June 2007
IMF Country Report No. 07/199

Switzerland: Financial Sector Assessment Program—Technical Note—The Swiss Banking System: Structure, Performance, and Medium-Term Challenges

This technical note on the banking system structure, performance, and medium-term challenges for Switzerland was prepared by a staff team of the International Monetary Fund as background documentation for the periodic consultation with the member country. It is based on the information available at the time it was completed in May 2007. The views expressed in this document are those of the staff team and do not necessarily reflect the views of the government of Switzerland or the Executive Board of the IMF.

The policy of publication of staff reports and other documents by the IMF allows for the deletion of market-sensitive information.

To assist the IMF in evaluating the publication policy, reader comments are invited and may be sent by e-mail to publicationpolicy@imf.org.

Copies of this report are available to the public from

International Monetary Fund ● Publication Services
700 19th Street, N.W. ● Washington, D.C. 20431
Telephone: (202) 623 7430 ● Telefax: (202) 623 7201
E-mail: publications@imf.org ● Internet: http://www.imf.org

Price: $18.00 a copy

International Monetary Fund
Washington, D.C.

FINANCIAL SECTOR ASSESSMENT PROGRAM UPDATE

SWITZERLAND

TECHNICAL NOTE
THE SWISS BANKING SYSTEM—STRUCTURE, PERFORMANCE, AND MEDIUM-TERM CHALLENGES

MAY 2007

INTERNATIONAL MONETARY FUND
MONETARY AND CAPITAL MARKETS DEPARTMENT

Contents **Page**

I. OVERVIEW

1. **This technical note was prepared in the context of the 2006 Switzerland FSAP update**.[1] It presents an analysis of the structure, medium-term trends, and key challenges of the Swiss banking system, which is complemented with an assessment of various efficiency indicators based on data envelopment models. It also offers some policy recommendations.

2. **The Swiss banking system is large and plays an important role for the economy**. It comprises a segment of large and internationally-oriented banks (UBS and Credit Swiss), three segments of domestically-oriented banks that focus on retail lending to households and small- and medium-size companies (the cantonal, regional, and Raiffeisen banks), two segments of banks that focus mainly on private banking activities (the foreign banks and the Swiss private banks), and a segment of assorted institutions.

3. **The system has been undergoing substantial consolidation since the mid-nineties, albeit with substantial differences across bank segments**. Bank concentration ratios have been increasing to moderately high levels by international comparison, due to the combined effect of asset growth and a sustained drop in the number of institutions. Growth, however, has been uneven across bank segments, with a rapid increase in the balance sheets of the large banks, mainly reflecting their international expansion, and a relatively stagnant evolution in the domestically-oriented retail segments.

4. **Mirroring these trends, the domestically-oriented retail segments appear to systematically under-perform in terms of cost efficiency**. The note presents various estimates of cost efficiency (or the ability of a bank to produce a target set of outputs with the cost-minimizing input mix) for the entire banking system and for individual bank segments. The estimates suggest that about 15–25 percent of costs can be attributed to inefficiencies, which is within the range observed in other countries and somewhat lower than those obtained by Rime and Stiroh (2003) for Switzerland.[2] In various exercises, the segments of large banks and private banks are consistently selected in the sets of benchmark (i.e., more efficient) performers. On the other hand, the evidence suggests that there is room to attain additional efficiency gains in the segments of domestically-oriented banks (i.e., cantonal, regional, and Raiffeisen banks). Further, the results indicate that the domestically-oriented segments operate under increasing returns to scale, implying that the sizes of their constituent banks remain below the optimal efficient scale. Looking at the time evolution of efficiency, the gap between the benchmark institutions and the less efficient performers has been

---

[1] Prepared by Francisco Vázquez (Monetary and Capital Markets Department).

[2] This comparison, however, is only indicative, since it is based on point estimates without a measure of the statistical significance of the differences.

widening over the last ten years. In addition, there is also evidence of a widespread rebound in total factor productivity growth in the banking system since 2002, following a period of relative stagnation between 1995 and 2001.

5. **Over the medium term, a possible deceleration of potential growth would likely renew consolidation pressures**. The findings support the notion that underlying cost inefficiencies and economies of scale may be a key driving force behind the observed consolidation. Strong competition in the domestic market, combined with limited growth opportunities, would likely induce further development of the ongoing cost-sharing mechanisms between the relatively less efficient institutions, and possibly lead to additional exits and mergers. From the stability perspective, this is not likely to entail systemic risks due to the relatively small size of the institutions involved, particularly if the forced exits occur sparsely over time.

6. **The widespread public ownership of cantonal banks, and the existence of public guarantees on their deposits, entail public policy considerations**. In that regard, the note puts forward three recommendations. First, it is important to ensure that the cantonal banks operate with sufficient flexibility to conduct their business in a way consistent with profit maximization.[3] In this vein, the resources used to pay for social ends should ideally be taken exclusively from the taxes and dividends paid by the cantonal banks to their cantonal governments,. Second, the governance structures of cantonal banks should be strengthened to shield their operations from unwarranted political interference on their business objectives and managerial decisions. Third, over the medium-term, consideration could be given for further government divestment from the banking sector (an overview of reforms of public sector banks in the European Union is presented in Brunner *et al.*, 2004).

7. **The rest of the note is organized as follows**. Section II provides a brief description of the banking system structure and medium-term trends, including a cross-country comparison of customary structure and performance indicators. Section III describes the methodology used to assess cost efficiency. Section IV describes the data and results. Section V concludes with some policy recommendations.

---

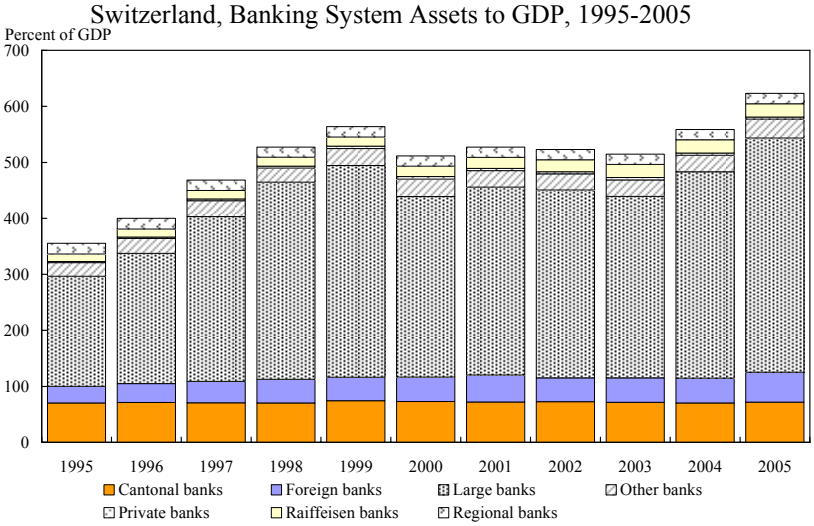
[3] A study by Bichsel (2006) finds no systematic differences between cantonal banks and the privately-owned banks regarding interest rate levels, pass-through rates, and mark-ups. These findings suggests that the behavior of cantonal banks has been driven by profit maximization rather than public welfare considerations.

II. Background and Medium-Term Trends

8. **The Swiss banking system is large and plays an important role for the economy**. Total system assets accounted for roughly six-times GDP in 2005, which is considerable by international comparison. In addition, deposits in custody accounts, which are held off-balance sheet, represented almost ten times GDP in 2005, reflecting the important role of private banking activities—a large part of which originates from foreign clients. The banking system contributes with about 12 percent of GDP and employs three percent of the labor force. Average labor productivity in banking, thus, is about four times overall productivity in the economy.

9. **The system has a dualistic nature, with two large and internationally-oriented banks, combined with a myriad of smaller institutions operating in various segments**. The two large banks, UBS and Credit Suisse, rank among the top ten worldwide and are important global players in exchange and derivative markets. Over the last ten years they have been growing substantially faster than the system average, mostly due to the expansion of their international activities. As a result, their share in the banking system has increased from about one-half in 1995 to two-thirds in 2005. The rest of the system is highly fragmented and, with exceptions, tends to be more closely oriented to the domestic market.[4]

Switzerland, Banking System Assets to GDP, 1995-2005



Source: SNB and IMF staff calculations.

10. **While all Swiss banks are allowed to operate as universal banks, most institutions tend to focus on specific business niches**. Swiss bank legislation does not distinguish between commercial and investment banking, allowing all banks to offer a wide range of financial services, including lending and deposit taking, trading, brokerage, underwriting, and portfolio management. The large institutions are widely diversified across

[4] The main exceptions are in the segments of foreign banks and the Swiss private banks which tend to be focused in private banking, mostly to non-resident clients.

the entire business spectrum. On the other hand, the smaller banks tend to be more focused on specific activities, ranging from asset and wealth management to traditional retail lending in specific geographic areas.

11. **Swiss banks may be classified in seven segments, reflecting differences in their ownership and business orientation**:

- The two **large banks** are listed on the Swiss and other international stock exchanges. They operate across the entire spectrum of financial activities, ranging from retail banking to investment banking, dominating most segments in the domestic market. They are also very active internationally.

- Most **cantonal banks** are entirely owned by their cantons, although they are allowed to sell up to two-thirds of their equity stakes without loosing their cantonal status, and may also raise capital through issuance of non-voting shares listed on the stock exchange. Cantonal banks are required to fulfill social objectives and enjoy public guarantees on their liabilities. They vary substantially in term of size and business activities, but their operations tend to be geographically limited to their cantons. Most cantonal banks focus on traditional retail lending, mostly mortgages, albeit the larger are also active in a wide range of financial activities.

- The **regional banks** have mutual ownership and are grouped under the umbrella of the RBA Holding, which they own. The RBA Holding facilitates the cost-sharing of support processes such as finance, information systems, and communication. Regional banks are mostly focused on traditional retail mortgages and, to a lesser extent, on lending to small- and medium-size enterprises. Their activities tend to be limited to specific geographical areas, reflecting historic and cultural differences.

- The **Raiffeisen banks** are credit cooperatives traditionally located in rural areas, which have been more recently expanding into the cities. They also focus on retail services, mainly mortgages and credit to small- and medium-sized enterprises. The Raiffeisen banks are grouped under an umbrella organization that facilitates cost-sharing, providing its members with various services.

