The law of proportionate effect and OECD bank sectors

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Abstract
This paper investigates the growth dynamics of the bank sectors in the OECD area over the period 1985-1994 and examines whether the structural financial reforms of the late 1980s have affected their growth path. Based on a test of Gibrat's law of proportionate effect, we find that the 1985-89 period was characterised by size convergence, implying that smaller bank sectors were expanding more rapidly. However, in the 1990-94 period the pattern reversed to proportionate growth. The analysis of the determinants of bank market growth reveals that macroeconomic growth, operational bank efficiency, credit quality, and capitalisation are the main drivers of bank industry growth.

Keywords: Gibrat's Law, bank growth, OECD banking sectors, convergence
JEL F36, G21

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1. Introduction

Since the 1980s the financial markets and institutions of developed countries have been going through a process of deregulation and restructuring. The abolition of interest rate controls, the liberalisation of capital flows, the gradual deregulation of banking powers and the modernisation of money and capital markets feature among the most prominent examples (see OECD, 1992). The consequences have been wide-ranging. Several studies have documented a growing degree of capital market integration across the major economies (see Ammer and Mei, 1996; Longin and Solnik, 1995). There is evidence of increased levels of international banking activity (see Jones, 1992) and cross-border financial flows (see Armstrong et al., 1996). Partly as a response to these trends, the developed banking markets have also witnessed a new wave of mergers and acquisitions (see Rhoades, 1996 for the USA and Vander Vennet, 1996 for the EU). Together, these phenomena suggest a growing convergence among the financial systems of the major economies.

An important question is how these trends are affecting the growth pattern of the banking industries of the industrialised countries and what they imply for the configuration of world banking in the future. One way to approach the comparative growth issue would be to look at the evolution of the major banks in the industrialised countries[1]. However, the evolution of individual banks will to a large extent be determined by the economic and regulatory environment of their home country. This is especially true in terms of the available strategic options in areas such as functional despecialisation, degree of internationalisation, access to funding and capital. Therefore we analyse the evolution of aggregate national bank sectors in the OECD area. We examine the existence of a conditional relationship between size and growth of these banking industries and analyse the economic determinants of their observed growth rates. The question is whether size and other factors convey a comparative advantage to national bank systems and whether these advantages persist. We also test for a structural break in the growth pattern of bank sectors caused by a series of regulatory shift at the end of the 1980s.

The analysis of the size-growth relationship is based on the random growth process known as Gibrat's law of proportionate effect (LPE, Gibrat, 1931). The law states that the change in a variate at any stage of the process is a random proportion of the previous value of the variate. Applied to OECD banking systems, the working of Gibrat's law would imply that the smaller banking sectors have the same chance of growing, or shrinking, by any rate as the largest banking sectors. Growth prospects would then be independent of initial size. Among other things, the law implies that size inequalities between bank systems, and thus world banking concentration, would increase at a constant rate over time.

2. Methodology and data

The growth process of bank sectors can be written as

$$S_{t,i} = S_{t-1,i}^{\beta} \exp(\varepsilon_{t,i}) \qquad [1]$$

[1] Tests of the relationship between size and growth of banks have been performed by Tschoegl (1983) and Saunders and Walter (1994). Tschoegl (1983) finds that growth rates are independent of size for the 100 largest banks over the period 1969-1977. For the 200 largest banks in the world over the period 1982-87, Saunders and Walter (1994) find that the elasticity of growth with respect to size was less than one.

