$$

where R is the holding income in monetary units (not the rate), $\bar{y}$ is the average account value of the associated financial product stock, and $\ddot{a}$ is given by the number of accounts.[17] This model will tend to be more resistant to extremely high and low outliers than one without the log transformation of the data.[18] The elasticity of the holding cost rate with respect to average account size is $\hat{a}_{\bar{y}} = \tilde{a} - 1$ and with respect to number of accounts is $\hat{a}_{\ddot{a}} = \grave{u} - 1$.[19] In general, for asset interest holding income we expect $\hat{a}_{\bar{y}} < 0$ and $\hat{a}_{\ddot{a}} > 0$, and for liability (deposit) net holding cost we expect $\hat{a}_{\bar{y}} < 0$ and $\hat{a}_{\ddot{a}} > 0$. These expectations imply an *attenuating* effect on growth in output from average account size and an *augmenting* effect from number of accounts.

The variables needed to estimate equation (8) are available for Commercial and industrial loans, Loans to farmers, and Deposits in domestic offices.[20] Table 3 presents the elasticity results from such hedonic regressions. The second panel of the table gives the elasticity of the holding income rate for loans or holding cost rate for deposits with respect to the average account size, and the third column the elasticity with respect to the number of accounts. The results generally favour the quantity discount hypothesis, with exceptions for loans in certain years, but with strong confirmation for deposits.

For example, in 1993 both loan types show negative elasticities with respect to loan size. Since the user cost price for loan services, which are assets, is the holding income rate minus the reference rate, these results indicate the unmodified quantity index Q would overstate output growth during a period of growth in average loan size. The corresponding elasticity of the holding cost for deposits is strongly positive. Since the user cost price for deposits, which are liabilities, is the reference rate minus the holding cost rate, these results also indicate a downward adjustment to the growth in the quantity index Q during a period of growth in average deposit size. All products generally show positive elasticities of the user cost price with respect to number of accounts, indicating an *upward* modification to the unadjusted quantity index Q.

5. Concluding remarks

We have focused on the implications for economic measurement of Divisia monetary and credit aggregation, the financial firm approach to conceptualizing and compiling an output index for financial services that accounts for quality and ‘quantity discount’ effects, and the recent change in recommendations for compiling financial services in national income accounting. We find that (1) the link between the real and monetary accounts is direct within the financial firm framework and the output index for the banking component of the financial business sector is identical to the financial stock aggregates that are the subject of central bank policy; (2) there exists an operational definition for the reference rate with an appealing conceptual interpretation that empirically gives

TABLE 3
Holding income and cost elasticities of account characteristics

	199306	199406	199506	199606
Holding income and cost regression parameters, double log regressions				
Deposit interest holding cost (with CMSA fixed effects)				
Average account size	0.9581	0.9596	1.0406	1.0080
Number of accounts	0.0454	0.0366	-0.0216	0.0080
Share of noninterest bearing deposits (unlogged)	-2.4905	-2.3652	-2.3641	-2.4537
Sample size	5577	5288	5015	4747
Deposit service charge income (with CMSA fixed effects)				
Average account size	0.2815	0.2882	0.3118	0.2849
Number of accounts	0.6974	0.7062	0.6921	0.7414
Share of noninterest bearing deposits (unlogged)	4.4037	4.8077	4.8541	4.6684
Sample size	5422	5137	4870	4592
Commercial and industrial loan interest holding income				
Average account size	0.7631	0.9662	1.0357	0.9785
Number of accounts	0.0470	0.0782	-0.0103	0.0506
Sample size	138	39	30	39
Loans to farmers interest holding income				
Average account size	0.8972	0.7756	0.3914	0.7596
Number of accounts	0.0566	0.1023	0.5298	0.1883
Sample size	184	125	107	120
Holding rate elasticities with respect to average account size				
Deposit net holding cost, of which	0.414	0.556	0.410	0.364
Deposit interest holding cost	-0.042	-0.040	0.041	0.008
Service charge holding income	-0.718	-0.712	-0.688	-0.715
Commercial and industrial loan holding income	-0.237	-0.034	0.036	-0.022
Loans to farmers holding income	-0.103	-0.224	-0.609	-0.240
Holding rate elasticities with respect to number of accounts				
Deposit net holding cost, of which	-1.394	-1.558	-1.383	-1.353
Deposit interest holding cost	-0.955	-0.963	-1.022	-0.992
Service charge holding income	-0.303	-0.294	-0.308	-0.259
Commercial and industrial loan holding income	-0.953	-0.922	-1.010	-0.949
Loans to farmers holding income	-0.943	-0.898	-0.470	-0.812
User cost price elasticities with respect to average account size				
Deposits	-0.169	-0.112	-0.149	-0.144
Commercial and industrial loans	-0.432	-0.094	0.086	-0.051
Loans to farmers	-0.180	-0.537	-1.091	-0.487
User cost price elasticities with respect to number of accounts				
Deposits	0.568	0.313	0.503	0.536
Commercial and industrial loans	-1.737	-2.567	-2.444	-2.255
Loans to farmers	-1.651	-2.150	-0.843	-1.646