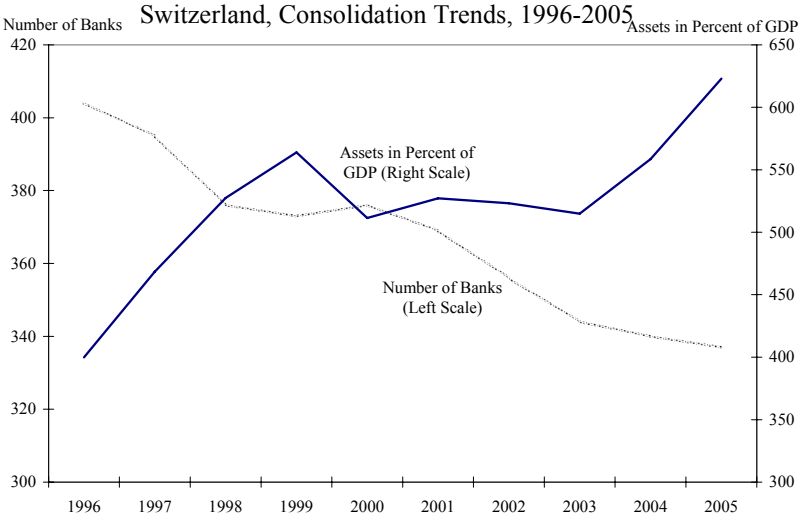
- The **foreign banks** include subsidiaries and branches of foreign institutions and are mostly focused on private banking to foreign residents. In recent years, some foreign banks have been also expanding their focus to retail business in the domestic market.

- The structure of **private banks** is varied and often family-oriented. The top-end Geneva-based private banks have partnership structures with unlimited liability as a prevailing rule. They do not issue deposits and are not bound by regulatory capital requirements nor required to disclose their financial statements. They focus on private banking to foreign clients.

- **Other banks** include institutions with miscellaneous activities that cannot be clearly assigned to the previous categories.

12. **In the recent past, the system has been undergoing substantial consolidation**. Following the collapse of the property market and the economic slowdown in the early 1990s, the system experienced a large reduction in the number of institutions, from 495 in 1990 to 404 in 1996 and further to 337 in 2005. The number of branches also decreased by a substantial 21 percent over the last decade, from 4,424 in 1996 to 3,503 in 2005, mainly driven by rationalization in the segments of large banks, cantonal, and regional banks. Concurrently, the size of the aggregated bank balance sheet almost doubled, from about three-times GDP in 1996 to six-times GDP in 2005, resulting in a steady increase in the average bank size, from ChF 3.7 billion in 1996 to ChF 8.4 billion in 2005.

Switzerland, Consolidation Trends, 1996-2005

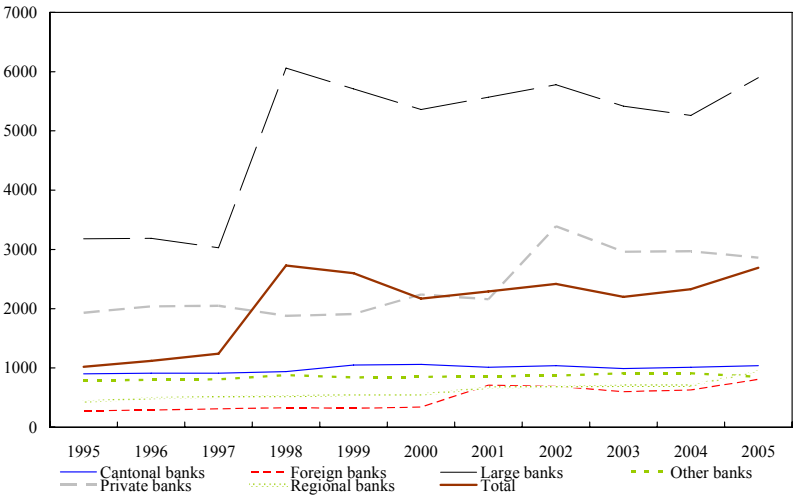


Source: SNB and IMF staff calculations.

13. **The growth of bank balance sheets, however, has been uneven both in time and across segments**. For the entire system, a sharp drop in asset growth between 1997–2000 was followed by a stagnant period between 2000–2003 and a strong rebound afterward. To a large extent, these trends reflected developments in the segment of large banks. A somewhat distinct pattern was displayed by the Raiffeisen banks, with growth rates above average since 2000, reflecting their decision to expand into the cities. As a result, their share in system assets increased from 2.9 percent in 1999 to 3.8 percent in 2005. On the other hand, the segments of regional and cantonal banks were relatively less dynamic, shrinking in relative terms over the last ten years from a joint share of 25.3 percent of system assets in 1995 to 14.4 in 2005.

14. **Bank concentration ratios have been increasing to relative high levels, albeit with substantial differences across segments**. The Herfindhal concentration index[5] increased from 1,020 in 1995 to 2,690 in 2005, which is high by international comparison (Table 1), and the five-bank concentration ratio from 60 percent in 1995 to 76 percent in 2005. The strongest increases in concentration occurred in the segment of large banks, driven by their substantial asset growth, followed by the segment of private banks. In contrast, concentration in the domestically-oriented retail segments has remained roughly unchanged at moderate levels. In 2005, the Herfindhal index was 1,040 in the segment of cantonal banks, and 950 in the segment of regional banks.

Switzerland, Herfindhal Indexes by Bank Segments, 1995-2005



Source: SNB and IMF staff calculations.

15. **Consolidation has been generally accompanied by a decrease in the importance of traditional retail banking relative to financial market activities**. With the exceptions of the Raiffeisen banks and regional banks, which remain focused on retail lending, trading activities have been increasing in other bank segments since 2002. In the case of the large banks, trading portfolios account for an important share of their assets, increasing from 14.3 percent in 2001 to 20.6 percent in 2005. In other bank segments, however, trading portfolios remain considerably less important in relative terms despite recent trends. Asset and wealth management activities have been also expanding rapidly across the board since 2003. Securities maintained off-balance sheet in custody accounts increased by 51.9 percent in 2002–2005, rebounding from a previous downturn. On the liabilities side, the reliance on customer deposits as a source of financing has been increasing in all bank segments since 2000.

[5] Measured on a scale from 0 to 10,000—with larger values indicating higher concentration.

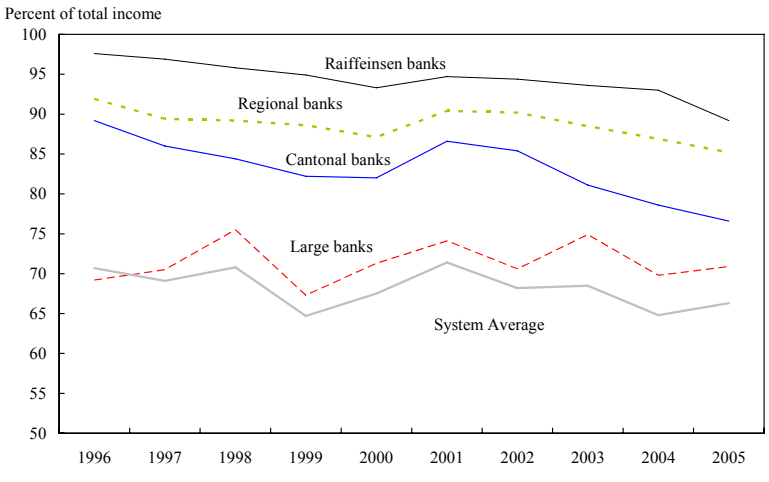
Table 1. Indicators of Banking System Structure in Comparator Countries, 2005

	Assets to GDP	Credit to GDP	5-bank Concentration Ratio	Herfindahl Index	Number of Credit Institutions	Number of branches per Th. inhabitants
Austria	294	134	45	560	880	0.5
Belgium	354	122	85	2108	100	0.4
Denmark	346	184	66	1115	197	0.4
Finland	151	76	83	2730	363	0.3
France	298	99	54	758	854	0.4
Germany	304	135	22	174	2089	0.5
Ireland	588	208	46	600	78	0.2
Italy	177	90	27	230	792	0.5
Luxembourg	2702	494	31	312	155	0.5
Netherlands	338	189	85	1796	401	0.2
Spain	238	141	42	487	348	1.0
Sweden	227	120	57	845	200	0.2
U.K.	470	156	36	399	400	0.2
Average	499	165	52	932	527	0.4
Switzerland	623	389	76	2690	337	0.5

Source: ECB, SNB and IMF staff calculations.
1/ Data as of end-2004 for France and the Netherlands.

16. **Reflecting these trends, and intense competition in the domestic market, the relative importance of interest revenues relative to trading and fee income has been decreasing**. For the system as a whole, interest revenues accounted for 66 percent of total revenues in 2005, down from 71 percent in 1996. There are, however, significant differences across segments. The large banks have a diversified revenue structure, with interests accounting for about 70 percent of total revenues in 2005, fee income for another 20 percent, and trading income for the remaining 10 percent. Foreign and private banks, rely heavily on fee income, which represents 44 percent and 75 percent of their total revenues, respectively, in 2005. On the other hand, the cantonal, regional, and Raiffeisen banks depend

Switzerland, Evolution of Interest Revenues, 1996-2005



Source: SNB and IMF staff calculations.

almost exclusively on interest revenues, albeit their importance has been also declining steadily over time.

17. **Customary performance indicators appear roughly in line with comparator countries**. The undergoing consolidation process has been likely supporting an improvement in performance in the Swiss banking system. At the same time, the development of cooperation and cost-sharing arrangements between small institutions has also contributed to improve bank performance, providing a way to exploit synergy opportunities and standardize key productive processes. Customary performance indicators for the Swiss banking system appear roughly in line with comparator EU countries. For example, operating costs to assets have been falling steadily, from 2 percent in 2000 to 1½ percent in 2005, and are slightly above the average of comparator EU countries (Table 2). Cost-to-income ratios[6] increased somewhat during the same period, from 53.7 percent in 2000 to 63 percent in 2005, which is roughly similar to the average of comparator EU countries. The profitability of Swiss banks has improved to solid levels, with return on assets (ROA) increasing from 0.5 percent in 2002 to 0.9 percent in 2005, compared with an average of 0.6 percent in comparator countries.[7] These performance indicators suggest that, by international comparison, the Swiss banking system stands in a middle range. However, as argued below, this information somewhat limited to assess operating efficiency. The rest of the note takes a closer look into this.