in which $S_{t,i}$ is the size of market i in year t and $\varepsilon_{t,i}$ is iid $N(\mu,\sigma^2)$. Taking natural logs $z_{t,i} = \ln(S_{t,i})$ gives

$$z_{t,i} = \beta z_{t-1,i} + \varepsilon_{t,i} \quad [2]$$

Gibrat's law holds when ß=1.However, Chesher (1979) has shown that, even if ß is close to unity, the law will not hold if the error terms in equation 2 are serially correlated. Serial correlation in the disturbances induces dependence between $z_{t,i}$ and $\varepsilon_{t,i}$ which may render OLS estimates of ß inconsistent even with cross-sectional data. Therefore it is necessary to estimate both ß and the autocorrelation coefficient of the error terms ρ. If

$$\varepsilon_{k,i} = \rho \varepsilon_{k-1,i} + u_{k,i}, \quad 0 < k \leq t \quad [3]$$

equation [2] may be rewritten as

$$z_{t,i} = \gamma_1 z_{t-1,i} + \gamma_2 z_{t-2,i} + u_{t,i} \quad [4]$$

Applying OLS to cross-sectional data may be expected to yield consistent estimators of the γ's. Since $\gamma_1 = \beta+\rho$ and $\gamma_2 = -\beta\rho$, β and ρ may be obtained as the solution of the quadratic form

$$(\beta,\rho) = 1/2\,[\gamma_1 \pm (\gamma_1^2 + 4\gamma_2)^{1/2}] \quad [5]$$

The null hypothesis that Gibrat's law is effective may be tested against the alternative that ß does not equal 1 and/or the disturbances ε are first order serially correlated by testing γ_1=1 and γ_2=0. An estimate of ß>1 implies that large bank sectors grow faster and that their dominance tends to increase. A ß below 1 means that smaller markets experience prospects of faster growth so that they catch up with the larger ones. Consistent positively serially correlated growth would imply that comparative advantages acquired over time carry over to subsequent periods. Finding negatively serially correlated growth would imply the working of some process that systematically reverts fortunes. In banking, one would expect to find no particular correlation pattern in growth since there are almost no opportunities to appropriate advantages over long periods. In banking, technological advances are quickly emulated by the whole industry. Finding persistent serial correlation should then be ascribed to institutional or legal features of the banking market or the economic environment in which the credit institutions operate. Since both the regulatory systems and the economic conditions in the OECD countries are converging, we may expect the growth rates of the various bank systems to converge, too. If the law of proportionate effect holds, the distribution of bank systems will become highly skewed and concentration will increase over time. This outcome is due strictly to the working of chance and requires no assumption about the structure of bank markets or the aggregate behaviour of bank managers.

In this study, we test for the working of a law of proportionate effect in the growth pattern of OECD banking systems over the period 1985-1994. This period is characterised by intensified bank restructuring as a response to major deregulation and re-regulation efforts with a clear cross-border impact. Since Gibrat's law is expected to hold in turbulent periods, we may expect growth to follow a stochastic process in the period under study. Over the longer term, the hypothesis is that bank systems will converge to a common technology due to free capital flows and increased cross-border trade in financial services. We divide the sample in two subperiods 1985-89 and 1990-94. The justification for this choice is that a series of major deregulation initiatives were implemented at the end of the 1980s (see OECD, 1992; Dermine, 1996). Examples include interest rate deregulation, liberalisation of capital flows and a harmonisation

of bank capital requirements initiated by the Basle Committee. In the EU the Second Banking Directive allowing free cross-border banking and servicing was enacted in 1989. The change of decade furthermore coincided with a reversal in the business cycle. Some authors have argued that the strengthened bank capital regulations may have contributed to a credit crunch in the early 1990s (Peek and Rosengren, 1995). The question is whether the cluster of major deregulations implemented in the late 1980s has shifted the relative growth pattern of large versus small bank systems.

We use two indicators to measure the size of national banking systems. The first measure is the total asset volume of the aggregated banking sector, calculated for the broadest possible sample of credit institutions, including commercial, savings, cooperative and public banks. The data cover the period 1983-1994 and are obtained from the OECD Bank Profitability database, supplemented with statistics from the central banks (or national bank supervisors for the countries where the prudential control is exercised by an independent authority) and the European Banking Federation's annual reports. The total asset variable has been deflated and adjusted for exchange rate movements (all numbers are converted to ECU).