SOURCE: Call Reports for June quarter 1993-1996.All model parameters statistically significant at the 5 percent level.

heavier weight to sales of asset services than current U.S. imputation practice; and (3) quality adjustments for service characteristics are of two kinds: a standard adjustment for service characteristics relating to the facilitation and convenience of transactions and intermediation, and a second adjustment relating to 'quantity discounts' for services rendered on larger accounts. This second adjustment is what provides a link between the fundamentally nominal monetary and financial asset stock measures and the real output measures needed for the national accounts and compilation of real GDP. The real output measure is, we argue, an important measure for the monetary authority, since it incorporates service characteristics relating to the efficiency of the transmission of policy actions such as open market operations.

Finally we have provided information on micro-data for the U.S. banking sector, depicting, we think, the practicality of implementing the *SNA93* FISIM-Divisia monetary aggregation-user cost financial services price measurement methodology in the United States. We provide an initial analysis of these data sources in examining calculation of the reference rate, the output index, and service quality and quantity discount adjustments to output reflecting the changing composition and pricing structure of financial services.

Clearly, more could be done with the data sources we identify here. However, the evidence we have accumulated so far suggests that the existing bank output measures for the U.S. are understating output growth. From 1987 to 1994, growth in real GDP for depository institutions from official data sources was -8.6 percent, while the gross output series in table 2 of this paper grew by 35.4 percent. This comparison should be handled carefully, as the official figures are for real value-added, and thus effectively subtract the real intermediate consumption of depository institutions from their real gross output. However, for intermediate consumption to explain the difference in growth rates between our gross output index and current estimates of real GDP, the volume of intermediate inputs purchased by banks would have to have had a substantially higher rate of growth than that in the gross volume of output over the period. Further, although the adjustments for differences between marginal and average service prices (the 'quantity discount' effect) we discuss in the paper might have offset some of the growth in the latter figure, the presently unaccounted-for enhancements in service convenience over the same period would have increased it further. In our view, refined versions of the output measures we propose are unlikely to tell a story of retrenchment in either the gross output or GDP of banks in recent years.

Notes

This paper represents the views of the authors alone, and does not represent Bureau of Labor Statistics or IMF policy or the views of other staff members of either organization. The paper was substantially completed while Kimberly Zieschang was in his former position with the Bureau of Labor Statistics.

1 One of the contentious issues in the banking literature is whether some liability products (mainly deposits) should be designated as inputs. Hence the designation of nonfinancial inputs. In the financial firm model the financial input-output status of a product is determined by the sign of the product's user cost price, discussed below. In this framework the focus is on the production of financial services and so the designation of a product as a financial input-output is a subsidiary concern.