III. Assessing Cost Efficiency: an Application of Data Envelopment Analysis

18. **As in other industries, assessing economic performance in banking is difficult**. Commonly-used financial indicators such as ROA, or cost-to-income ratios, convey useful information on financial performance, but offer little guidance to identify best practices and are clearly insufficient to assess operating efficiency. The later is further complicated by the fact that productive processes usually entail the combination of many inputs to produce several outputs, while the relationships among them, or technologies, generate trade-offs that are unknown to the external observer.

---

[6] Cost-to-income ratios provide a rough measure of operating performance. They are computed by dividing operating expenses (excluding interest expenses and loan-loss provisions), by the sum of net-interest revenues plus non-interest income.

[7] Profits per employee also doubled over the same period, from ChF 92.6 thousands per employee in 2002 to ChF 207.5 thousands in 2005.

Table 2. Indicators of Bank Performance in Comparator Countries, 2005

(In percent)

	Net interest income to assets	Total expenses to assets	ROA	Interest income to total income	Cost-to-income ratio
Austria	1.7	1.6	0.6	67.0	63.3
Belgium	1.1	1.2	0.5	61.7	65.3
Denmark	1.1	0.9	0.6	67.0	55.9
Finland	1.3	1.1	0.7	67.1	56.8
France	0.7	1.7	0.6	26.0	66.0
Germany	1.0	1.2	0.1	55.9	68.9
Ireland	1.0	0.9	0.7	58.5	49.4
Italy	2.1	2.0	0.6	61.1	58.1
Luxembourg	0.6	0.8	0.5	41.4	53.9
Netherlands	1.4	1.6	0.5	58.6	67.3
Portugal	1.9	1.9	0.8	59.9	58.9
Spain	1.7	1.5	0.8	62.4	55.3
Sweden	1.4	1.3	0.6	65.2	60.1
U.K.	1.6	1.0	0.8	69.3	42.9
Average	1.3	1.3	0.6	58.6	58.7
Switzerland	0.8	1.5	0.9	60.9	63.0

Source: ECB, SNB and IMF staff calcualtions.

19. **This note uses data envelopment analysis (DEA) to analyze cost efficiency in the Swiss banking system**. DEA is a linear programming technique for performance evaluation and benchmarking in a multivariate setting. The methodology exploits information on the input-output mix of individual entities to construct an efficient frontier enveloping the data, and then uses the frontier as a benchmark to assess various efficiency indicators for individual entities.[8] An appealing feature of DEA originates from its capacity to produce efficiency estimates without requiring *a priori* functional restrictions on the underlying productive processes. By duality, the DEA problem can be set up in two equivalent and exchangeable ways, producing two alternative distance orientations. The first set up minimizes the use of inputs given a target output mix, and the associated measures are called input-orientated. The second maximizes output using a given input mix, and the associated measures are called output-orientated. The exercises presented in this note exploit one

[8] Detailed presentations of DEA are provided, for example, in Fare, Grosskopf, and Lovell (1994), and Zhu, (2003).

approach, or the other, depending on the objective. In particular, the input-orientated measures are used in several exercises which assess bank performance in a static way (i.e., at a particular point in time), exploiting the cross-section dimension of the data. In addition, the output-orientated measures are used to assess the time evolution of performance and efficiency indicators, exploiting both the time and the cross-section dimensions of the data. Since DEA has been widely documented in the literature (see, for example: Fare, Grosskopf, and Lovell, 1994, and Zhu, 2003), only a brief illustration follows to help the interpretation of the results.

20. **In this note, DEA was used to produce estimates of technical efficiency (TE), allocative efficiency (AE), cost efficiency (CE), and returns to scale (RTS) in the Swiss banking system**. Technical efficiency refers to the ability of a bank to minimize input use, given a target output mix (or, alternatively, to maximize the output mix with a given a set of inputs). Allocative efficiency refers to the ability of a bank to select the cost-minimizing input combination, given input prices and a target output mix. Overall cost efficiency is the compounded effect (i.e., the product) of technical and allocative efficiency, and provides a measure of the gap between an observed input-output mix and its cost-minimizing alternative. Returns to scale provide a measure of the change in production in response to a proportional increase in all inputs, thus allowing to compare the observed size of a given bank with it's efficient scale.

21. **The results obtained with DEA depend on the validity of two conditions**. First, the technologies used by the banks included in each estimation have to be comparable (i.e., the institutions have to be dedicated to similar activities). Second, the sets of inputs and outputs used in the comparison must adequately reflect the nature of banking activity. The fact that all Swiss banks are allowed to conduct universal banking provides some ground to compute efficiency indicators based on the entire population of banks—if markets are contestable. However, the fact that Swiss banks tend to specialize in different business niches also raises some caveats on the validity of this approach.

22. **Recognizing this, four complementary exercises were carried out to overcoming methodological limitations and checking the robustness of the results**. The note presents various exercises to check robustness to changes in the sample of banks and alternative input-output choices. A baseline exercise computes efficiency estimates using the entire population of Swiss banks classified in seven segments.[9] A second exercise was conducted taking into

[9] These comprise the segments of: large banks, foreign banks, private banks, cantonal banks, cooperative banks (Raiffeisen), regional banks, and other banks. A brief description is provided in Section II.

account possible differences in the technologies of banks operating in various segments. This exercise was similar to the baseline, but applied only to banks operating in the domestically-oriented retail segments. These include the cantonal, regional, and Raiffeisen, which are more likely to be comparable. A third exercise provided an international comparison of efficiency in the domestically-oriented retail segments in Switzerland, using information on comparable bank segments in four industrial countries: France, Germany, Spain, and the UK. Finally, a fourth exercise looked at the evolution of efficiency in the Swiss banking system during 1996–2005, using a Malmquist index of total factor productivity growth (Malmquist, 1953; Caves, Christensen, and Diewert, 1982), and applying the efficiency decomposition proposed by Fare *et al.*, 1994.

23. **The exercises were based on two alternative sets of inputs and outputs aimed at capturing the nature of banking activities**. The choice of inputs and outputs followed the bank intermediation approach originally proposed by Sealey and Lindley (1977), which assumes that banks intermediate funds between depositors and borrowers at the lowest possible cost. The applications presented in this note used two alternative input-output specifications. The preferred one assumed that banks produce three outputs: loans, trading securities, and securities held in custody accounts, by combining three inputs: deposits, personnel, and bank branches. The corresponding input prices were also estimated by dividing interest expenses over total deposits, total personnel expenses over number of staff, and other operating costs (i.e., excluding interest expenses and personnel expenses) over the number of branches. The alternative specification considered two inputs: interest revenues and non-interest income, with the same set of inputs described before.

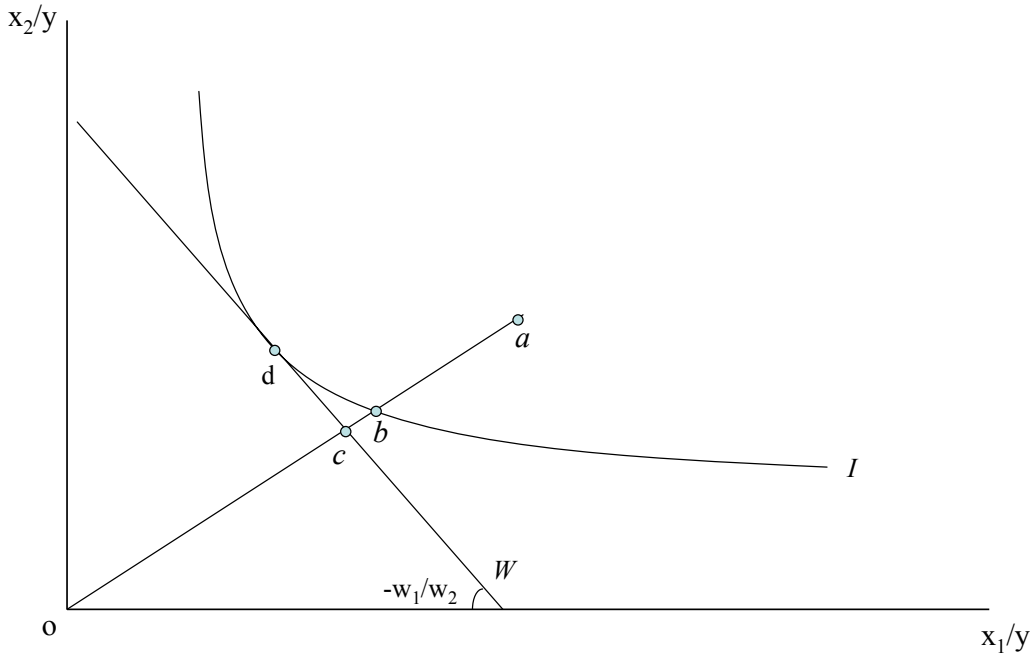
A. Input-Orientated Efficiency Measures

24. **The concept of technical efficiency (TE) and its measurement can be illustrated with the help Figure 1**. Consider a firm producing a single output y with two inputs x_1 and x_2 with the input-output combination represented by point a. To facilitate the presentation, further assume that the technology entails constant returns to scale (CRS) technology, represented by the unit isoquant I.[10] Clearly, the input-output mix given by point a is inefficient, as it lies inside the production frontier entailed by the isoquant. A measure of the technical inefficiency could be given by the distance ab, which measures the amount by which the two inputs could be proportionally reduced without affecting output. Alternatively, technical inefficiency could be normalized using the ratio of ab/ao, and represented by its

[10] The assumption of CRS is not critical for DEA. The general application considers a setting with multiple inputs and outputs, as well as non-constant returns to scale.

complement TE=1–*ab*/*ao*=*bo*/*ao*. The resulting measure, which is commonly used, varies between zero and one, with a larger value indicating higher technical efficiency. In particular, a value of one would indicate that a specific input-output combination lies on the efficient isoquant.

Figure 1. An Illustration of Technical and Allocative Efficiency



25. **In this setting, allocative efficiency (AE) can also be assessed if information on input prices is also available**. Suppose input prices in the example are given by w_1 and w_2 and represented by the isocost line *W*. At the relative input prices, the cost-minimizing input mix would be given by point *d*. Therefore, the technically-efficient point *b* entails an excess cost equivalent to the distance *bc*, and a relative measure of this allocative inefficiency could be given by the ratio AE=*co*/*bo*. Following a similar reasoning, total cost efficiency (CE) can be defined as:

$$CE = \frac{co}{ao} \equiv \frac{co}{bo} \times \frac{bo}{ao} \equiv TE \times AE \qquad (1)$$

These three measures are bounded between zero and one, where higher values imply higher efficiency. Further, they can be readily interpreted as percent deviations. For example, a value of economic efficiency of 0.8 implies a gap of 0.2, or that the firm is 20 percent less efficiency than its benchmark comparators.

