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PRODUCTIVITY GROWTH MEASUREMENT IN THE BELGIAN BANKING SECTOR 1985-1989 *

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Abstract

This paper uses cross sectional data on 44 Belgian banks over the period 1985-1989 to analyze the characteristics of the cost structure in the banking sector and to estimate indices of productivity growth.

The results suggest that only the smallest banks are characterized by increasing returns to scale. The largest banks in the sample are estimated to operate under slight diseconomies of scale. Moreover, when output composition is taken into account it seems that specializing banks gain more from expansion than banks with mixed activities.

For the 'average' bank the size of productivity growth is estimated to be on average 0.7 % per year. However, productivity growth rates differ substantially according to the output mix and the scale of the bank.

Introduction

The banking sector has been confronted with a completely changing environment over the last decade. The commercial banking industry is now in the process of restructuring itself in response to both a number of drastic changes in information technology and the trend towards deregulation. These changes take place on a world-wide scale. National borders are opened and financial markets become global markets with global banking. In addition, there is a trend to "disintermediation". Because of new financial products (sicav's, new types of bonds, etc.) there is a movement to a direct contact between the borrower and the final investor through efficient markets with low information and transaction costs. Therefore banks lose their best (low-risk) borrowers and need other sources of revenue. On top of this evolution Belgian commercial banks are confronted with the phenomenon of despecialisation and the unification of the European Market in 1993 (Steinherr and Huveneers (1992)).

The consequence of the described trends is increased competition in the financial sector. To cope with this, banks rationalize their operations, change the scope of their operations through diversification or specialisation, and seek new ways to increase income (fee-business). Bank costs, the efficiency of borrowers, and investment in new technology form the hub of the discussion in the adaptation process of the commercial banks to the world-wide deregulation and increased competition in the financial markets (see, e.g., Belgische Vereniging der Banken (1990) and Steiner and Teixeira (1990)).

In this context of change, it is valuable to analyze the economic characteristics of the Belgian banking sector. Our purpose is not to prescribe what bank managers should do, but rather to produce empirical evidence about scale economies, cost complementarities and productivity growth. With respect to the latter, we want to find out whether productivity growth is affected by the output mix and/or the scale of the bank. Both knowledge of the structure of costs and of productivity growth should be useful in describing the implications of the restructuring process.

A number of authors have previously considered the cost and production structure in the banking industry. Early studies include Benston (1972), Gilligan and Smirlock (1984) and Gilligan and Marshall (1984)). More recently, Mester (1987) and Ferrier and Lovell (1991) estimated carefully specified multiproduct cost functions to analyze the degree of economies of scale and scope in US banking. Empirical studies are not limited to the US, however. For example, Dietsch (n.d.) derived estimates of scale and scope economies in the French commercial banking industry. Moreover, several similar studies have also been executed using Belgian data. Both the careful study of Pacolet (1989) and the time-series analysis of two major banks by Pallage (1991) have provided interesting insights into the production structure of the Belgian banking sector. Importantly, however, none of these studies pay attention to the evaluation of productivity growth over time[1].

The structure of this paper is as follows. In Section 1 we describe the methodology used to estimate the economic characteristics of the banking sector and to investigate the size of productivity growth. The methodology is largely based on the work of Caves et al. (1981). The empirical cost model that forms a crucial part of the suggested methodology is presented in Section 2. A review of the data available for this study is given in Section 3. The data were derived from the balance sheets and the loss-profit accounts of the individual institutions for the

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[1] Given the differences in terms of both the methodology and the data used it will be interesting to see if the results of these Belgian studies with respect to scale economies can be confirmed, see below.

years 1985 and 1989[2]. The results of the empirical investigation are discussed in Section 4. We describe the estimated characteristics of the cost structure of the bank sector and review the estimated nature of technological progress. Conclusions are summarized in Section 5.

