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Abstract

We employ the Luenberger productivity indicator to estimate productivity growth and its decomposition into technical change and efficiency change components for savings banks sectors in ten EU countries between 1996 and 2003. The Luenberger indicator requires less restrictive assumptions than standard non-parametric productivity indexes, and it allows the assumption of profit maximisation to be made for sample firms. We estimate average productivity growth in the savings banks sector to be 2.78 percent per annum and driven almost entirely by technical change. Whilst the general results confirm earlier findings, this study is one of the earliest to identify cross-border differences in productivity growth in the savings banks sector.

Keywords: Europe; savings banks; Luenberger productivity indicator.

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1. Introduction

The EU financial deregulation process constituted a major structural change that altered the competitive environment of the European banking system. As banking market structures become more liberalised, it is expected that these changes would feed through into competition, efficiency gains and productivity improvements for banks (Molyneux and Williams, 2005). The issue of productivity measurement is long debated. Following Nishimizu and Page (1982), total factor productivity change is decomposed into technological progress (the rate of change of the best practice frontier) and technical efficiency change (learning-by-doing, improved managerial practice as firms attempt to catch-up with industry best practice). A remaining question is how best to estimate productivity change.

Whilst productivity change can be determined by parametric and non-parametric methods (Odeck, 2007, and Casu et al, 2004 provide comparisons of estimated productivity growth derived from frontier methods and data envelopment analysis), the non-parametric Malmquist productivity index is used in several applications in banking (see Guzmán and Reverte, 2007). A drawback of the Malmquist approach is that it requires a choice to be made between an output or input perspective, which depends on the assumption of either revenue maximisation or cost minimisation at sample firms but not profit maximisation (Boussemart et al, 2003). This limiting assumption does not hold if productivity change is estimated using the Luenberger productivity indicator, which is a difference-based indicator as opposed to ratio-based like the Malmquist.[1] In its favour, the Luenberger indicator can account for output expansion and input contraction whilst assuming that sample firms maximise

[1] For further elaboration on productivity measurement by ratios (indexes) and differences (indicators), see Chambers (1996, 2002) and Diewert (2000, 2005).

profit. Evidence shows that ratio-based productivity indexes overestimate productivity change compared to productivity indicators (Briec and Kerstens, 2004; Boussemart et al, 2003, 2006).

We apply the Luenberger indicator to estimate productivity change in the European savings banks sector between 1996 and 2003.[2] Various implications for public policy arise from the productivity performance of savings banks (Williams, 2004). There is the need to establish if the deregulation model is achieving its intended effects on savings banks, which, typically, are small-sized banks serving local retail banking customers, and whose ownership rights are often ambiguous implying that the disciplining effect of the market for corporate control is absent.[3] For savings banks, the decomposition of productivity change can show to what extent national group organisational structures and their technology sharing arrangements benefit all savings banks irrespective of size. Productivity growth, attained by technological progress and/or efficiency gains, is an important goal for savings banks that target cost savings as transfers to reserves, which are intended to lessen the long standing capitalisation problems facing the sector.

The remainder of the paper is organized as follows: Section 2 synthesises the salient literature. The methodology is detailed in Section 3. Section 4 presents the data and the results whilst some conclusions are offered in Section 5.

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[2] So far as we are aware, there is one other application of the Luenberger productivity indicator in banking (see Park and Weber, 2006 for a study of productivity growth in Korean banks).

[3] The role of savings banks varies across countries: in the EU savings banks account for roughly 25% of non-bank customer deposits, 50% in Spain and around 40% in Germany (as at January 2006).