26. **Additional restrictions on the basic model can be used to relax the CRS assumption and compute scale effects**. The CRS assumption is valid only when banks are operating at the efficient scale. If this fails to hold—due for example to imperfect competition or other frictions—the TE estimates will be biased by the presence of scale efficiencies (SE). A subtle modification of the model, however, can be used to relax the CRS assumption and compute TE under non-increasing returns to scale (NIRS), as well as under variable returns to scale (VRS). Since the TE scores obtained under the later are not influenced by scale effects, they provide a way to testing the validity of the CRS assumption and obtaining an estimate of scale effects.[11]

27. **The practical implementation of these measures requires information on the production function of the fully efficient—or benchmark—firms**. This usually entails some sort of frontier estimation. The literature provides two main alternatives: (i) stochastic frontier models, and (ii) DEA. The first approach requires the specification of a production function which is fitted to the data using econometric techniques. As mentioned before, this note used the second approach, which is non-parametric and can be implemented without prior knowledge on the trade-offs between inputs and/or outputs. The formal set-up of the input-orientated DEA problem is briefly presented in Annex I.

B. Malmquist Index of Total Factor Productivity Growth

28. **This note uses an output-orientated Malmquist index of total factor productivity growth to measure the evolution of productivity over time, and disentangle between changes in technical efficiency and changes in technology**. In addition to the cross-section described above, DEA-like linear programs can be applied to panel data to compute a Malmquist index of total factor productivity growth in a multiple input-output setting, allowing for technology changes along the time dimension Fare *et. al.* (1994). Further, the Malmquist index can be split in two mutually exclusive and exhaustive components: changes in technical efficiency (i.e., catching up), and changes in technology (i.e., innovation) over time.

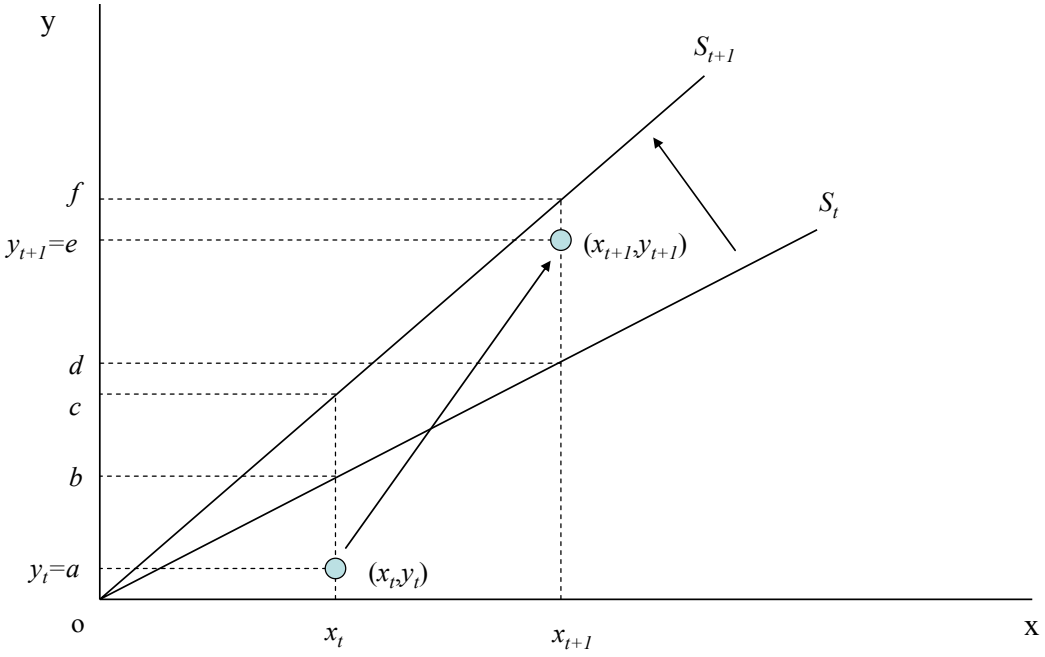
29. **To illustrate, suppose that banks produce one output using a single input and a CRS technology shown in Figure 2**. At time *t*, the observed input-output mix is given by

---

[11] In particular, there are three possible combinations. For a bank operating under CRS, the VRS TE estimates will be equal to both the NIRS TE estimates and the CRS TE estimates. On the other hand, for a bank operating under increasing returns to scale (IRS), the VRS TE estimates will exceed the NIRS TE estimates, and the later will be equal to the CRS TE estimates. Finally, for a bank operating under decreasing returns to scale (DRS), the VRS TE estimates will be equal to the NIRS TE estimates, and these in turn will be exceed the CRS TE estimates.

(x_t, y_t) and the maximum feasible production set by S_t. Similarly, the observed input-output mix at time t+1 is given by (x_{t+1}, y_{t+1}) and the maximum feasible production set by S_{t+1}. In this example, the two input-output combinations are technically inefficient, as they lie below their corresponding frontiers. A measure of the inefficiency at a specific point in time could be given by the vertical distance between the corresponding input-output mix and its frontier. Since the distance is vertical, it would indicate the amount by which output could be expanded with the observed input use (i.e., the distance if output-orientated). For period t, this distance is given by $D_t(x_t, y_t)=oa/ob$.[12] Similarly, the distance for t+1 is $D_{t+1}(x_{t+1}, y_{t+1})=oe/of$. These two distances vary between zero and one, with a larger value indicating higher technical efficiency. In principle, two parallel distance measures could be also defined, by comparing the input-output mix at a given point in time against the frontier of the other period. For instance, the distance between input-output mix at time t and the potential output under technology at t+1 is: $D_{t+1}(x_t, y_t)=oa/oc$. Similarly, by re-labeling the variables, $D_t(x_{t+1}, y_{t+1})=oe/od$. The last two distances, however, can result in values greater than one, since the input-output combination in a specific point in time may fall outside the production set of the other period.

Figure 2. An Illustration of the Distance Functions Under CRS



[12] In words, this distance compares the observed output y_t with its potential, given input x_t and the technology available at time t.

30. **These four distances described above can be used to disentangle changes in technology and changes in efficiency between two points in time**. Notice that, in this illustration, the relative position of the two production frontiers implies technical improvement between time *t* and *t*+1. At the same time, the vertical distances between the input-output mixes and their corresponding frontiers may change over time. These two effects (i.e, changes in technology, and changes in technical efficiency) can be measured separately by combining the four distance measures described above in a single index. In particular, an output-oriented Malmquist productivity index may be expressed as:

$$M_{t+1} = \frac{D_{t+1}(x_{t+1}, y_{t+1})}{D_t(x_t, y_t)} \times \left[\frac{D_t(x_{t+1}, y_{t+1})}{D_{t+1}(x_{t+1}, y_{t+1})} \times \frac{D_t(x_t, y_t)}{D_{t+1}(x_t, y_t)} \right]^{1/2}, \quad (2)$$

where the first term measures the change in relative efficiency between the two time periods (i.e., the catch-up effect), while the term in square brackets measures the technical change (i.e., the evolution of the production frontier). In the example provided in Figure 2, the index becomes:

$$M_{t+1} = \frac{oe/of}{oa/ob} \times \left[\frac{oe/od}{oe/of} \times \frac{oa/ob}{oa/oc} \right]^{1/2} = \frac{oe/of}{oa/ob} \times \left[\frac{of}{od} \times \frac{oc}{ob} \right]^{1/2}. \quad (3)$$

Notice that the term under square brackets is a geometric mean of the vertical distances between the two production functions, with the distances measured through the observed input-output mixes.

31. **Under this metric, an improvement in productivity would produce an index greater than one, while a deterioration would imply an index below unity**. In addition, improvements in any of the two components of the Malmquist index would be associated with values exceeding unity, while a deterioration would be associated with values below unity. The overall index therefore reflects the relative changes in these two components, which may be mutually reinforcing, neutral, or opposite.

IV. DATA AND RESULTS

32. **This section describes the results of four exercises carried out to assess efficiency in the Swiss banking system**.[13] All the exercises exploit a large bank-level dataset comprising the population of Swiss banks, classified by bank segments, during 1995–2005.[14] The first compares efficiency across bank segments in Switzerland using the entire population of banks. As discussed above, this exercise provides a useful preliminary benchmark notwithstanding differences in business focus across bank segments, as all Swiss banks are allowed to conduct universal banking (and are, therefore, potential competitors in any market niche). The second exercise goes a step further, restricting the analysis to banks that focus on retail lending in the domestic market. In particular, it compares efficiency between the cantonal, regional, and Raiffeisen banks banks. The third exercise provides a cross-country perspective of cost efficiency, exploiting data for domestically-oriented retail banks in selected industrial countries. Finally, the fourth exercise assesses the time evolution of productivity and efficiency indicators in the seven Swiss bank segments during 1996–2005.

33. **Each exercise was carried out using two alternative characterizations of banking activity, to ameliorate possible methodological limitations and provide a robustness check to the results**. While DEA does not require an explicit modeling of the underlying technologies and trade-offs between inputs, the results depend on the relevance of the selected inputs and outputs. The exercises exploit two alternative specifications:

- The preferred specification (Model 1) assumes that banks produce three outputs with three inputs. The set of outputs includes: (i) loans, (ii) trading securities, and (iii) securities in custody accounts. The first two are customary in the literature and represent a considerable part of bank assets (85 percent in 2005). The inclusion of securities in custody accounts seems justified by the importance of private banking in Switzerland.[15] On the set of inputs, the preferred specification includes deposits, personnel, and number of bank branches. The later is intended to measure banks' distribution networks. More customary measures such as fixed assets was not

---

[13] All the estimations were carried out using the code developed by Coelli (1996).

[14] The author is grateful to the Swiss National Bank (SNB) for providing the data.

[15] Two variants of this specification were also explored with roughly similar results: (i) a two-output specification using loans and trading securities; and (ii) a two-output specification using loans and total securities (i.e., including securities in the banking book). These two specifications, however, neglect the role of private banking activities, as they ignore securities in custody accounts.

considered because they represent a nil proportion of total bank assets (0.6 percent in Switzerland at end-2005) and tend to be a poor measure of the market value of fixed assets. Input prices were estimated using information from the financial statements. In particular, average interest expenses were computed by dividing total interest expenses over deposits, while average personnel remunerations were computed by dividing total personnel expenses over the number of employees. The cost of branches was approximated by dividing the remaining operating costs (i.e., excluding interest expenses, personnel expenses, and loan provisions) over the number of branches. These three cost categories, thus, add-up to the entire operating expenses.