2 See Fixler and Zieschang (1998), table 1, for details on these financial products. The Department of Commerce 1992 Census of Financial, Insurance, and Real Estate Industries also contains information in its *Sources of Revenue Report* that augments the detail of direct service charge income available in the Call Reports. Additional detail in certain other areas of bank and depository institution activity are provided in the *Establishment and Firm Size* and *Miscellaneous Subjects Reports.* The next such Census will be taken in 1998.

3 These user cost expressions follow from the profit maximization of the financial firm. Hancock (1985) provides a derivation. We ignore the role of discounting. We also treat non-interest-bearing assets, such as reserve balances held with the central bank, distinctly, rather than adjusting the prices of assets for the 'reserve tax' by multiplying the benchmark rate by one minus the reserve ratio, as in Barnett's treatment.

4 In paragraph 6.125, the *SNA93* defines the value of gross output of financial intermediation *indirectly* measured as interest and property income receivable less interest payable by financial intermediaries, excluding property income from investing their *own funds*. This definition is straightforward, with the exception of the last qualifier, as there is a range of opinion on what constitutes own funds. In this paper, we assume own funds are equity and secured debt, resulting in a broad definition of liability financial products: all other financial liabilities, including unsecured debt and, for the central bank, currency liabilities, as well as deposits. As we note below, national accounts experts favour a broader view of own funds and a narrower view of liability products, excluding all items from the latter other than deposits. To simplify exposition, we are ignoring non-interest property income here, which would include, for example, dividends on stock or rent on land owned by the bank (paragraph 7.89), and are, therefore, left with net interest only. FISIM is thus the sum of the first and third terms of equation (2). The value of *explicitly* measured financial intermediation services would be the second, service charge, item in equation (2).

5 The *SNA93*, paragraph 6.127, describes a 'reference rate' methodology for determining the use of output by institutional sector that would sum across sectors to a gross output value for (indirectly measured) intermediation services including the third term in equation (2). On the other hand, in paragraph 6.125 it defines the total value of intermediation output (implicitly measured) as net interest (actually, net property income) only, implicitly excluding this term. In our discussion, we are taking the first interpretation of the reference rate methodology advocated by the *System*.

6 The *SNA93* includes both realized and unrealized *ex post* capital gains (paragraph 12.72) in the *Revaluation* sub-account of the *Other Changes in Assets* accounts. Losses are defined as actual, *ex post* write-offs (paragraph 12.51) in the *Other Changes in the Volume of Assets* sub-account of the *Other changes in assets* account. The *System* does provide for calculation of comprehensive *ex post* user-cost valuations by including the relevant appreciation and loss items in these accounts. Assuming these *Other Changes in Assets* accounts are compiled, users can then compute their own versions of the value of services derived from financial stocks.

7 See Fixler and Zieschang (1992a,b, 1993) for applications of the output distance function to measuring the productivity of banks.

8 The index (4) is exact if the distance function is homothetic in *y*--or if the quantity index is defined in the 'Fisher' manner as

$$Q^{t-1,t} = \left[\frac{D^{t-1}(x^{t-1}, y^{t})}{D^{t-1}(x^{t-1}, y^{t-1})} \frac{D^{t}(x^{t}, y^{t})}{D^{t}(x^{t}, y^{t-1})} \right]^{\frac{1}{2}}$$

under certain conditions. See Caves, Christensen, and Diewert (1982).

9 For the private banking sector, this excludes currency in circulation, as it is a liability of the central bank. However, the *SNA93* and current U.S. practice include the central bank among financial corporations. Currency in circulation would be included as part of the set of financial liabilities generating financial intermediation services in the broad view of bank output we take here. In the narrow view favoured at present by national accounts experts, currency yields no intermediation services and is excluded from output. We do not include the central bank in our empirical results below, but we do include treatment of currency in vault and deposits with the central bank as reserve assets in the financial product vector for commercial banks.