2. Bank efficiency, technical change and productivity growth

The empirical literature on European savings banks estimates bank efficiency, technical change and productivity change, with the bulk of studies concerned with estimating the level of efficiency. Carbo et al (2002), for instance, in a cross-country study use parametric methods to estimate the cost efficiency of EU savings banks between 1989 and 1996. They report an average cost inefficiency of around 22% with cross-country variations. Williams and Gardener (2003) also use parametric methods and report relatively low levels of cost inefficiency (7%), implying that " … regional bank management is responsive to changing market conditions with prudently managed banks becoming more cost efficient" (Williams and Gardener, 2003, p. 327). Other EU-wide studies seek to draw inferences about the efficiency performance of savings banks and commercial banks. Schure et al (2004) find on average that savings banks can reduce costs by between 15-20% compared with 20-25% for commercial banks. Consistent with Carbo et al (2002), Schure et al (2004) report considerable heterogeneity in cross-border inefficiencies. Single country studies tend to examine if bank organisational form explains efficiency differences. Evidence from Germany, where there is a large public-owned savings banks sector, implies the results are inconclusive (Altunbas et al, 2001).

Another strand of literature estimates the effect of technical change on bank costs. For the EU banking industry, Altunbas et al (2001) estimate that technical change lowered bank costs by 3.6% per annum between 1989 and 1996. In a study of the savings banks sector between 1989 and 1997, Carbo et al (2003) report a similar per annum reduction in bank cost of 3.4%. Wagenvoort and Schure (1999) report a similar finding that savings banks costs fell by 2% per annum because of technological progress. Evidence from the Spanish savings banks sector confirms the generalisation that technical change has lowered bank costs (Maudos et al, 1996).

European banks, in general, are realising productivity improvements, although the rate of growth varies across countries, possibly reflecting differences in the pace of banking sector consolidation (see Dietsch and Weill, 2000; Casu et al, 2004; Molyneux and Williams, 2005). This contrasts with evidence from the US that suggests productivity growth is limited (see Bauer et al, 1993; Humphrey and Pulley, 1997; Stiroh, 2000; Alam, 2001; Berger and Mester, 2003). US evidence finds a positive relationship between financial deregulation and profit productivity but the opposite for cost productivity (Berger and Mester, 2003). In Europe, the evidence is mixed: Kumbhakar et al (2001) and Kumbhakar and Lozano-Vivas (2005) find deregulation led to productivity growth in the Spanish savings banks sector but the opposite is reported by Griffel-Tatjé and Lovell (1997). This is attributed to differences in the specification of banks' output vectors.

In order to identify the sources of productivity change in the European savings banks sectors in six EU countries between 1990 and 1998, Williams (2001) uses parametric methods and finds mean growth of 2.86% per annum with technical change the main driver. Casu et al (2004) confirm the role played by technical change in driving productivity growth at a large sample of European banks, and supported by both parametric and non-parametric estimates. Similar results are observed for large US commercial banks (Mukherjee et al, 2001); Swedish banks (Kumbhakar et al, 2002); savings banks (Dietsch and Weill, 2000; Kumbhakar et al, 2001) and banks in general in Spain (Guzmán and Reverte, 2007).

3. Methodological Framework

3.1 Technology, directional distance function & Luenberger productivity indicator

Chambers et al (1996, 1998) propose more flexible measures of firm performance deriving from production theory. They introduced the "directional distance function", which is the transposition in production theory of Luenberger's "benefit function" in a consumer context (see Luenberger, 1992). This function determines a distance in one direction which permits an observed production unit to reach the production frontier. In economic terms, the function makes it possible to evaluate the economies which can be achieved, and the possible improvements in production; it also provides a "benchmark" by defining a reference point to be reached. The principal advantage of this function lies in its ability to take account simultaneously, and in a broader context, of both inputs and outputs. The directional distance function, therefore, measures the largest changes in inputs and outputs in a given direction which are necessary for a firm to reach the production frontier.

Let the technology be described by a set, $T_t^k \subseteq R_+^n \times R_+^p$, defined by

$$T_t^k = \{(x_t^k, y_t^k) : x_t^k \text{ can produce } y_t^k\}, \tag{1}$$

where $x_t^k \in R_+^n$ is a vector of inputs and $y_t^k \in R_+^p$ is a vector of outputs at the time period *t* for the bank *k*.