The second size measure tries to accomodate for the structural shift in the activities of financial services companies. Confronted with deregulation, disintermediation and increased competition in their core business, banks have attempted to diversify their revenue sources. As a result, banks increasingly engage in off-balance sheet activities. The income stream generated thereof is recorded as non-interest income. However, the aggregation of off-balance sheet items is difficult because they consist of a wide variety of activities ranging from contingent claims such as loan guarantees to trading derivatives. A simple addition of the notional value of these heterogeneous categories would be erroneous. We follow the approach of Boyd and Gertler (1995) to obtain an estimate of off-balance sheet activities based on the behaviour of non-interest income relative to net interest income. The essential step is to calculate the equivalent asset volume that would generate the observed level of income by using the rate of return on on-balance sheet assets to capitalise non-interest income. The appendix contains the calculation of the composite bank size measure ATA (adjusted total assets). Both total assets (TA) and adjusted total assets (ATA) are used to estimate equation 4 across OECD bank sectors. In the regression, data for 23 OECD countries[2] are pooled for the period 1985-1994. Since equation 4 uses two lags, data on total banking activity starts in 1983.

Next to size, other determinants may explain the observed growth pattern of banking industries. The factors that may explain the growth of bank markets are taken from 3 categories of potential microeconomic and macroeconomic determinants: (1) the macroeconomic environment, (2) bank market structure measures, and (3) bank performance indicators. The macroeconomic variables capture the demand and supply of loanable funds. The short and long term interest rates (RST and RLT) proxy for the cost of deposits and the return on loans and investments. Their difference is the term spread (TERM) which serves as an indicator for the overall intermediation margin. Real economic growth (GROWTH) is included as a determinant of loan demand. Both TERM and GROWTH are expected to contribute positively to bank

2 The countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Italy, Japan, Luxemburg, Mexico, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, UK, USA.

growth. Finally, we include the government deficit ratio (GOVDEF) because it is a fundamental determinant of savings and real interest rates.

The bank market structure variables capture the incidence of market power and entry barriers on the performance of domestic banks. The concentration ratio is measured as the proportion of the banking assets held by the five largest banks in each national banking system[3]. As in other industries (see Porter, 1980) it is expected that high levels of bank market concentration are associated with less competition and less growth. The variable BRANCH, defined as the population per bank branch in each country, captures the degree of branch density. We expect that bank growth will be more easily achieved in countries with relatively low branch coverage. This will especially be the case in countries where branching restrictions have been abolished recently (e.g., Italy). BRANCH also proxies for entry barriers, because a higher branch density means that foreign bank entry is more difficult, especially in the retail segment. Vander Vennet (1994) concluded that banks in a number of EU countries may be able to exploit oligopoly rents when bank scale and entry barriers are taken into account (see also Clark and Speaker, 1992).

Finally, we include a series of bank performance indicators (see Bourke, 1989; Rhoades, 1994). The profitability measures are return on assets (ROA) and return on equity (ROE), both calculated before taxes because of differences in the tax treatment of bank profits across countries. High profit levels are expected to contribute positively to growth. The cost-income ratio (COSTINC, the ratio of operating costs to total revenues) captures the degree of operational efficiency of bank industries. A high cost ratio is indicative of suboptimal performance and will influence growth negatively. A combination of low cost-income ratios and high return on assets may be indicative of a persistent comparative advantage. The quality of the outstanding loans is measured by the ratio of loan loss provisions to net loans (CRED). This variable also controls for the bank crises that occurred in a number of countries during the sample period. Finally, we include the capital-to-assets ratio (CAP) because a solid capital coverage is necessary to sustain asset growth, especially in a framework of increasingly stringent capital adequacy rules. All the variables are obtained from two main sources: OECD (Bank Profitability database, Economic Outlook) and IMF (International Financial Statistics).