1. Productivity growth measurement: methodology

In this section we present the underlying methodology that was used in this paper to analyze the cost structure and to evaluate productivity growth in the Belgian banking sector. The procedure closely follows the suggestions of Caves et al. (1981). They show how to derive information with respect to scale economies, cost complementarities, and productivity growth from a careful interpretation of estimated cost models. Although in principle all relevant results can be obtained from both a total cost function and from a variable cost model, we preferred to use the latter option in this paper[3].

A variable or restricted cost function of a multiproduct firm relates the minimum variable production costs to output levels, input prices for the variable inputs, and the levels of those production factors that are assumed to be fixed in the short-run. It has the following general form:

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[2] We are very grateful for the help received from R. Hendrickx, D. Vanden Broeck and P. Verpoest of the National Bank of Belgium in gathering these accounts. Despite these efforts it will become clear that the data are of somewhat less than desirable quality. Consequently, the results should be cautiously interpreted.

[3] The main problem with estimating a total cost function was that it required information on the user cost of capital for all banks included in the sample. We were unable to construct an acceptable user cost variable on the basis of the available data.

$$CV = CV(Y_1, \ldots . Y_n, K, p_1 \ldots . p_m, T) \tag{1}$$

where:

CV: variable cost

Y_i: output i (i=1,.....,n)

p_j: price of input j (j=1,.....,m)

K: capital stock

T: time index

The time index refers to the time period under consideration and is included to allow the measurement of the rate of productivity growth over time.

An important characteristic of the production structure in any industry is the degree of returns to scale. It is defined as the proportional increase in all outputs that could be realized after a given proportional increase in all inputs. Alternatively, it indicates how a proportional increase in all outputs affects costs. As a consequence, it provides information on the evolution of costs in an expanding industry. The sector under consideration is characterized by increasing, decreasing or constant returns to scale when costs increase less than proportionately, more than proportionately, or proportionately with a given percentage increase in all outputs. The degree of returns to scale can be estimated on the basis of the elasticities of the estimated variable cost function using the expression (see Caves et al. (1981))

$$RTS = \frac{1 - \frac{\partial lnCV}{\partial lnK}}{\sum_{i=1}^{n} \frac{\partial lnCV}{\partial lnY_i}} \tag{2}$$

There exist increasing or decreasing returns to scale if this expression is greater than or less than 1.

We consider two alternative indices of productivity growth over time. Intuitively, it makes sense to define productivity growth as the common rate PGY at which all outputs can grow over time with inputs held constant at their initial levels. In this framework productivity growth has occurred if a firm is able to produce more output with the same inputs. Alternatively, one could define productivity growth as the common rate PGX at which all inputs can be decreased over time with output held fixed at their initial levels. In this interpretation there is productivity growth if a firm is able to produce the same outputs with fewer inputs.

It is easy to show (Caves et al. (1981)) that the indices PGY and PGX are related to the variable cost function according to the following expressions

$$PGX=\frac{\frac{-\partial lnCV}{\partial t}}{1-\frac{\partial lnCV}{\partial lnK}} \tag{3}$$

$$PGY=\frac{-\frac{\partial lnCV}{\partial t}}{\sum_{i=1}^{n}\frac{\partial lnCV}{\partial LnY_i}} \quad . \tag{4}$$

Before proceeding an important remark is in order, however. Note from the above discussion that productivity growth is defined in a continuous time framework, i.e., it is defined in terms of the elasticities of the cost function with respect to time. Obviously, these elasticities can only be directly estimated on the basis of time-series information. In this paper, we only have information on costs for two sample years, 1985 and

1989. Therefore, our procedure for calculating productivity growth is based on a discrete-time interpretation of the expressions previously given. In a first step costs functions are estimated for the two years separately. In a second step we then use discrete approximations to formulas (3) and (4) in order to estimate average annual productivity growth between 1985 and 1989.