- The second specification (Model 2) uses two outputs: (i) interest revenues and (ii) non-interest revenues (i.e., the sum of net trading income, plus commission and fee income). Inputs were the same as before. Accordingly, this specification encompasses the entire operating revenues and expenses.

A. Baseline Results: Cost Efficiency Across Bank Segments

34. **The baseline exercise assessed efficiency across the seven bank segments in Switzerland**. The results of the preferred specification, presented in Table 3, were computed using end-2005 data aggregated by bank segments, and are thus indicative of their respective averages. All the efficiency scores are in percent. A score below 100 indicates that the corresponding segment failed to operate at the efficient frontier, and thus implies the presence of unexploited efficiency gains. The upper panel presents the results under CRS, while those in the lower panel allow for VRS.

35. **The results indicate that average efficiency in the system is relatively high, with technical efficiency slightly better than allocative efficiency**. As discussed in the methodology, the efficiency estimates under the CRS specification, presented in the upper panel, are generally lower than those computed under VRS. This reflects the better fitting of the frontier to the data under VRS. Overall, the average cost efficiency for the entire system is 81.7 percent, implying that the average gap between the observed input-output mixes and their efficient references along the frontier is 18.3 percent (i.e., 100–81.7). The benchmark segments under the two specifications are the large banks and the private banks (i.e., they have an overall cost efficiency score of 100). The foreign banks are also selected as benchmark institutions regarding technical efficiency, but their input mix does not seem adequate given the relative cost of inputs. This is reflected in their allocative efficiency scores (72.1 percent in the VRS model).

36. **The results also indicate that the retail, domestically-oriented segments have the potential to attain further efficiency gains**. Overall, the lowest efficiency scores under both the CRS and the VRS estimations were attained by the institutions grouped under the category “other banks”. On the other hand, the cost efficiency estimates for the cantonal, Raiffeisen, and regional are roughly similar, albeit the later belong to the set of benchmark

institutions for technical efficiency under the VRS model. In fact, the relative ordering of the efficiency scores for these three segments appeared to be sensitive to model specification, as discussed below. A closer look into the intermediate calculations, not presented in the table, suggests that these three bank segments are using excessive personnel and number of branches to attain their observed output, relative to the efficient segments. There is also evidence that the domestically-oriented bank segments are not operating at the efficient scale, since the TE estimates obtained under the VRS assumption are larger than those obtained under CRS (see footnote 13). A closer look at the NIRS TE estimates, not shown, indicates that these segments are in fact operating under increasing returns to scale (IRS), suggesting that their sizes are too small to exploit scale economies.

Table 3. Efficiency Scores, Model 1, 2005

(In percent)

	Technical Efficiency	Allocative Efficiency	Cost Efficiency	
Constant Returns to Scale				
Cantonal banks	85.3	82.3	70.2	
Foreign banks	100.0	74.0	74.0	
Large banks	100.0	100.0	100.0	
Other banks	73.1	78.9	57.7	
Private banks	100.0	100.0	100.0	
Raiffeisen banks	77.7	79.1	61.5	
Regional banks	84.2	78.7	66.3	
Mean	88.6	84.7	75.7	
Variable Returns to Scale				
Cantonal banks	88.8	85.2	75.7	IRS
Foreign banks	100.0	74.9	74.9	-
Large banks	100.0	100.0	100.0	-
Other banks	75.8	76.7	58.1	DRS
Private banks	100.0	100.0	100.0	-
Raiffeisen banks	89.7	85.0	76.3	IRS
Regional banks	100.0	89.7	89.7	IRS
Mean	93.5	87.4	82.1	

Source, SNB and IMF staff calculations.

Based on a DEA excersice with three outputs: loans and trading securities, and securities in custody accounts, and three imputs: deposits, personnel, and number of branches.

37. **These findings are not entirely surprising, since the domestically-oriented retail segments tend to be populated by small institutions**. While in recent years competitive pressures have encouraged the development of cost-sharing arrangements through the outsourcing of back operations, the results suggest that there is still further room to attain

efficiency gains. In the case of Raiffeisen, which comprise a large number of cooperatives operating under a common organizational umbrella, there may be tension between the potential efficiency gains of further centralization and the aim of preserving some degree of diversity across members. Regional banks have also explored a parallel centralized arrangement under the RBA, but cultural barriers appear to be factoring in. Cantonal banks operate under institutional constraints originating from their public ownership and their social mandate. They may not enjoy complete flexibility in staffing policies and their branch network may be also influenced by geographic outreach goals more closely linked with social considerations.

38. **The efficiency gap with the benchmark performers has been widening somewhat over the last ten years**. A complementary exercise was conducted to assess the medium-term evolution of cost efficiency across segments. The exercise was similar in all aspects, but the data was divided in two equal sub-periods and separate efficiency scores were computed for 1996–2000 and 2001–2005. The results are presented in Table 4. The first three columns show the efficiency scores for the more recent period (i.e., 2001–2006), while the last three columns show the change in the efficiency scores relative to the first period. A negative value indicates a drop in the corresponding efficiency score between the two sub-periods. Overall, the results are qualitatively consistent with those presented above. Chiefly, the cantonal, regional, and Raiffeisen, together with the group of other banks, seem to lag somewhat in terms of cost-efficiency, relative to the benchmark segments. At the same time, there is also evidence that the efficiency gap with the benchmark segments increased somewhat between these two sub-periods. For example, the estimated average efficiency gap under the VRS model widened by 10.1 percentage points. In the domestically-oriented retail segments, the efficiency gap increased for the cantonal (–9.0 percentage points), and Raiffeisen banks (–7.6 percentage points), but narrowed somewhat for the regional banks (1.8 percentage points) due to improved allocative efficiency.

39. **A robustness check using Model 2 was also computed, yielding similar qualitative results, albeit generally lower efficiency estimates for the domestically-oriented retail segments**. The results are presented in Table 5. Overall, the average efficiency score (83.9 percent), as well as its components, are roughly consistent with those obtained under the previous specification, albeit the difference between technical efficiency and allocative efficiency is now smaller. The relative ordering of the bank segments is also consistent with the previous findings, with the exception of foreign banks, which are now included in the set of benchmark institutions. In contrast, the efficiency scores of the cantonal, Raiffeisen, and regional banks are now generally lower, particularly for technical efficiency, indicating a larger gap in revenue generation relative to the benchmark institutions, given input use. As before, the results for these three segments indicate the presence of IRS, suggesting that the size of banks operating in the domestically-oriented segments is below the optimal scale. In fact, the difference between the VRS TE estimates

and the CRS TE estimates for these three segments under Model 2 is larger than the difference obtained under Model 1.

Table 4. Evolution of the Efficiency Scores under Model 1, 1996–2005

(In percent)

	Average 2001-2005			Difference 2001-05 relative to 1996-00		
	Technical Efficiency	Allocative Efficiency	Cost Efficiency	Technical Efficiency	Allocative Efficiency	Cost Efficiency
Constant Returns to Scale						
Cantonal banks	90.1	85.5	77.0	-9.9	-5.4	-13.9
Foreign banks	100.0	72.5	72.5	0.0	-21.6	-21.6
Large banks	100.0	100.0	100.0	0.0	0.0	0.0
Other banks	74.7	78.9	58.9	-25.3	-21.1	-41.1
Private banks	100.0	100.0	100.0	0.0	0.0	0.0
Raiffeisen banks	81.7	82.9	67.8	-18.3	-6.6	-21.7
Regional banks	88.9	80.0	71.2	-11.1	-10.2	-19.0
Mean	90.8	85.7	78.2	-9.2	-9.3	-16.8
Variable Returns to Scale						
Cantonal banks	93.3	87.7	81.9	-6.7	-3.2	-9.0
Foreign banks	100.0	73.8	73.8	0.0	-20.3	-20.3
Large banks	100.0	100.0	100.0	0.0	0.0	0.0
Other banks	89.3	72.7	64.9	-10.7	-27.3	-35.1
Private banks	100.0	100.0	100.0	0.0	0.0	0.0
Raiffeisen banks	92.1	89.0	81.9	-7.9	-0.5	-7.6
Regional banks	100.0	92.0	92.0	0.0	1.8	1.8
Mean	96.4	87.9	84.9	-3.6	-7.1	-10.1

Source, SNB and IMF staff calculations.

Based on a DEA excersice with three outputs: loans, trading securities, and securities in custody accounts, and three imputs: deposits, personnel, and number of bank branches.

Table 5. Efficiency Scores under Model 2, 2005

(In percent)

	Technical Efficiency	Allocative Efficiency	Cost Efficiency	
Constant Returns to Scale				
Cantonal banks	60.4	81.6	49.3	
Foreign banks	100.0	78.9	78.9	
Large banks	100.0	100.0	100.0	
Other banks	83.2	76.0	63.2	
Private banks	100.0	100.0	100.0	
Raiffeisen banks	52.4	78.3	41.0	
Regional banks	59.3	78.7	46.7	
Mean	79.3	84.8	68.4	
Variable Returns to Scale				
Cantonal banks	68.2	83.3	56.9	IRS
Foreign banks	100.0	100.0	100.0	-
Large banks	100.0	100.0	100.0	-
Other banks	100.0	91.0	91.0	DRS
Private banks	100.0	100.0	100.0	-
Raiffeisen banks	78.6	79.5	62.5	IRS
Regional banks	100.0	77.0	77.0	IRS
Mean	92.4	90.1	83.9	

Source, SNB and IMF staff calculations.

Based on a DEA excersice with two outputs: interest revenues and trading revenues plus fee income, and three imputs: deposits, personnel, and number of branches.

40. **A limitation of the exercise presented in this section arises from the potential differences in business technologies between bank segments**. As discussed previously, differences in the business focus of banks operating in various segments may lead to differences in their technologies. The next section takes a closer look into this.

B. Cost Efficiency in the Domestically-Oriented Retail Banks

41. **The exercise presented in this section restricts the assessment of cost efficiency to the segments of domestically-oriented retail banks, in order to convey a more homogeneous comparison**. The sample covers 104 institutions (out of the 337 system-wide) operating in three segments: 24 cantonal, 79 regional, and the Raiffeisen banks banks. Together, the institutions operating in these segments represent 18 percent of assets, operate 66 percent of the total number of branches in the country, and employ 23 percent of total bank employees. A quick comparison of these figures indicates that the combined institutions

included in this exercise have more branches, and also more employees per unit of assets, than the system average.