Throughout this paper, technology satisfies the following conventional assumptions:

A1: $(0,0) \in T_t^k, (0, y_t^k) \in T_t^k \Rightarrow y_t^k = 0$ i.e., no free lunch;

A2: the set $A(x_t^k) = \{(u_t^k, y_t^k) \in T_t^k ; u_t^k \leq x_t^k\}$ of dominating observations is bounded $\forall x_t^k \in R_+^N$, i.e., infinite outputs are not allowed with a finite input vector;

A3: T_t^k is closed;

A4: $\forall (x_t^k, y_t^k) \in T_t^k, (x_t^k, -y_t^k) \leq (u_t^k, -v_t^k) \Rightarrow (u_t^k, v_t^k) \in T_t^k$, i.e., fewer outputs can always be produced with more inputs, and inversely (strong disposal of inputs and outputs);

A5: T_t^k is convex.

The directional distance function generalizes the traditional Shephard (1970) distance function. Directional distance functions project input and output vectors from themselves to the technology frontier in a pre-assigned direction. In the case of a radial direction out of the origin, we retrieve the classical Shephard distance function. The directional distance function is defined as follows:

The function $D_t^k : R^{n+p} \times R^{n+p} \to R \cup \{-\infty\} \cup \{+\infty\}$ defined by

$$D_t^k(x_t^k, y_t^k; g) = \begin{cases} \sup\{\delta : (x_t^k - \delta h; y_t^k + \delta l) T_t^k\} & if \quad (x_t^k - \delta h; y_t^k + \delta l) \in T_t^k, \delta \in R \\ -\infty & otherwise \end{cases} \quad (2)$$

is called directional distance function in the direction of $g = (h, l)$.

To operate the approach, it is necessary to take an appropriate direction. We do this by considering the direction $g = (x, y)$. Then, the directional distance function is similar to the proportional distance function of Briec (1997). This distance function is based on simultaneous proportional modifications of inputs and outputs; it generalizes the Debreu and Farrell measures and is straightforward to interpret.

One of the most important properties of the production technology is its dual relation to the profit function. The profit function $\Pi : R_+^{n+p} \to R \cup \{\infty\}$ is defined as:

$$\Pi_t^k(r,w) = \sup_{x^k, y^k} \{ r y_t^k - w x_t^k : (x_t^k, y_t^k) \in T_t^k \}, \quad (3)$$

where $r \in R_+^p$ is the output price vector and $w \in R_+^n$ is the input price vector. Suppose that an individual bank is represented by a production vector (x_t^k, y_t^k) with corresponding technology T_t^k, and then the production vector is changed to (x_{t+1}^k, y_{t+1}^k) with corresponding technology T_{t+1}^k. In order to assign a cardinal measure to the productivity change we can use the directional distance function in one of two ways; corresponding to using either the initial technology at *t* or the final technology at *t+1* as reference. In this case, the Luenberger productivity indicator proposed by Chambers (1996) can be employed to evaluate productivity change. The productivity indicator is constructed as the arithmetic mean of the productivity change measured by the technology at T_{t+1} and the productivity change measured by the technology at T_t.

The Luenberger productivity indicator is defined as[4]:

$$L(z_t, z_{t+1}) = \frac{1}{2}\left[D_{t+1}(z_t; g) - D_{t+1}(z_{t+1}; g) + D_t(z_t; g) - D_t(z_{t+1}; g) \right]. \quad (4)$$

Positive growth (decline) is indicated by positive (negative) value. Unlike the Malmquist index, the Luenberger productivity indicator is additively decomposed:

$$L(z_t, z_{t+1}) = \left[D_t(z; g) - D_{t+1}(z_{t+1}; g) \right] +$$

$$\frac{1}{2}\left[D_{t+1}(z_{t+1}; g) - D_t(z_{t+1}; g) + D_{t+1}(z_t; g) - D(z_t; g) \right], \quad (5)$$

[4] We simplify the notations by posing $z_t = (x_t, y_t)$.

where the first term (inside the first brackets) measures efficiency change between time periods t and t+1 while the arithmetic mean of the difference between the two figures inside the second brackets expresses the technological change component, which represents the shift of technology between the two time periods. This decomposition was inspired by the multiplicative breakdown of the Malmquist productivity index (see Färe et al, 1989).