2. The empirical model

In the economic literature two different conceptions of the bank as a firm are found simultaneously (for more details see Mester (1987), Pacolet (1989) and Ferrier and Lovell (1991)). First, the production approach emphasizes the role of banks as producers of deposits and loans, using capital, labour and materials. In this case, bank output is typically measured by either the number of accounts or the number of operations related to them. Total bank costs include all operating costs incurred in the production of the outputs, but exclude interest costs. Second, the intermediation approach views banks as financial intermediaries that transform deposits into loans and other assets. In this interpretation bank outputs are usually defined as balance sheet aggregates and, in some cases, proxy variables for off-balance sheet activities. Under this approach, costs consist of operating costs plus interest costs.

Depending on the application one has in mind either of the two approaches may be appealing[4]. This paper is based on the intermediation approach, because in Belgian commercial banks the intermediation aspect remains the hub of the banking activity (Belgische Vereniging der Banken (1990, p.61)). We assume that banks use deposits (D), labor (L) and capital (K) as inputs in

[4] For example, Ferrier and Lovell (1991) argue that either approach is preferable to the other under particular circumstances.

order to provide credit in a variety of ways[5]. Given the heterogeneity of bank loans in terms of risk, maturity, etc., and in order to explicitly take into account the multi-product character of banks, we use three different types of bank lending as outputs, viz., loans to the private sector and to the foreign sector (Y_1), loans to the Belgian public sector (Y_2), and re-investment of funds by other bankers (Y_3). Moreover, we also introduced a proxy variable to capture the effect of "branching". The number of offices (VEST) is treated as a technological condition of production. Given the current debate on the possibility of excessive networks of offices in the banking sector, it is interesting to consider the cost implications of this branching variable.

In choosing an appropriate variable cost function we traded off flexibility versus robustness. On the one hand, one wants the cost function to be quite general, and to impose no strong undesirable a priori restrictions on the structure of the technology. This suggested the use of a general flexible functional form such as the translog (Christensen, Jorgenson and Lau (1973)). However, on the other hand it would be undesirable to derive results that are strongly affected by minor changes in the specification of the cost function. Given the relatively small sample (see below for more details) and the large number of parameters to be estimated in a fully flexible cost function our estimates of a general translog model turned out not to be robust for small changes in the specification. The large number of cross-products of outputs, capital stock and the number of offices introduced high collinearity in the data. As a consequence, the empirical procedure used to estimate the model required a large number of iterations before convergence could be achieved, and many parameters were estimated to have extremely large standard errors.

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[5] Note that no materials input is included because of lack of reliable data.

Given these experiences, we preferred to give up some generality in return for robustness of the results. Specifically, the figures reported further in this paper are based on the following model, in which the theoretical restrictions of symmetry and of homogeneity in input prices have been directly imposed on the parameters

$$\ln(\frac{CV}{p_d})=\alpha_0+\alpha_{Y1}*lnY_1+\alpha_{Y2}*lnY_2+\alpha_{Y3}*lnY_3+\alpha_K*lnK+\alpha_L*\ln(\frac{p_l}{p_d})$$

$$+1/2*\alpha_{Y11}*(lnY_1)^2+1/2*\alpha_{Y22}*(lnY_2)^2+1/2*\alpha_{Y33}*(lnY_3)^2+\alpha_{Y12}*lnY_1*lnY_2$$

$$+\alpha_{Y13}*lnY_1*lnY_3+\alpha_{Y23}*lnY_2*lnY_3+1/2*\alpha_{LL}*(\ln(\frac{p_L}{p_D}))^2$$

$$+\alpha_{Y1L}*lnY_1*\ln(\frac{p_L}{p_D})+\alpha_{Y2L}*lnY_2*\ln(\frac{p_L}{p_D})+\alpha_{Y3L}*lnY_3*\ln(\frac{p_L}{p_D})$$

$$+\alpha_v*lnVEST+\alpha_{Y1v}*lnY_1*lnVEST+\alpha_{Y2v}*lnY_2*lnVEST+\alpha_{Y3v}*lnY_3*lnVEST$$

$$+\alpha_{Lv}*lnVEST*\ln(\frac{p_L}{p_D})+\alpha_{LK}*lnK*\ln(\frac{p_L}{p_D}) \qquad (5)$$