Table 6. Summary Efficiency Estimates for the Domestically Oriented Retail Banks, 2005

(In percent)

	Technical Efficiency	Allocative Efficiency	Cost Efficiency	Number of Banks	Number of Benchmark Banks
Cantonal banks	90.7	92.0	83.8	24	6
	(10.3)	(6.5)	(13.3)		
Raiffeisen banks	100.0	100.0	100.0	1	1
	(n.a.)	(n.a.)	(n.a.)		
Regional banks	87.7	88.5	77.6	79	8
	(12.9)	(6.6)	(13.3)		
Entire Sample	88.5	89.4	79.2	104	15
	(12.4)	(6.7)	(13.6)		

Note: Unweighted averages, in percent; standard deviations in parenthesis.
Source, SNB and IMF staff calculations.
Based on a DEA excersice with three outputs: loans, trading securities, and securities in custody accounts, and three imputs: deposits, personnel, and number of bank branches.

42. **The overall estimates of cost efficiency are roughly in line with the previous exercise, but the relative ordering of the three bank segments is different**. The estimation was carried out using Model 1 and assuming VRS. Since the institutions included in this exercise tend to be small, no attempt was made estimate of returns to scale. As shown in the last column of Table 6, the selected benchmark institutions comprise 15 banks, including six cantonal banks, the Raiffeisen, and eight regional banks. The average cost efficiency for the entire sample (79.2 percent) is relatively high and roughly consistent with the range of values obtained in previous exercises. The estimates of technical efficiency are also high and similar to allocative efficiency. This suggest that average deviations from the benchmark institutions is relatively small and that the input mix is roughly consistent with cost minimization given the relative input prices. Looking across bank segments, all the technical and allocative efficiency scores of the cantonal banks are above those of the regional banks, running contrary to the relative ranking obtained in previous exercises. The average gap for technical efficiency is 3 percent (i.e., 90.7–87.7), and the average gap for allocative efficiency the gap is 3.5 percent.

43. **The estimated cost efficiency does not appear to be systematically related with the size of the sampled institutions**. The distribution of the results, classified by bank segments and quartiles of bank size, is presented in Table 7. The Raiffeisen banks are in the largest size group (i.e., the fourth quartile) because their member cooperatives are pooled

together as a single institution. The cantonal banks are also classified mainly in the fourth quartile, while the regional fall in the first three quartiles, reflecting their smaller sizes. The results suggest that the efficiency gap does not vary systematically with bank size, which probably reflects relative homogeneity within the bank segments used in the exercise (i.e., the exclusion of the large institutions). Banks classified in the first quartile obtained an average cost efficiency of 82.8 percent, which stands very close to the 82.4 percent obtained in the fourth quartile. Moreover, the estimated cost efficiency is roughly similar across bank segments and bank sizes, and the distribution of the benchmark institutions is also uniform. Out of the 15 benchmark institutions, four are located in the first quartile, compared with seven in the fourth quartile. Further evidence that the distribution of the cost efficiency estimates for the domestically-oriented banks is not related with their size is provided in Figure 3.

Table 7. Distribution of Cost Efficiency by Segments and Quartiles of bank Size, 2005

(In percent, unless otherwise indicated)

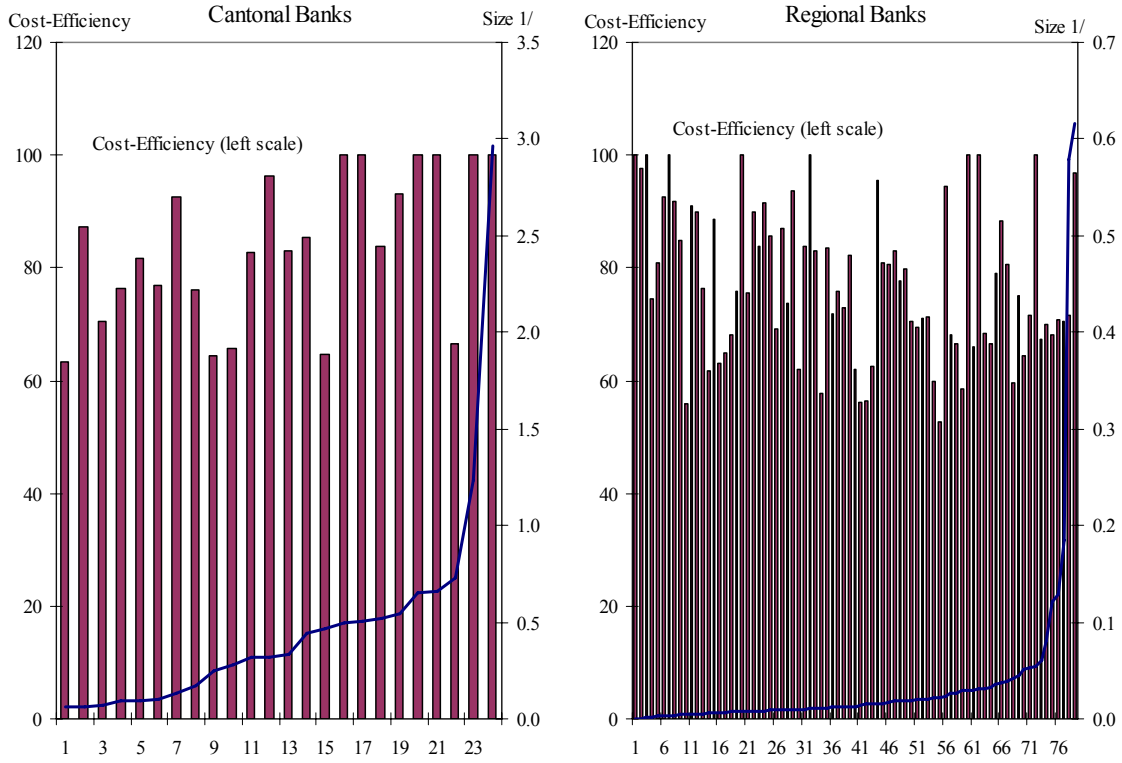
	Quartiles of bank size				
	1	2	3	4	Total
Cantonal banks					
Average cost efficiency	.	.	74.4	85.6	83.8
Number of benchmark banks	.	.	.	6	6
Number of banks	.	.	4	20	24
Raiffeisen banks					
Average Cost Efficiency	.	.	.	100.0	100.0
Number of benchmark banks	.	.	.	1	1
Number of banks	.	.	.	1	1
Regional banks					
Average Cost Efficiency	82.8	75.8	74.0	75.5	77.6
Number of benchmark banks	4	1	3	.	8
Number of banks	26	26	22	5	79
Total					
Average Cost Efficiency	82.8	75.8	74.1	84.2	79.2
Number of benchmark banks	4	1	3	7	15
Number of banks	26	26	26	26	104

Source, SNB and IMF staff calculations.

Based on a DEA excersice with three outputs: loans, trading securities, and securities in custody accounts, and three imputs: deposits, personnel, and number of bank branches.

Figure 3. Cost-Efficiency Estimates for the Domestically-Oriented Banks, 2005

(In percent)



1/ Bank size in percent of system assets.
Source: SNB and IMF staff calculations.

C. A Cross-Country Perspective

44. **This section presents a complementary view, providing a cross-country assessment of cost efficiency in the segment of domestically-oriented retail banks**. It uses information for parallel bank segments in four industrial countries: France, Germany, Spain, and the UK. These countries offer a useful reference as they are comparable to Switzerland in terms of development of financial markets and the broad institutional framework. Furthermore, the structure of the banking systems in France, Germany and Spain is based on a three-pillar system composed of public institutions, private institutions, and a segment of cooperatives, (see Brunner, *et al.*) and thus offer a relevant comparison for Swiss banks. The data was gathered from the OECD Banking Statistics, covering five years 1999–2003 (the more recent information available). The institutions covered include only resident banks, including their domestic and foreign branches and their domestic subsidiaries, but excluding their foreign subsidiaries. The bank segments were selected trying to cover retail-oriented institutions mainly focused on their domestic markets. Depending on the characteristics of

individual countries, these included: commercial banks (excluding large international institutions), savings banks, credit cooperatives, and regional institutions (Table 8). In some countries, the sample includes institutions operating under a social mandate, sometimes entailing public ownership. For example, the regional banks in Germany act as financial institutions to state governments, while the savings banks in Spain operate as non-profit organizations entrusted with social objectives.

Table 8. List of Sampled Bank Segments by Country

Country	Bank Segment
France	Cooperative banks
	Comercial banks
	Other banks
	Savings banks
Germany	Cooperative banks
	Comercial banks
	Regional Inst. of Cooperatives
	Regional Giro Inst. (Landesbanken)
	Savings banks
Spain	Commercial banks
	Cooperative banks
	Savings banks
Switzerland	Cantonal banks
	Raiffeisen
	Regional and savings banks
U.K.	Commercial banks

45. **The assessment was conducted using two alternative input-output choices, trying to maintain consistency with the previous exercises within data constraints**. The first specification (Model 1) used loans and securities holdings as outputs, and deposits, personnel, and number of branches as inputs. As before, input prices were approximated by dividing interest expenses over customer deposits, personnel expenses over the number employees, and operating expenses (net of interest and personnel expenses over the number of branches). Unfortunately, a variation of this specification using loans and trading securities was not possible due to data limitations, since the OECD dataset does not separate securities holdings into trading and non-trading portfolios. The second specification (Model 2) used the same inputs, but considered interest revenues and non-interest revenues as outputs, using a parallel treatment to compute input prices. All the financial data in the

OECD database was converted into US dollars by using the end-of period market exchange rates.

46. **Overall, the Swiss cantonal, regional, and cooperatives compared well against their sampled peers**. The results, presented in Table 9, are roughly consistent with the conclusions of the previous exercises. Under Model 1, presented in the left panel, the overall cost efficiency ranges between 71.8 percent for the cantonal, to 95.6 for the regional banks. The scores of the three Swiss bank segments exceed the average cost efficiency obtained for the entire sample, 65.5 percent, which is presented at the bottom. The efficiency scores of the Swiss banks are also considerably higher than those obtained by the cooperative banks in France, Germany, and Spain, and by the savings banks in France and Spain. These differences tend to be attributable to technical efficiency, albeit the Swiss banks also seem to perform relatively well in allocative efficiency, indicating that their input mix is roughly consistent with the relative input prices. Lastly, the model suggest that the three Swiss segments are operating under IRS, corroborating the conclusions obtained in previous exercises.