3.2 *Structural efficiency and aggregation*

In an aggregate context, and following Farrell (1957) and Briec et al (2003), we use an aggregate directional distance function constructed as:

$$D_t\left(\sum_{k=1}^{K} x_t^k, \sum_{k=1}^{K} y_t^k\right). \tag{6}$$

This aggregate efficiency indicator is referred to as a structural efficiency indicator, and the aggregate Luenberger productivity indicator (AL) is constructed as follows:[5]

$$AL\left(\sum_{k=1}^{K} z_t^k, \sum_{k=1}^{K} z_{t+1}^k\right) = \frac{1}{2}\left[D_{t+1}\left(\sum_{k=1}^{K} z_t^k\right) - D_{t+1}\left(\sum_{k=1}^{K} z_{t+1}^k\right) + D_t\left(\sum_{k=1}^{K} z_t^k\right) - D_t\left(\sum_{k=1}^{K} z_{t+1}^k\right)\right]. \tag{7}$$

Equation (7) allows similar decompositions to equation (5).

Farrell (1957) was the first to propose the concept of "structural efficiency" to measure the overall efficiency of an industry (as a group of firms). In a radial context, he suggested that it can be measured by the weighted average (by output) of the efficiency scores of individual units. Along this line, several studies clarify and develop a framework for the measurement of structural efficiency (see, for instance, Førsund and Hjalmarsson, 1979; Färe, Grosskopf, and Li, 1992; Li and Ng, 1995;

[5] See Färe and Primont (2003) and Färe and Grosskopf (2004) for discussion of the aggregation of the Luenberger productivity indicator.

Ylvinger, 2000; Färe and Zelenyuk, 2003; Li and Cheng, 2007). The different developments are based on the fact that the group of firms has an identical technology, which is a common assumption in efficiency analysis.

In a directional distance function framework, the aggregation of efficiency measures is investigated by Briec et al (2003) and Färe and Grosskopf (2004). However, these authors do not study fully the specific case of structural efficiency, and especially how the aggregate technology is constructed according to the returns to scale. To overcome this problem and define our aggregate technology, we follow Briec and Peypoch (2004) and show the equivalence between structural and industrial efficiency by employing Koopmans (1957) theorem.

The resource directional distance function proposed by Briec and Peypoch (2004) is the transposition in a production context of the resource function introduced by Luenberger (1996) in order to analyse the consumer's welfare from an aggregate viewpoint.

The resource directional distance function $R : R_+^{n+p} \times R_+^{n+p} \to R \cup \{-\infty\} \cup \{+\infty\}$ is defined as[6]:

$$R_t(x_t^j, y_t^j; g) = \sup\left\{\sum_{k=1}^{K} D_t^k(x_t^k, y_t^k; g) : \left(\sum_{k \in K_j} x_t^k, \sum_{k \in K_j} y_t^k\right) = (x_t^j, y_t^j)\right\}, \quad (8)$$

where the production choice for a group of banks j (at the country level in our case) is denoted by $z_t^j = (x_t^j, y_t^j) = \prod_{k \in K_j} (x_t^k, y_t^k)$.

Assume that for $k = 1,\ldots,K$, T_t^k satisfies A1-A5 (see page 7) at each time period t and denote $T_t = \sum_{k=1}^{K} T_t^k$ the aggregate technology. Then, the structural efficiency indicator in equation (6) is equal to the resource directional distance function defined by equation (9).