In this specification CV is variable cost, and p_L and p_D are the prices of labor and deposits, respectively. The corresponding cost share equations, derived using Shephard's lemma, are given by

$$S_L=\alpha_L+\alpha_{LL}*\ln(\frac{p_L}{p_D})+\alpha_{Y1L}*lnY_1+\alpha_{Y2L}*lnY_2+\alpha_{Y3L}*lnY_3+\alpha_{Lv}*lnVEST+\alpha_{LK}*lnK \qquad (6)$$

$$S_D=(1-\alpha_L')-\alpha_{LL}*\ln(\frac{p_L}{p_D})-\alpha_{Y1L}*lnY_1-\alpha_{Y2L}*lnY_2-\alpha_{Y3L}*lnY_3-\alpha_{Lv}*lnVEST-\alpha_{LK}*lnK \quad (7)$$

The main deviation of the specified model from a general translog is that we have assumed that the capital stock is separable from outputs and the number of offices. In other words, the marginal rates of transformation between the different outputs is assumed to be independent of the value of the capital stock. This hypothesis seems to be defensible on economic grounds. Moreover, statistical testing justified the chosen approach[6].

3. Description of the data

In order to be able to evaluate productivity growth on the basis of the estimated models we needed data on the prices as well as the quantities of labor and deposits, on the three bank outputs previously defined, on banks' capital stock, and on the number of offices operated by each bank. Moreover, this information was needed for both 1985 and 1989. Unfortunately, an important part of the required data is considered confidential by the banking sector and could not be directly obtained. Several variables that were not directly available had to be proxied on the basis of observable information. The primary source of data were the balance sheets and the loss-profit accounts of the individual banks. If better data become available, this defect can easily be remedied.

Data on the bank outputs previously identified was directly taken from the annual accounts of the individual banks. Similarly, no problems were encountered in obtaining the number of offices operated by each bank, and total employment in each

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[6] We were unable to reject the hypothesis that the capital stock was separable from outputs and the number of offices.

bank. The latter information was received from the 'Vereniging der Banken'. Note that the number of workers is not the most appropriate indicator of the labor input in banking. At least two corrections would be desirable. First, there may be some differences in the average number of hours worked per person between different banks as well as over time. In this sense a direct measure of the number of hours worked would be preferable to the number of workers itself. Second, it would be desirable to adjust the number of workers for quality differences. Unfortunately, the necessary information to make the appropriate adjustments were not available.

The expenditures associated with interest payments on deposits were directly taken from banks' profit-loss accounts. The price of deposits was constructed by dividing these interest payments by the total value of deposits, as indicated on the banks' balance sheets. Obviously, it would have been desirable to separate several types of deposits, viz. demand, short-term, and time deposits. However, due to a lack of data we were not able to make this distinction. Finally note that for most banks the interest costs represent the largest share of total costs.

Major problems were encountered in the determination of the two remaining explanatory variables of the cost function, viz. the capital stock and the price of labor. To start with the former, it seems reasonable to proxy the stock of physical capital by the book value of buildings, furniture, equipment and materials, as reported on the banks' balance sheets. However, it is well known that reported capital stocks are affected by firms' depreciation policies, variations in tax laws, etc. Moreover, they to some extent depend on whether banks own or rent their infrastructure. This does not imply, obviously, that the capital services provided by their office space is substantially different in the two cases.

Close inspection of the reported book values revealed that they were in some cases a very poor substitute for the stock of capital used in the production of outputs. Therefore, in order to obtain a more consistent proxy for the capital stock we proceeded as follows. First, nine banks with suspiciously low reported real estate were identified[7]. Their real estate input was then predicted on the basis of an auxiliary regression estimated using the remainder of the sample. This auxiliary equation related the book value of real estate to a variety of instrumental variables. This equation was used to predict the real estate capital for the nine unreliable observations. After making the reported corrections the capital stock variable was constructed by adding up the estimated real estate value and the reported book values of the category furniture, equipment and materials.