47. **The robustness check produced similar qualitative results, albeit generally lower efficiency estimates, for the three Swiss bank segments**. The results of Model 2, presented in the right panel of Table 9, produced a similar ranking of efficiency scores for the three Swiss bank segments. The magnitude of the efficiency scores, however, is generally lower than those obtained in the first model. This is particularly the case of the cantonal banks, whose overall cost-efficiency is 43.6 percent (indicating a gap of 56.4 percent with its comparator institutions). An inspection to the background calculations (not shown) suggest that both the volume of deposits and the number of branches of the cantonal, are too large for their interest and non-interest revenues. Overall, these results provide some support to the idea that cantonal are somewhat less efficient, which stands in contrast with the findings of Rime and Stiroh (2003). A thorough comparison between these two studies, however, would require exploring the statistical properties of the DEA estimators, which is not pursued in this note.

D. Technical Progress and Efficiency Change in the Swiss Banking System

48. **The time evolution of productivity in Switzerland was assessed with a Malmquist productivity index, using yearly data during 1996–2005**. The exercise was based on the methodology described in section II-B, which constructs a best-practice technology frontier against which the individual bank segments are compared. In total, the method requires the estimation of the distances specified in equation (6), entailing 196 optimization problems. The yearly evolution of the Malmquist index and its two components was computed for each bank segment. Table 10 presents a summary, with the yearly averages of the index and its components, taken over all bank segments. Going to the last row, the average improvement in total factor productivity was 4.4 percent per year (i.e., $100\times(1.044–1)$). On average,

Table 9. Cross-Country Estimates of Cost Efficiency by Segments, 2003

(In percent)

	Model 1				Model 2			
	Technical Efficiency	Allocative Efficiency	Cost Efficiency		Technical Efficiency	Allocative Efficiency	Cost Efficiency	
France								
Cooperative banks	24.4	82.9	20.2	-	35.5	60.8	21.6	DRS
Commercial banks	100.0	96.3	96.3	DRS	100.0	100.0	100.0	DRS
Other banks	100.0	100.0	100.0	-	100.0	100.0	100.0	-
Savings banks	23.6	90.6	21.4	IRS	24.4	90.4	22.1	IRS
Germany								
Cooperative banks	39.6	71.2	28.2	DRS	23.7	63.9	15.1	DRS
Regional institutions	100.0	100.0	100.0	-	100.0	100.0	100.0	-
Commercial banks	100.0	100.0	100.0	DRS	100.0	97.4	97.4	DRS
Landesbanken	100.0	100.0	100.0	-	100.0	100.0	100.0	-
Savings banks	66.3	65.8	43.6	DRS	28.4	92.8	26.4	DRS
Spain								
Cooperative banks	59.9	55.5	33.3	IRS	59.9	56.3	33.7	IRS
Commercial banks	65.5	66.2	43.4	DRS	62.4	60.7	37.9	DRS
Savings banks	50.5	66.9	33.7	DRS	24.7	47.9	11.8	DRS
Switzerland								
Cantonal banks	84.3	85.1	71.8	IRS	43.2	66.5	28.7	DRS
Raiffeisen	84.1	97.0	81.6	IRS	76.4	83.1	63.5	IRS
Regional and savings banks	100.0	95.6	95.6	IRS	100.0	83.4	83.4	IRS
United Kingdom								
Commercial banks	100.0	100.0	100.0	DRS	100.0	100.0	100.0	DRS
Average	74.5	81.9	63.4		71.0	83.5	63.4	

Source, SNB and IMF staff calculations.
Model 1 is based on a DEA excercise with two outputs: loans and securities holdings, and three imputs: deposits, personnel, and number of branches.
Model 2 is based on a DEA excercise with two outputs: interest revenues and non-interest revenues, and three imputs: deposits, personnel, and number of branches.

technical change was the main driving force, with an average increase of 5 percent per year, as opposed to technical efficiency, which decreased at an average 0.6 percent per year. This indicates a slightly widening gap with the benchmark producers throughout the period. Looking at the time evolution of the indexes, overall productivity improved since 2002, mainly induced by technical change since 2003. Interestingly, there is also evidence of a counteracting effect between technical change and efficiency. For example, between 2000–2002 the receding technical change is accompanied by a catch-up process in technical efficiency (i.e. banks closing the gap with their benchmark institutions).

Table 10. Evolution of the Average Malmquist Index, 1997–2005

	Year-on-year Change in:		
	Malmquist Index	Technical Efficiency (CRS)	Technical Change
1997	1.152	0.970	1.188
1998	1.032	0.985	1.048
1999	1.052	0.974	1.080
2000	0.998	1.018	0.980
2001	0.959	1.003	0.956
2002	1.007	1.039	0.969
2003	1.082	1.010	1.071
2004	1.061	0.997	1.065
2005	1.066	0.956	1.115
Mean	1.044	0.994	1.050

Source, SNB and IMF staff calculations.

Based on a DEA excersice with two outputs: interest revenues, and non-interest revenues, and three imputs: deposits, personnel, and number of branches.

49. An alternative description of the results is provided in Table 11, which shows the average Malmquist indexes, and their components, by bank segment. Going to the first column, the largest improvement in total factor productivity was attained by the large banks with an average of 6.9 percent per year, followed by the segment of other banks also with 6.9 percent, and the private banks with 5.8 percent. Total productivity in all the other bank segments also expanded during the period, but at a rate lower than the average for the whole system. The technical change components of the Malmquist indexes reflect a roughly similar picture, except for the cantonal banks, which attained improvements in technology slightly higher the system average. In turn, the yearly change in technical efficiency for the large banks and the private banks averaged one over the entire period, indicating that these two segments were consistently operating at the frontier. There is some evidence that the segment of regional banks and the bucket of other banks have been caching-up to the frontier (as their average technical efficiency surpass one). On the other hand, the distance between the benchmark frontier and some segments has been widening, including the foreign banks, the cantonal, and the Raiffeisen.

50. **Overall, average productivity in the system stagnated between 1999 and 2002, and picked-up strongly afterward**. To convey additional information on the path of total factor productivity growth for selected bank segments, Figure 3 presents the cumulated Malmquist index, computed as the sequential product of the corresponding yearly indexes. Productivity growth in the segment of large banks has been consistently above the system average and the difference increased after 2003. The evolution of productivity growth in the segments of cantonal and regional banks has been roughly similar, catching-up with the

system average. Productivity growth for the Raiffeisen banks has been also improving since 2000, albeit at a lower pace.

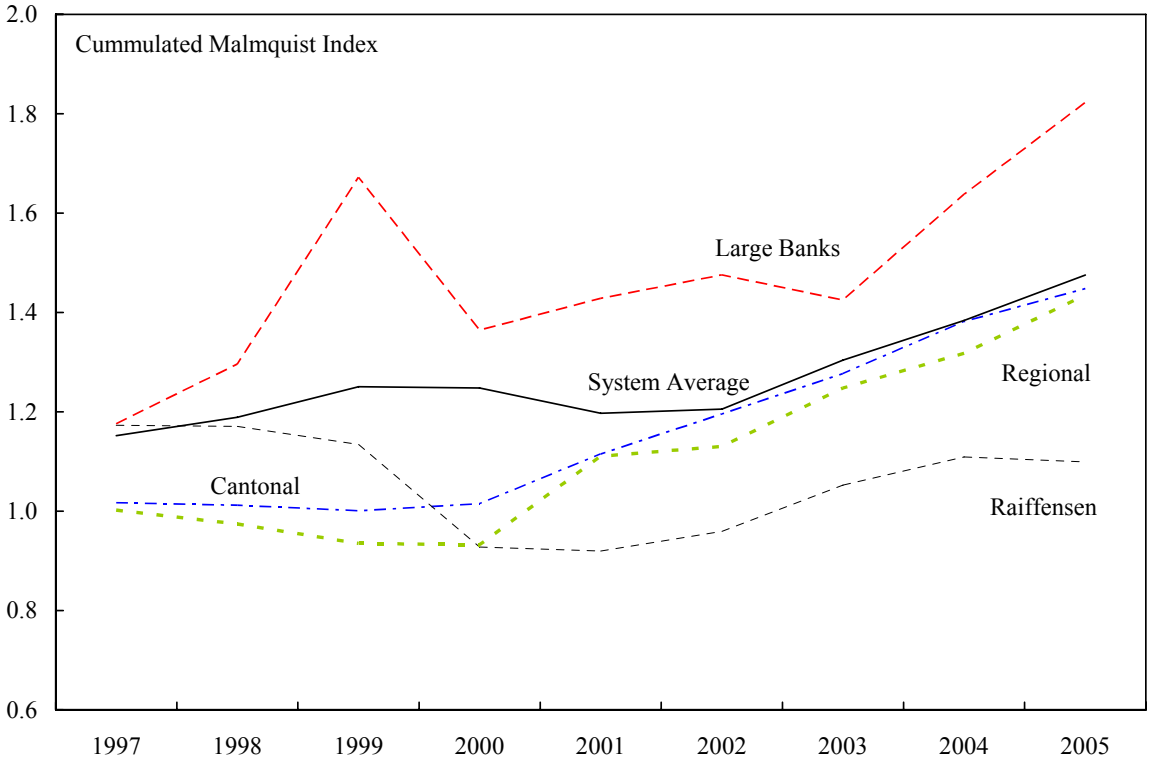
Table 11. Average Malmquist Indexes by Bank Segments, 1997–2005

	Year-on-year Change in:		
	Malmquist Index	Technical Efficiency (CRS)	Technical Change
Cantonal banks	1.042	0.990	1.052
Foreign banks	1.022	0.975	1.048
Large banks	1.069	1.000	1.069
Other banks	1.069	1.003	1.065
Private banks	1.058	1.000	1.058
Raiffeinsen banks	1.010	0.985	1.025
Regional banks	1.041	1.007	1.034
Mean	1.044	0.994	1.050

Source, SNB and IMF staff calculations.

Based on a DEA excersice with two outputs: interest revenues, and non-interest revenues, and three imputs: deposits, personnel, and number of branches.

Figure 4. Cumulated Evolution of the Malmquist Productivity Index, 1996–2005



Source: SNB and IMF staff calculations.