3. Results

Table 1 reports the estimated coefficients of equation 4 with unadjusted total assets (TA) and adjusted total assets (ATA) as the size variables. The t-statistics below the regression coefficients test for $\gamma_1=1$ and $\gamma_2=0$. The χ^2 statistic provides a test of the joint hypothesis that $\gamma_1=1$ and $\gamma_2=0$. If the null hypothesis is rejected, it can be concluded that the LPE was not in operation during that period. We also calculate β and δ with their approximate standard errors. Table 1 shows for the whole period 1985-1994 and for both size proxies, that γ_1 and γ_2 are 4 standard errors away from their test values. Based on the χ^2 test value the joint hypothesis that $\gamma_1=1$ and $\gamma_2=0$ can be safely rejected at better than the 1% level. This result suggests that the growth pattern of OECD bank markets did not obey the law of proportionate effect over the entire period.

[3] Data on large bank's total assets were taken from IBCA-Fitch.

However, this overall finding masks a striking difference between the two subperiods. For the 1985-1989 subsample the γ_1 and γ_2 coefficients are significantly different from their test values, both individually and jointly. Since β is below one we can conclude that the relatively smaller banking systems evolved along a more rapid growth path than the established banking centres in the second half of the 1980s. Presumably, the expanded access to revenue sources, growing internationalisation of trade in financial services and cross-border competition has allowed the less developed banking sectors to catch up in that period. However, the convergence movement has been short-lived. For the 1990-1994 both the γ_1 and γ_2 coefficients are insignificantly different from their reference values. The χ^2 test indicates that the joint hypothesis that $\gamma_1=1$ and $\gamma_2=0$ cannot be rejected. Hence, it appears that OECD national banking markets transferred to a growth pattern consistent with Gibrat's LPE in that subperiod. The combined finding that β is indistinguishable from 1 and ρ is insignificant implies that large and small bank systems had the same chance of growing or shrinking. The reversal from a size convergence movement to size-dependent growth implies that the largest bank systems are reclaiming their dominance over world banking.

An interesting question is how the observed serial correlation measured by ρ can be interpreted. Theoretically, consistently positively serially correlated growth would imply that advantages acquired over time carry over to the next periods. As such it would provide an indication of the relative competitiveness of the various banking markets. The positive serial correlation observed in panel A for the 1985-94 and 1985-89 periods may suggest that the fastest growing banking sectors had quasi-monopolistic access to growth-sustaining resources or technologies. The reversal to a low degree of positive autocorrelation in the last subperiod 1990-94 would then indicate that such access eroded quickly. In panel B the ρ coefficient is negative and significant at the 5% level for the 1985-89 period, indicating a quick reversal of growth paths. The most probable reason for this finding is that the ATA variable also captures a series of off-balance sheet activities including items such as loan guarantees, fund management fees, investment banking revenues (at least in those countries where this kind of activities can be exercised by banks), and financial market trading income. The revenues generated by these activities are inherently dependent on the business cycle, trading conditions on financial markets and the general evolution of interest rates. As a result, it is not unexpected that we find no persistence in the growth paths of these revenues. This applies especially to the 1985-89 subperiod with, e.g., the occurrence of the stock market crash of 1987[4].

The empirical evidence in the previous section supports the hypothesis that OECD bank systems were gradually converging in size during the second half of the 1980s, but returned to proportionate growth in the 1990s. This shift in the growth pattern should be related to other determinants of bank market expansion. Hence we re-estimate equation 2 adding variables that are hypothesised to influence bank market growth (see also Saunders and Walter, 1994). The regressions are run for the 1985-94 period and for the two subperiods in order to test for structural shifts in growth explanations. In the estimations, bank market growth is measured as ln(size)-ln(size(-1)). As expected the lagged dependent variable has very high explanatory

[4] However, as Tschoegl (1983) notes, consistent negative serial correlation may also be a statistical artifact due to the fact that growth rates for adjacent periods use the same numbers in the construction of consecutive growth rates.

power, the associated β coefficient is usually close to unity and the R^2 statistics are all above 0.98. Hence, only few additional explanatory variables enter significantly[5].