Finally consider the construction of the unit price of labor. In principle, this can be calculated for each bank by dividing total labor expenditures by total employment. Total labor expenditures are defined as the sum of wages and salaries on the one hand and the statutory and other benefits on the other hand. The statutory and other benefits can easily be found in the published loss-profit accounts. Unfortunately, total wages and salaries for each bank are treated as confidential by the banking sector. Although they are included under the heading of operating costs in the published loss-profit accounts, this item also contains other cost elements such as rental costs, material costs etc.[8]. As information received from within the banking sector suggested that the share of material costs was quite stable across the different banks, we only made a correction for real estate rental costs. For those banks that were assumed to rent their office space we subtracted the estimated rental costs from the reported operating costs. Following common practice in the

[7] These nine banks reported book values of buildings of less than 2,5 million Belgian Francs per office. The implicit assumption was that these banks are most likely to rent their offices.

[8] Figures with respect to item 9219 of the loss-profit accounts, which contains the required information, are not made available.

real estate literature we estimated these rental costs at 12 percent of the predicted book value of real estate. After making the described corrections the price of labour was calculated as the ratio of total labour expenditures to the number of workers.

4. Empirical results

In this section we report on the results obtained with respect to the cost characteristics and the size of technological progress in the banking sector using data for the years 1985 and 1989. All results were obtained using a sample of 44 banks. Although data were initially collected for 62 banks the information with respect to a number of observations turned out to be unreliable. Moreover, several banks were clearly outliers in the empirical analysis and had to be dropped from the original sample. We finally ended up with a consistent data set on 44 banks.

In each of the two years the cost model consisting of (5), (6) and (7) was estimated by iterative seemingly unrelated regression (Zellner (1962)). To avoid the singularity of the variance-covariance matrix of the residuals, equation (7) was deleted from the system. All variables were normalized by dividing each observation by the sample mean prior to estimation.

Regression results are reported in Table 1. The majority of the coefficients is significantly different from zero at conventional significance levels. The adjusted R-squared of the respective cost functions amounted to 0,963 and 0,957, respectively. Almost all parameters are of the same sign in 1985 and 1989. Moreover, many of them are of the same order of magnitude.

Table 1 : Estimates of the coefficients of the translog cost function and t-ratios

parameter	1985		1989	
	estimate	t-ratio	estimate	t-ratio
α_o	0,1037	1,2278	-0,2297	-1,9945**
α_{y1}	0,2224	1,7272	0,4579	2,7562**
α_{y2}	0,3803	3,2627**	0,5091	2,7132**
α_{y3}	0,3089	4,0001**	0,1797	1,9597**
α_K	-0,0054	-0,5938	-0,1942	-2,9438**
α_L	0,2351	5,9242**	0,2169	7,2193**
α_{y11}	0,0811	1,9782**	0,0794	1,3725
α_{y12}	-0,0036	-0,1667	0,0962	4,2814**
α_{y13}	-0,0445	-1,5914	-0,0941	-2,5243**
α_{y22}	0,0270	2,5462**	0,0212	1,8767**
α_{y23}	-0,0051	-0,2468	-0,0363	-1,5247*
α_{y33}	0,0456	2,0057**	0,0438	1,6346*
α_{LL}	0,1641	1,9932**	0,1171	4,3376**
α_{y1L}	-0,0132	-0,6539	-0,0522	-3,1997**
α_{y2L}	0,0003	0,3619	-0,0014	-0,1419
α_{y3L}	-0,0487	-3,8873**	-0,0206	-1,8952**
α_{LK}	0,0274	0,9858	0,0125	0,6209
α_V	0,0092	1,1696	0,0341	0,8767
α_{LV}	0,0296	2,4355**	0,0459	3,0791**
α_{y1V}	-0,0677	-1,4972*	-0,1393	-3,0028**
α_{y2V}	0,0272	0,8952	0,0089	0,2143
α_{y3V}	0,0136	0,3855	0,1257	3,3223**

* indicates significant at the 10 % level.