V. Conclusions and Policy Recommendations

51. **The Swiss banking sector has been undergoing a substantial consolidation over the last ten years, but retains a rich collection of institutional types operating in various business segments**. Consolidation has been partly driven by competitive pressures following the burst of the house market bubble and entailed a substantial reduction in the number of institutions and branches. Smaller banks have been also developing to various types of cost-sharing arrangements and outsourcing their back operations to benefit from scale economies and remain afloat under a highly competitive environment.

52. **The assorted landscape of the Swiss banking system adds to its strength, but also poses a challenge to the medium-term profitability of banks oriented to domestic retail, given the expected slow-down in economic activity induced by population aging**. Under the current benign macroeconomic environment, banks have been posting robust results across the board, easing immediate pressures for additional cost-cutting measures. Over the medium-term, however, the domestically-oriented retail banks continue to face a challenging environment. Competitive pressures are expected to resume, potentially leading to new waves of forced exits.

53. **Due to the relatively small size of the institutions involved, this is unlikely to pose a threat to systemic financial stability, particularly if the consolidation process occurs over an extended period**. However, the current situation entails public policy considerations, given the public ownership of the cantonal banks and the contingent public liability associated with their deposit guarantees. Some measures could be considered to ensure that cantonal banks operate under sufficient flexibility. For example, the governance structures of cantonal banks could be strengthened to shield them from unwarranted political interference in their operations. A clear and strong separation between social goals and the business operations of the cantonal banks would also seem advisable. This could be attained, for example, by using cantonal banks taxes and dividends to finance legitimate social goals, while avoiding interference with the business decisions of cantonal banks. Over the medium term, further public divestment from the banking system could be also considered.

54. **Four main conclusions emerge from the analysis presented in this note**. First, there is evidence that the segments of domestically-oriented retail banks have the potential to improve further their cost efficiency. At the same time, the performance of these segments compares relatively well against similar segments in the four countries included in the study. Third, the large banks and the segment of private banks are systematically selected as benchmark, and the efficiency gap with other segments has been increasing over the last ten years. Lastly, the overall productivity in the Swiss banking sector remained relatively constant during 1996–2001, but has picked-up strongly since 2002.

REFERENCES

Bichsell, R. (2006), "State-Owned Banks as Competition Enhancers, or the Grand Illusion," *Journal of Financial Services Research*, Vol. 30, pp. 117–150.

Brunner, A., J. Decressin, D. Hardy, and B. Kudela (2004), "Germany's Three-Pillar Banking System: Cross-Country Perspectives in Europe," *IMF Occasional Paper 233*.

Caves, D., L. Christensen, and E. Diewert (1982), "The Economic Theory of Index Numbers and the Measurement of Input, Output, and Productivity," *Econometrica*, Vol. 50, (No. 6), pp. 1393–1414.

Coelli, T. (1996), "A Guide to DEAP Version 2.1: A Data Envelopment Analysis Program," CEPA Working Paper 96/08, University of New England, Australia.

Fare, R., S. Grosskopf, and K. Lowell (1994), *Production Frontiers*, Cambridge University Press, Cambridge.

Fare, R., S. Grosskopf, M. Norris, and Z. Zhang (1994), "Productivity Growth, technical Progress, and Efficiency Change in Industrialized Countries," *American Economic Review*, Vol. 84, (No. 1), pp. 66–83.

Rime, B., and K. Stiroh (2003), "The Performance of Universal Banks: Evidence from Switzerland," *Journal of Banking and Finance*, Vol. 27, pp. 2121–2150.

Sealey, C. Jr., and J. J. Lindley (1977) "Inputs, Outputs, and a Theory of Production and Cost at Depository Financial Institutions," Journal of Finance, Vol. 32, 4, pp. 1251–1266.

Zhu, J., (2003), *Quantitative Models for Performance Evaluation and Benchmarking*, Springer International Series in Operations Research and Management Science, New York.

APPENDIX I. THE BASIC INPUT-ORIENTATED DEA PROBLEM

55. DEA is a linear-programming technique for frontier estimation that exploits input-output data for individual firms—or decision-making units—to construct a piecewise-linear convex set encompassing the data. The basic DEA problem can be described as follows. Assume there is data on K inputs and M outputs for each of N banks indexed by i=1,...,N. Let $\mathbf{X}$ denote the $K\times N$ matrix of inputs, $\mathbf{Y}$ the $K\times M$ matrix of outputs, and use $\mathbf{x}_i$ to identify the vectors of observed inputs for bank i and $\mathbf{y}_i$ the corresponding vector of observed outputs. Under the assumption of CRS, the basic DEA problem to estimate the relative efficiency of each bank is given by:

$$\min_{\theta_i,\lambda_i} \theta_i \qquad \text{(A-1)}$$

$$\text{s.t.}$$

$$-\mathbf{y}_i + \mathbf{Y}\boldsymbol{\lambda}_i \geq 0,$$

$$\theta_i \mathbf{x}_i - \mathbf{X}\boldsymbol{\lambda}_i \geq 0,$$

$$\boldsymbol{\lambda}_i \geq 0,$$

where θ_i is a bank-specific scalar that varies between zero and one and conveys the efficiency score of bank i (i.e., the distance between its input-output mix and the frontier, measured through a ray from the origin). A θ_i=1 indicates that the bank is a benchmark institution, and its input-output mix lies on the efficient frontier. The $\boldsymbol{\lambda}_i$ is a $N\times 1$ vector of bank-specific weights that conveys information on the benchmark comparators for bank i. For example, an efficient bank (θ_i=1) will be trivially its own benchmark, resulting in a $\boldsymbol{\lambda}_i$ with zeros everywhere except by a one in the i^{th} position. An inefficient bank (θ_i<1) will have a $\boldsymbol{\lambda}_i$ vector with a zero in the i^{th} position, and non-zero weights in the positions of its benchmark institutions, with higher weights for the benchmark institutions of higher relevance.

56. Additional restrictions to the basic model can be used to relax the CRS assumption and compute scale effects. The CRS assumption is only appropriate when banks are operating at the optimal scale, which may be too restrictive under normal circumstances. If the assumption does not hold, the CRS model would produce TE estimates which are biased by scale efficiencies (SE). However, a subtle modification of the model allows to compute efficiency under variable returns to scale (VRS) and disentangle technical efficiency from scale effects. This requires adding the convexity constraint $\mathbf{l}'\boldsymbol{\lambda}_i$=1, where $\mathbf{l}$ is a $N\times 1$ vector of ones. The VRS model produces a convex hull of intersecting planes that envelope the data more tightly than the CRS model and thus tends to produce generally higher estimates of technical efficiency.

The estimation of allocative efficiency requires additional data on input prices. Using $\mathbf{w}_i$ to denote the N×1 vector of input prices for bank *i*, the optimization problem is given by:

$$\min_{\mathbf{x}_i, \boldsymbol{\lambda}_i} \mathbf{w}_i' \mathbf{x}_i^* \qquad \text{(A-2)}$$

s.t.

$$-\mathbf{y}_i + \mathbf{Y}\boldsymbol{\lambda}_i \geq 0,$$
$$\mathbf{x}_i^* - \mathbf{X}\boldsymbol{\lambda}_i \geq 0,$$
$$\boldsymbol{\lambda}_i \geq 0,$$

where $\mathbf{x}_i^*$ is the cost-minimizing vector of inputs for the i^{th} bank, taking the input prices and output levels as given. After solving these problems, the total cost efficiency (CE) of bank *i* would be given by the ratio of the minimum cost to the observed cost:

$$CE = \frac{\mathbf{w}_i' \mathbf{x}_i^*}{\mathbf{w}_i' \mathbf{x}_i} \qquad \text{(A-3)}$$

Using equations (1) and (A-3), it is possible to compute allocative efficiency as: AE=CE/TE.

An Output-Orientated Malmquist Index

57. The assessment of total factor productivity presented in section III-B is based on an output-orientated Malmquist index. A brief description of this methodology based on the notation used by Fare *et al.* (1994) follows. Assume that for each time period t=1,...,T, banks produce an observed vector of M non-negative outputs $\mathbf{y}_t=(y_{1t},...,y_{Mt})$, with a vector of N non-negative inputs $\mathbf{x}_t=(x_{1t},...,x_{Nt})$ using the unobserved, possibly time-variant, production technology

$$S_t=\{(\mathbf{x}_t, \mathbf{y}_t): \mathbf{x}_t \text{ can produce } \mathbf{y}_t\}, \qquad \text{for} \qquad t=1,...,T \qquad (5)$$

The output set S_t is assumed to satisfy usual regularity conditions,[16] which allow to construct a well-defined output distance function $D_t(\mathbf{x}_t, \mathbf{y}_t)=\inf\{\theta \text{ such that } (\mathbf{x}_t, \mathbf{y}_t/\theta) \text{ belongs to } S_t\}$. In words, D_t measures the distance between the observed output of each institution at time *t* and the maximum output attainable with the observed input mix, given the technology available

[16] The output set S_t is assumed to be closed, bounded, convex, and satisfy strong disposability of outputs.

at time t. Notice that $D_t(\mathbf{x}_t, \mathbf{y}_t)=1$ if and only if the observed input-output combination observed at time t lies at the boundaries of the technology frontier available at time t, otherwise, $D_t(\mathbf{x}_t, \mathbf{y}_t)<1$. Three additional distance functions $D_t(\mathbf{x}_{t+1}, \mathbf{y}_{t+1})$, $D_{t+1}(\mathbf{x}_t, \mathbf{y}_t)$, $D_{t+1}(\mathbf{x}_{t+1}, \mathbf{y}_{t+1})$ are defined in a similar way, either by re-dating the variables or by re-dating the technology, although in the first two cases the resulting distances may exceed unity (i.e., the observed input-output mixes may lie above the production set of the other period).

58. Using the above definitions, an output-oriented Malmquist productivity index may be expressed as:

$$M_{t+1} = \frac{D_{t+1}(x_{t+1}, y_{t+1})}{D_t(x_t, y_t)} \times \left[\frac{D_t(x_{t+1}, y_{t+1})}{D_{t+1}(x_{t+1}, y_{t+1})} \times \frac{D_t(x_t, y_t)}{D_{t+1}(x_t, y_t)} \right]^{1/2}, \qquad \text{(A-4)}$$

where the first term measures the change in relative efficiency between the two time periods (i.e., the catch-up effect), while the term in square brackets measures the technical change (i.e., the evolution of the production frontier). The term under square brackets is a geometric mean of the distances between the two production functions, measuring the distances through the observed input-output mixes.