Table 2 reports the coefficients when TA is used as the size measure[6]. In the columns the two most significant independent regressions outputs are shown for each sample period. Over the entire 1985-94 period the variables with the most significant impact on bank market growth are the macroeconomic growth performance of the economy and the degree of operational efficiency of the banking sector. The coefficient of the cost/income ratio has a negative sign and is significant, implying that higher cost ratios, i.e. inferior efficiency, are associated with lower growth rates. Since increased efficiency is usually the outcome of competition, we can state that intensified international bank competition has allowed the most efficient bank systems to grow relatively faster. As expected, real economic growth (GROWTH) has a positive and significant effect on bank growth. This finding reflects the association between banking activity and the supply and demand of savings and loans, which, over longer periods, are obviously dependent on the dynamics of the economic environment.

The coefficient of the credit quality measure CRED is negative across the sample periods, implying that a worsening loan quality affects growth negatively. This effect is particularly pronounced in the 1985-89 period but it becomes less strong in the 1990-94 sample. Presumably, the debt crisis of the 1980s has made banks more prudent in the management of their exposures. Another partial explanation is probably the effect of credit rationing in a number of bank markets, induced by the strengthened capital adequacy requirements imposed by the Basle Agreement. The likely outcome of such behaviour is a shift towards safer loans that require less loss provisioning. The CRED variable is also associated with the business cycle because less loan losses are expected in boom years. Hence, CRED may capture some of the cyclical growth pattern of banking related to the overall macroeconomic performance of the countries under study.

The BRANCH variable, i.e. population per bank branch, consistently carries a positive sign. To a certain degree, BRANCH can be thought of as a growth indicator in itself, because the quick expansion of a national branch network is a typical manifestation of bank growth. This effect is probably very strong in countries where branching restrictions have been relaxed in the period covered by this study (e.g. Italy). By expanding their local presence, domestic banks also erect a barrier to entry so that some bank market segments, especially at the retail end, become less contestable. The concentration ratio has the expected negative sign, but only in the 1985-89 subperiod. Concentration is not significant in the 1990-94 era, which may indicate that national banking systems have become more competitive, probably due to deregulation.

We find a positive relationship between bank growth and the relative degree of bank sector capitalisation (CAP). The effect becomes particularly important in the 1990-94 subperiod. This clearly illustrates the impact of the capital adequacy regulation introduced at the end of the 1980s. Since banks have to maintain minimum capital levels against risky assets and off-balance sheet contingent claims, an adequate capital base is needed to sustain asset growth. Moreover, a solid capital coverage decreases the overall riskiness of banks and leads to better ratings, so that non-insured funding can be obtained cheaper. For individual banks, Berger

[5] The explanatory variables were lagged one period to alleviate the endogeneity problem and to allow banks to respond to changes in the economic environment.
[6] The results with adjusted total assets as the size measure are qualitatively similar.

(1995) already found a relationship between earnings and capital adequacy for US banks in the 1980s.

The interest rate variables only appear as significant in a specific subperiod. The short term interest rate, RST as a proxy for the relative funding cost of the banking system, has a negative sign in the 1985-89 sample. When interest rates rise, short term funding becomes more expensive so that the interest margin narrows. Decreasing short term interest rates have a negative effect on the supply of deposits. Both influences are negatively related to bank growth. Moreover, rising short term rates are usually associated with a more contractionary stance of monetary policy, which typically occurs around the end of a positive business cycle. Lastly, the coefficient on the yield spread (TERM) is marginally significant in the 1990-94 period. This reflects the importance of solid core profitability in the intermediation activities of the banking system. Due to competitive pressure, interest margins tend to narrow in most industrialised countries. However, a positive yield curve, which was the prevalent situation in the OECD area during most of the 1990-94 period, is usually beneficial for bank profits and asset growth.