** indicates significant at the 5 % level.

Many of the individual α_{jk} parameters have little direct economic meaning. Moreover, given the relatively small sample one should be careful not to draw too strong conclusions from individual parameters. Despite these limitations, however, the results are interesting in a number of respects. For example, consider the effect of the number of offices on variable costs. The estimated cost model plausibly suggests that a larger number of offices, ceteris paribus, tends to imply larger cost shares of labour. Moreover, the number of offices decreases the marginal cost of lending to the private sector. In other words, it is easier to provide additional loans to the private sector if a more elaborate network of offices is available. There is also some evidence that the number of offices increases the marginal cost of interbank operations.

The estimation results do not allow clear conclusions with respect to the existence of cost complementarities between outputs. Cost complementarities are said to exist if an increase in one output reduces the marginal cost of another output. The negative and significant parameter of the cross product of private lending and interbank operations suggests the possible existence of cost complementarities between these outputs. However, strict application of the approximate tests proposed by Denny and Fuss (1977) indicated evidence of cost complementarities for 1989 only, the corresponding result for 1985 being inconclusive. Moreover, no other cases of cost complementarities were found. On the other hand, output composition does seem to affect the share of labor in variable costs. In the two sample years increased interbank lending is found to decrease the share of labor, ceteris paribus.

Combinations of the estimated parameters can be used to derive estimates of the economic characteristics of the banking sector. We first report estimates of the cost elasticities. These estimates are crucial to evaluate the degree of returns to scale and productivity growth. Table 2 reports cost elasticities with respect to outputs for the 'average' bank in the sample, i.e., the hypthetical bank which has all expanatory variables in the cost function precisely equal to the sample mean. These cost elasticities give the effect on variable cost of increasing an individual output by 1%. All cost elasticities are positive and five out of six are statistically significant. Taking the results at face value they suggest that, evaluated at the sample mean, increasing private and public lending has become more costly over time in the sense that it generates larger percentage increases in variable costs. A somewhat unexpected result is that lending to the public sector has a higher cost elasticity than lending to the private sector.

Table 2 : Estimated cost elasticities w.r.t. outputs, evaluated at the sample mean (standard errors in parentheses)

	y1	y2	y3	Sum
1985	0,2224 (0,146)	0,3803 (0,116)	0,3088 (0,077)	0,9115
1989	0,4579 (0,166)	0,5091 (0,188)	0,1794 (0,092)	1,1464

Note : y1 : loans in favour of the private sector and the foreign country
y2 : loans in favour of the Belgian public sector
y3 : re-investment of money by other bankers

Cost elasticities with respect to the fixed capital stock and with respect to the number of offices (the 'branching' variable) are presented in Table 3. Evaluated at the sample mean these elasticities are small and mostly insignificant. Obviously, this does not imply that the number of offices operated by a bank would have no impact on variable costs. The regression results indicated that the number of offices, ceteris paribus, reduced variable costs for banks specializing in lending to the private sector. Moreover, branching was found to increase the share of labor in variable costs.

Table 3 : Estimated cost elasticities w.r.t. capital stock and "branches" , evaluated at the sample mean (standard errors between brackets)

	Capital stock	Number of branches
1985	-0,0054 (0,0091)	0,0092 (0,0079)
1989	-0,1942 (0,0660)	0,0341 (0,0389)

We now turn to an analysis of the estimated indicators of returns to scale and productivity growth. Estimated scale economies are reported for the average bank in Table 4. In each sample year two figures are provided. The first one, denoted RTS, refers to the degree of scale economies on the assumption that the number of offices remains constant at the observed level. In other words, it gives the proportional increase in all outputs that can be realized for a given percentage increase in all inputs, but holding the number of offices constant. It can be loosely interpreted as economies of scale at the level of the individual office. The second indicator, RTS2, measures the degree of scale economies on the assumption that the number of offices increases proportionately with the inputs labor, deposits and capital[9].