Koopmans (1957) provides a useful result that pertains to aggregation across units. If each of K banks maximizes profit, we have:

$$\Pi_t^k(r,w) = \max_{x^k,y^k}\{ry_t^k - wx_t^k : (x_t^k, y_t^k) \in T_t^k\}, k = 1,\ldots,K.$$

By choosing $(x_t^{k*}, y_t^{k*}), k = 1,\ldots,K$, then

$$(x_t^{k*}, y_t^{k*}) = \left(\sum_{k=1}^{K} x_t^{k*}, \sum_{k=1}^{K} y_t^{k*}\right)$$

maximizes profit on the aggregate technology set,

$$\Pi_t(r,w) = \max_{x,y}\{ry_t - wx_t : (x_t, y_t) \in T_t\}.$$

Conversely, if (x_t^*, y_t^*) maximizes profit on T and if there are vectors $(x_t^{k*}, y_t^{k*}), k = 1,\ldots,K$, such that

$$(x_t^*, y_t^*) = \left(\sum_{k=1}^{K} x_t^{k*}, \sum_{k=1}^{K} y_t^{k*}\right),$$

then each bank level vector, (x_t^{k*}, y_t^{k*}), maximizes profit on $T_t^k, k = 1,\ldots,K$. If we define the directional distance function for the aggregate technology by:

$$D_t(x_t, y_t; g) = \begin{cases} \sup\{\delta : (x_t - \delta h; y_t + \delta k) \in T_t\} & \textit{if} \quad (x_t - \delta h; y_t + \delta k) \in T_t, \delta \in R \\ -\infty & \textit{otherwise} \end{cases}$$

[6] See also Guironnet and Peypoch (2007) for an empirical contribution using this measure.

it is straightforward to prove that $D(x, y; g) = R(x, y; g)$. In words, the aggregation that takes place here is exactly the same as discussed by Koopmans (1957).

To estimate each aggregate efficiency indicator, we use a non-parametric approach (see Banker and Maindiratta, 1988; Varian, 1984). The technology can be written as:

$$\forall k \in K, T^k = T^K = \left\{ (x, y), x \geq \sum_{k \in K} \theta_k x^k, y \leq \sum_{k \in K} \theta_k y^k, \sum_{k \in K} \theta_k = 1, \theta \geq 0 \right\}. \quad (9)$$

The aggregate indicator requires the calculation of the aggregate technology and allows us to compare the banks of a country with the set of all banks of all countries. The linear program that calculates the values of the aggregate directional distance function is given by[7]:

$$R_t(z_t^j) = \max \sum_{k \in K_j} \delta_t^k$$

$$\text{s.t. } x_t^k - \delta_t^k g \geq \sum_{k \in K} \theta_k x_t^k, k \in K_j$$

$$y_t^k + \delta_t^k g \leq \sum_{k \in K} \theta_k y_t^k, k \in K_j \quad (10)$$

$$\sum_k \theta_k = 1,\ \theta_k \geq 0,\ \delta_t^k \geq 0$$

$$\sum_{k_j \in K_j} x_t^{k_j} = x_t^j,\ \sum_{k_j \in K_j} y_t^{k_j} = y_t^j.$$

Note that the constraint $\sum_k \theta_k = 1$ represents variable returns to scale.

[7] All the computations are programmed in Mathematica language with the Mathematica 5.0 software.

4. Data and empirical estimates of productivity change

The financial statements of European savings banks from ten EU countries are sourced from BankScope between 1996 and 2003 yielding 5,721 observations (see Table 1 for the distribution of sample data).

Table 1 here

We construct aggregate efficiency and productivity measures for saving banks in each country. To model the bank production process, we employ the intermediation approach of Sealey and Lindley (1977) which assumes that bank liabilities are transformed into earning assets.[8] Banks are assumed to produce four outputs that cover both on and off-balance sheet activities: (i) total customer loans, (ii) interbank loans, (iii) securities, and (iv) off-balance-sheet items.[9] Two inputs are used to produce bank output: (v) fixed assets and (vi) variable cost (defined as the sum of interest expense, personnel cost, and other non-interest income expense). The descriptive statistics are shown in Table 2.