The findings in table 2 are largely corroborated when we use the percentage growth of unadjusted assets as the dependent variable. The crucial determinants of growth (efficiency, profitability, capital, credit quality, and economic growth) reappear in table 3[7]. The only additional variable with a significant impact is the government deficit ratio. Apparently, higher public borrowing requirements stimulate bank growth, since governments typically rely on the banking system to absorb a large proportion of their bonds. When budget deficits exhibit a tendency to decrease, e.g. because most EU governments try to comply with the conditions spelled out in the Maastricht Treaty in the 1990s, the relationship becomes insignificant.

4. Conclusions

Based on a test of Gibrat's law of proportionate effect, we find that the 1985-89 period was characterised by size convergence, implying that smaller bank sectors in the OECD area were expanding more rapidly. This result holds for both measures of size used in this study (balance sheet assets versus on- and off-balance sheet activities). The enlarged access to revenue sources, growing internationalisation of trade in financial services and increased competition may have allowed the less developed banking sectors to catch up in that period. However, in the 1990-94 period the growth pattern reversed to proportionate growth, consistent with Gibrat's law. The reversal from a size convergence movement to size-dependent growth implies that the largest bank systems are reclaiming their dominance over world banking. The reversal to a low degree of autocorrelation in the last subperiod 1990-94 indicates that any comparative advantages eroded quickly. The analysis of the determinants of bank market growth reveals that macroeconomic growth, operational bank efficiency, credit quality, and capitalisation are the main drivers of bank market growth. Since increased efficiency is usually the outcome of competition, we hypothesize that intensified international bank competition has allowed the most efficient bank systems to grow relatively faster. Credit quality also affects growth positively, underlying the need for adequate risk management in banking. Finally, we find a positive relationship between bank growth and the relative degree of bank sector capitalisation, measured as the capital-to-assets ratio. This clearly illustrates the impact of the capital adequacy regulation introduced at the end of the 1980s.

[7] The R^2 is lower than in the previous estimations because of the different specification of the dependent variable.

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Table 1 : Test of the law of proportionate effect

Panel A : Size is measured as unadjusted total assets						
	γ_1	γ_2	R^2	β	ρ	χ^2
1985-1994	1,244 (3.84)	- 0,248 (3.92)	0,99	0,981	0,221 *	16,47 **
1985-1989	1,273 (2,97)	- 0,256 (3,24)	0,99	0,985 *	0,237 *	8,45 *
1990-1994	1,173 (1.83)	- 0,172 (1.82)	0,99	1,001	0,171	3,36
Panel B : Size is measured as adjusted total assets						
	γ_1	γ_2	R^2	β	ρ	χ^2
1985-1994	0,694 (4,76)	0,299 (4,65)	0,99	0,981 *	- 0,119	23,02 **
1985-1989	0,593 (5,17)	0,394 (5,05)	0,98	0,972 *	- 0,221 *	27,01 **
1990-1994	0,864 (1.25)	0,141 (1.28)	0,99	1,005	- 0,044	1,87

Numbers in parentheses are absolute t-statistics
*, ** indicate significance at the 5 % and 1 % level respectively

Table 2 : Determinants of OECD bank market growth

Regression coefficients for the period 1985-94 and the two subsamples, the dependent variable is ln(TA)