The results suggest that the 'average bank' has very small economies of scale, which even somewhat declined between 1985 and 1989. For all practical purposes the figures for 1989

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[9] The indicator RTS2 can easily be shown to be given by

$$RTS2=(1-\frac{\partial \ln CV}{\partial \ln K}-\frac{\partial \ln CV}{\partial \ln VEST})/(\sum_{i=1}^{n}\frac{\partial \ln CV}{\partial \ln Y_i}).$$

point at approximately constant returns to scale. The results at the level of the individual office are very similar to those for the firm as a whole.

Table 4 : Economies of scale, evaluated at the sample mean

	RTS	RTS2
1985	1,1030	1,0929
1989	1,0417	1,0120

Note : RTS : scale economies when the number of branches is constant.
RTS2 : scale economies when the number of branches and the inputs vary proportionally

However, it seems useful not to restrict reporting of the results to the 'average' bank in the sample. Indeed, it is interesting to investigate to what extent banks with different characteristics in terms of size and output composition have different degrees of scale economies and have experienced different rates of productivity growth. We therefore split up the sample according to two criteria. First, we divided all banks in four groups on the basis of their total assets, as reported on their balance sheets. Second, we investigated to what extent the type of credit provided by banks affected the estimated scale economies and productivity growth by considering four subsamples defined on the basis of the composition of the balance sheet. Three groups were identified as 'focusing' their lending behaviour on respectively the private sector, the public sector, and on re-investment by other bankers. A fourth group was defined as banks with 'mixed' activities, i.e., banks that did not particularly specialize in any of the three categories of bank lending.

In Table 5 we investigate the relation between economies of scale and bank size. The figures reported there suggest that only the smallest banks in terms of total assets are characterized by increasing returns to scale. Interestingly, the results for 1989 indicate that the largest banks in the sample have slight diseconomies of scale. A percentage expansion in all outputs would more than proportionately increase costs, especially if this expansion can only be realized by increasing the number of offices being operated. Note that these results confirm the earlier findings of Pacolet (1989), Pallage (1991) and Gathon and Grosjean (1991).

Table 5 : Economies of scale according to bank size

	1985		1989	
	RTS	RTS2	RTS	RTS2
Class 1	1,3244	1,0847	1,4233	1,3969
Class 2	1,2024	1,1169	1,0214	1,1452
Class 3	1,0868	1,0912	1,0854	1,0864
Class 4	1,0405	1,1037	0,9191	0,8723

Note : Q = total assets (in thousands)
Class 1 : Q <= 5 000 000
Class 2 : 5 000 000 < Q <= 20 000 000
Class 3 : 20 000 000 < Q <= 100 000 000
Class 4 : 100 000 000 < Q

Economies of scale according to bank specialization are considered in Table 6. The results seem to suggest that specializing banks have more to gain from expansion than banks with mixed activities. This is consistent with our earlier finding of unimportant cost complementarities. Also note that banks specializing in public sector lending apparently have exhausted the available scale economies since 1985.

Table 6 : Economies of scale according to specialization

	1985		1989	
	RTS	RTS2	RTS	RTS2
Re-Invest	1,3422	1,2046	1,1254	1,0877
Public	1,2258	1,1094	1,0351	1,0328
Private	1,1329	1,0821	1,1629	1,0694
Mixed	1,0893	1,0487	1,0451	1,0142

Note : Re-Invest : share of Y3 in total output is greater than 50 %
Public : share of Y2 in total output is greater than 50 %
Private : share of Y1 in total output is greater than 50 %
Mixed : shares of Y1,Y2 and Y3 in total output are all less than 50%