Table 2 here

The aggregate Luenberger productivity indicators are calculated using linear programming techniques and the results presented in Table 3. The productivity indicator (AL) is decomposed into its constituents: technical efficiency change (the diffusion or catch-up component - EFFCH); and technological change (the innovation or frontier-shift component - TECH). EFFCH represents the diffusion of best-practice technology in the management of banking activities and it is attributable to investment planning, technical experience, and management and

[8] There are several approaches to modelling the bank production process: the production approach, user-cost approach, value added approach and dual approach (see Berger and Humphrey, 1992).
[9] Our choice of bank output is consistent with the established literature. This is important because the definition and measurement of output could significantly affect the level of bank efficiency (Berger and Humphrey, 1997).

organization. TECH results from innovations and the adoption of new technologies by best-practice banks in each country.

The average annual rate of productivity growth for EU savings banks between 1996 and 2003 is 2.79 percent. This estimate is slightly lower, yet consistent with the 2.86 percent reported for six EU savings banks sectors between 1990 and 1998 (Williams, 2001). This implies that savings banks are achieving productivity growth across the current period of EU financial deregulation. Consistent also with evidence on savings banks (Williams, 2001; Maudos et al, 1996), our results confirm technical change (at 2.74 percent) is the main source of productivity growth. Our technical change estimate is slightly lower than the 3.4 percent per annum reported for the sector between 1989 and 1997 (Carbo et al, 2003) and for European banks between 1989 and 1996 of 3.6 percent per annum (Altunbas et al, 2001). Nevertheless, the result implies that the benefits of savings banks' technology sharing arrangements extend across all banks. The results show there is a limited contribution made to productivity growth by efficiency change (0.323 percent). However, efficiency change is contributing, which contrasts with earlier evidence (Williams, 2001).

This study reports cross-country estimates of productivity change for savings banks sectors. So far as we are aware, this is the first study to estimate productivity change and its decomposition for the European savings banks sector. As might be expected, the results displayed in Table 3 exhibit cross-country heterogeneity. Productivity growth is highest in Finland (4.53 percent), Spain (4.488 percent) and France (4.223 percent) yet negative in Germany (-1.688 percent).

Table 3 here

As noted above, productivity growth in savings banks sectors is almost entirely driven by technical change, with the exception of Italy, Portugal and Spain. This implies that savings banks are benefiting from investment in new technologies (methodologies, procedures and techniques) and in the commensurate skills upgrades related to this. However, the finding of zero efficiency change in several sectors is a source of concern for bankers and policymakers because it implies that management is lagging behind observed best practice. Although benefiting from technical change, the average savings banks in Italy (0.53 percent), Portugal (0.82 percent) and Spain (1.871 percent) are catching-up to best practice.

From the results we observe three distinct combinations of technical change and efficiency change. First, there are three sectors where improvements in technical efficiency co-exist alongside improvements in technological change: in Portugal, Spain and Italy. We class these savings banks as the best-performing banks between 1996 and 2003. Second, we observe six sectors in which zero technical efficiency change co-exist with improvements in technological change: in Austria, Belgium, Finland, France, Luxembourg and Netherlands. Finally, in Germany, zero efficiency change co-exists with deterioration in technological change.

5. Conclusion

We employ the Luenberger productivity indicator rather than commonly applied non-parametric indexes for two reasons. Indexes overestimate productivity change relative to difference-based indicators like the Luenberger. The assumption that sample firms maximise profits is accommodated by the Luenberger indicator. Our application is to the savings banks sectors in ten EU countries from 1996 to 2003.

The results show that the average savings bank achieved annualised productivity growth of 2.79 percent over the period. This rate of growth is consistent with previous findings for savings banks drawn from parametric models (Williams, 2001). With regard to public policy, our results suggest that financial deregulation is positively associated with bank productivity growth, which confirms earlier evidence from Spain (Kumbhakar et al, 2001; Kumbhakar and Lozano-Vivas, 2005); the US (Berger and Mester, 2001); and some EU savings banks sectors (Williams, 2001). The implication is that EU financial deregulation has lowered production costs, which translated into cost savings that have been reflected in productivity growth.