10 CCD (1982) also show that under non-increasing returns to scale, the exponential weights in the input formula reduce to the ratio of input costs, by category, to total sales.

11 Unit value interest rates are the ratios of the interest income or expense on various accounts divided by the balance sheet levels of the associated assets or liabilities.

12 A constant maturity rate for a given date is taken and a given maturity is read from a yield curve constructed as of that date.

13 Unfortunately these branch count data, which are computed from information in the so-called structure file of the Call Reports, are no longer available on the main micro file maintained by the Federal Reserve Board.

14 See items 22 and 23 in table 1 of Fixler and Zieschang (1998). A hedonic regression of the interest holding income from credit cards on number of transactions could identify this effect, but would require micro data on deposit interest holding cost, and deposit holding income from service charges, as well as number of ATM transactions by institution. The holding income can be taken from the Call Reports, and there exist limited data for about 50 institutions on ATM transactions from the source of the BIS data. We are investigating these data presently. Certain of the institutions in the transactions data have no obvious single correspondent in the Call Reports, however, as when they are specialized to providing ATM services for a group of banks.

15 See item 6, Loans to individuals in table 1 in Fixler and Zieschang (1998). Unfortunately, credit card loans are not separately identified on the Call Reports, but the interest income earned on them is. A hedonic regression of the interest holding income from credit cards on number of transactions could identify this effect, but would require micro data on credit card holding income and number of transactions by institution. The holding income can be taken from the Call Reports, but we are unaware of a readily available source of micro data on credit card transactions. However, such data may well be uncovered as the search continues.

16 See, for example, the *Survey of Terms of Bank Lending* made during February 3-7, 1997, Fed Survey E.2. These data show that, for fixed rate Commercial and Industrial Loans of less than one year maturity, the interest rate falls with the size of the loan.

17 Number of accounts would not ordinarily be chosen as a service characteristic indicator, so we include it in 'other conditioning variables.'

18 For deposits, the net holding cost rate--the interest rate paid less the service charge rate--can assume negative values, making log transformations problematic. We therefore estimated separate logarithmic models for interest holding cost and service charge holding income, and calculated holding cost elasticities for interest net of service charges from the two component elasticities. These are shown in table 3.

19 The derivation of this result is as follows. Consider the interest rate hedonic model:

$$\ln r = \acute{a} + \hat{a}_{\bar{y}} \ln \bar{y} + \hat{a}_{\bar{y}} \ln \ddot{a} + \varepsilon$$

and observe that log interest income or expense can be written in terms of the interest rate and total account value as $\ln R = \ln r + \ln y$, and log average account size can be written in terms of total account value and number of accounts as $\ln \bar{y} = \ln y - \ln\ddot{a}$. Multiply both sides of the interest rate model by total account value to obtain

$$\begin{aligned}\ln R = \ln r + \ln y &= \acute{a} + \hat{a}_{\bar{y}} \ln \bar{y} + \hat{a}_{\ddot{a}} \ln \ddot{a} + \ln y + \varepsilon \\ &= \acute{a} + \hat{a}_{\bar{y}} \ln \bar{y} + \hat{a}_{\ddot{a}} \ln \ddot{a} + (\ln \bar{y} + \ln \ddot{a}) + \varepsilon \\ &= \acute{a} + \hat{a}_{\bar{y}} + 1)\ln \bar{y} + (\hat{a}_{\ddot{a}} + 1) \ln \ddot{a} + \varepsilon \\ &= \acute{a} + y \ln \bar{y} + \grave{u} \ln \ddot{a} + \varepsilon\end{aligned}$$

from which it follows that $\hat{a}_{\bar{y}} = y - 1$ and $\hat{a}_{\ddot{a}} = \grave{u} - 1$.

20 The number of accounts data for the loan categories has limited and idiosyncratic coverage, as evidenced by the very small number of banks for which these data are available. Our results can only be interpreted as suggestive of what might be obtained should more comprehensive data become available on the Call Reports.

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