Finally, to evaluate productivity growth the shift in the variable cost function, i.e., $\partial \ln CV/\partial T$, has to be measured. As we only have two sample years we approximate the shift in the cost function between years 1985 and 1989 as

$$\frac{\ln(CV^{85}(85))-\ln(CV^{89}(85))}{(85-89)} \qquad (8)$$

where $\ln CV^{85}(85)$ and $\ln CV^{89}(85)$ are the estimated cost functions for 1985 and 1989 evaluated at the 1985 values for outputs, input prices, capital stock and number of offices. In evaluating $\ln CV^{89}(85)$ and $\ln CV^{85}(85)$ all variables are held fixed at the values for the variables in 1985. The idea behind this calculation is straightforward. Since we hold all explanatory variables constant at their 1985 values, the difference in variable costs as given by (8) can only be explained by changes in productivity between 1985 and 1989. When the costs in 1985 at 1985 values are greater than the costs in 1989 this effect can be labeled the cost-reducing effect of technological progress. In other words, a positive value for (8) suggests productivity growth.

The results with respect to the shift in variable costs is then used to calculate the two indices of productivity growth PGY and PGX previously defined. In evaluating expressions (3) and (4) the cost elasticities with respect to outputs and capital stock were taken to be the mean values of the two sample years 1985 and 1989.

Average annual productivity growth rates for the 'average' bank in our sample are presented in table 7. The growth rate is estimated to be positive, but very small, approximately 0,7% per year[10].

Table 7 : Average annual productivity growth

PGY (%)	PGX (%)
0.712	0.663

Note : PGX : the common rate at which all inputs can be decreased over time with outputs held fixed.
PGY : the common rate at which all outputs can grow over time with inputs held fixed.

As before, it is instructive to consider productivity growth according to bank size and specialization. In Table 8 growth rates are reported for the average bank in each of the four size classes previously defined. Interestingly, the two classes containing the smallest banks have been characterized by almost no productivity growth whatsoever. Although the estimated effects are positive, they are extremely close to zero. The third group on the contrary has realized fairly substantial productivity growth, approximately 2% per year. However, the relation between productivity growth and size is clearly not monotonic. The fourth class, in which the largest banks are

[10] Steiner and Texeira (1990) found comparable results for the US. Their explanation was that the banking industry is in a transition period of restructuring in which two information systems are used simultaneously, and in which banks compete heavily with each other in the home market.

situated, is found to have experienced a substantial decline in productivity.

Table 8 : Average annual productivity growth according to bank size

	PGY (%)	PGX (%)
Class 1	0,29	0,21
Class 2	0,11	0,10
Class 3	2,04	1,88
Class 4	-2,73	-2,84

Note : see table 5.

Table 9 finally reports productivity growth rates according to bank specialization. The 'average' bank focusing on providing loans to the private sector is characterized by a decline in productivity of about 2% annually. The other specialized banks have experienced productivity increases.

Table 9 : Average annual productivity growth according to specialization

	PGY (%)	PGX (%)
Re-Invest	1,67	1,36
Public	3,85	3,46
Private	-2,21	-1,92
Mixed	1,80	1,59

Note : see table 6.

CONCLUSION

The purpose of this paper was to estimate the extent of productivity growth in the banking sector in Belgium over the period 1985-1989 on the basis of a variable cost function. Translog cost models were estimated using data from 44 banks. Although a number of interesting findings result from our estimates, it should be emphasized that the quality of the data has prohibited the estimation of more rigourous models. This would have allowed us to provide more detailed explanations for the observed evolution of productivity growth.

The main conclusions are easily summarized. First, the results suggest that in 1989 the 'average' bank has constant returns to scale. The largest banks in the sample have even slight diseconomies of scale. The results according to bank specialization seem to indicate that specializing banks have more to gain from expansion than the multi-product bank.

The 'average' bank had an average annual productivity growth rate of approximately 0,7 %. The productivity change differs significantly according to bank size. Medium sized banks had a substantial productivity growth while the largest banks have experienced an important productivity loss. In terms of output composition we found that banks focusing on lending to the private sector have experienced a productivity decline. The other bank types show an increase in productivity, especially those banks that specialize in providing loans to the public sector.

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