Variables	**1985-94**	**1985-94**	**1985-89**	**1985-89**	**1990-94**	**1990-94**
ln(TA (-1))	0.971 (125.9)	0.975 (119.8)	0.972 (118.7)	0.968 (96.8)	1.001 (115.2)	1.001 (112.7)
CRED		-0.048 (2.12)	-0.061 (3.81)	-0.053 (3.77)		-0.022 (1.47)
COSTINC	-0.028 (3.80)	-0.033 (3.68)	-0.042 (2.87)	-0.038 (2.89)	-0.034 (4.13)	-0.031 (3.89)
BRANCH		6.2E-6 (2.22)	6.5^{E}-6 (2.29)	7.1E-6 (2.11)	7.4E-6 (3.81)	5.8E-6 (3.75)
CAP		0.017 (1.89)		0.018 (2.21)	0.021 (2.68)	0.025 (2.74)
CONC			-0.02 (1.98)			
GROWTH	0.007 (2.33)					
RST				-0.031 (2.19)		
TERM						0.031 (1.92)
R^2 N	0.992 230	0.995 230	0.994 115	0.995 115	0.993 115	0.992 115

Values in parentheses are absolute t-statistics

Table 3: Determinants of OECD bank market growth

Regression coefficients for the period 1985-94 and the two subsamples. The dependent variable is the percentage growth rate of total assets.

Variables	1985-94	1985-89	1990-94
Constant	9.93 (5.68)	8.53 (2.54)	5.68 (1.80)
BRANCH	0.006 (1.78)		
CRED	-1.88 (2.17)	-2.13 (2.11)	
ROAbt	7.35 (3.55)	8.67 (3.61)	4.72 (3.56)
GOVDEF	5.39 (3.12)	4.85 (2.69)	
GROWTH (-1)	0.72 (2.02)	0.87 (1.94)	0.54 (1.79)
CONC		-1.67 (2.12)	
CAP			0.14 (1.85)
COSTINC			-0.88 (1.91)
R^2	0.19	0.18	0.16
N	230	115	115

Values in parentheses are absolute t-statictics

Appendix

Suppose that INTINC is interest income, INTEXP stands for interest expenses, NONINTINC represents noninterest income, NONINTEXP are noninterest expenses and A equals total assets. Accounting profit before loan losses and taxes can be written as:

$$\pi = \text{INTINC} - \text{INTEXP} + \text{NONINTINC} - \text{NONINTEXP} \qquad [A1]$$

By accounting definition

$$\text{INTINC}_{bs} = \text{INTINC},\ \text{INTEXP}_{bs} = \text{INTEXP},\ \text{NONINTINC}_{obs} = \text{NONINTINC},\ A_{bs} = A$$

where the subscripts bs and obs denote on- and off-balance sheet items respectively. Assume that NONINTINC is generated by transactions based on a pool of hypothetical assets A_{obs} and that these assets have identical features as A_{bs}. The question becomes how large A_{obs} has to be to generate the observed income stream NONINTINC. Since all assets are assumed to be equally profitable the following proposition must hold

$$(\text{INTINC}_{bs} - \text{INTEXP}_{bs} - \text{NONINTEXP}_{bs}) / A_{bs} = (\text{INTINC}_{obs} - \text{INTEXP}_{obs} - \text{NONINTEXP}_{obs}) / A_{obs}$$

In published bank statements both NONINTEXP_{bs} and NONINTEXP_{obs} are unobservable. The assumption of symmetry between on- and off-balance sheet assets implies that

$$\text{NONINTEXP}_{bs} / A_{bs} = \text{NONINTEXP}_{obs} / A_{obs} \qquad [A2]$$

From [A1] and [A2] we get

$$A_{obs} = A_{bs}(\text{INTINC}_{obs} - \text{INTEXP}_{obs}) / (\text{INTINC}_{bs} - \text{INTEXP}_{bs}). \qquad [A3]$$

By assumption

$$\text{NONINTINC} = \text{INTINC}_{obs} - \text{INTEXP}_{obs} \qquad [A4]$$

Combining [A3] and [A4] gives

$$A_{obs} = A_{bs}[\text{NONINTINC} / (\text{INTINC}_{bs} - \text{INTEXP}_{bs})].$$

This expression can be used to estimate the on-balance sheet equivalent A_{obs}. Adding A_{obs} to A_{bs} provides an alternative measure of banking activity (ATA, adjusted total assets).