The main source of productivity growth for savings banks is technical change, which confirms other findings for savings banks (Williams, 2001) and European banks (Casu et al, 2004). The productivity-driving role of technical change is all the more important given there is minimal evidence that suggests savings banks are catching up with best practice. Possible reasons for this finding include the absence of a disciplining market for corporate control, and possible agency problems arising from public and/or mutual ownership. Whilst this would concern bank regulators, it may be partially offset by the fact that productivity growth can be used to support capitalisation of non-joint stock savings banks.

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Table 1: Number of Saving Banks & Observations: by Country, 1996-2003

	1996	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*Total*
Austria	13	65	66	67	67	67	65	65	475
Belgium	15	14	14	13	12	11	10	7	96
Finland	1	1	1	1	1	1	1	1	8
France	22	22	22	29	30	30	30	28	213
Germany	592	584	588	572	556	527	490	233	4,142
Ireland	3	3	3	3	3	2	2	2	21
Italy	58	58	58	57	54	56	53	13	407
Luxembourg	1	1	1	1	1	1	1	1	8
Portugal	3	3	3	3	3	3	3	2	23
Spain	30	38	39	39	39	41	42	46	314
All banks	741	792	798	787	767	740	698	398	5,721

Source: BankScope.

Table 2: Descriptive Statistics: ECU million (inflation-adjusted); 1996-2003

		Inputs		Outputs			
Country	Statistic	Fixed Assets	Variable Cost	Customer Loans	Interbank Loans	Securities	OBS
AUS	Average	31.84	151.35	106.65	500.96	1158.33	437.89
	Std dev	477.56	101.43	5394.75	2013.42	2775.96	353.19
BEL	Average	41.65	142.40	304.18	2145.77	603.82	2774.39
	Std dev	2534.47	754.27	5442.54	1755.04	5515.38	10618.43
FIN	Average	121.90	35.67	133.71	1847.04	79.70	591.31
	Std dev	144.78	23.88	511.51	37.69	64.89	34.71
FRA	Average	140.82	436.59	927.54	6163.41	7790.45	2886.08
	Std dev	2029.34	2856.36	19105.14	22436.73	9152.78	7320.11
GER	Average	25.45	29.19	90.39	986.83	141.62	459.35
	Std dev	123.06	110.26	1273.27	232.45	564.97	352.79
IRL	Average	66.33	17.43	192.51	3267.36	876.31	230.85
	Std dev	210.80	67.39	1692.92	537.50	142.74	459.82
ITA	Average	65.00	118.83	219.08	2047.21	680.18	765.14
	Std dev	683.90	538.65	4921.22	2386.20	1682.09	2632.85
LUX	Average	256.04	7.37	2108.30	7136.39	11464.76	12547.76
	Std dev	3161.56	535.61	773.52	751.90	2417.59	251.06
PTE	Average	417.73	462.52	1387.81	15055.90	3162.62	4278.01
	Std dev	12672.90	1545.38	15622.75	4138.03	5779.96	17910.01
SPA	Average	267.44	455.57	488.61	6366.27	977.47	2380.87
	Std dev	509.88	814.40	9791.04	1931.48	3948.66	1017.13

Table 3: Average annual productivity growth, %:

European Savings Banks (1996-2003)

Country	Aggregate Luenberger (AL)	Efficiency change (EFFCH)	Technical change (TECH)
Austria	2.020	0.000	2.020
Belgium	3.183	0.000	3.183
Finland	4.530	0.000	4.530
France	4.223	0.000	4.223
Germany	-1.688	0.000	-1.688
Ireland	3.860	0.000	3.860
Italy	2.383	0.530	1.853
Luxembourg	1.741	0.000	1.741
Portugal	3.179	0.820	2.359
Spain	4.488	1.871	2.616
Mean	2.791	0.323	2.470
Median	3.181	0.000	2.488
Std Dev.	1.865	0.616	1.770