Performance funding of Swiss universities - success or failure?

An ex post analysis

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Executive Summary

In the past decade, based on a change in paradigms in university policy, performance funding on a cantonal and central state level has been introduced in Switzerland: the universities have been granted higher autonomy, combined with global budgets and contract management by the responsible authorities (cantonal authorities). At the same time, the allocation of the central state subsidies, which is only of a secondary nature, has no longer been based on input but on the achievement of targets (new University Funding Law from the year 1999). As the introduction of these new performance-oriented elements – higher autonomy combined with global budgets and contract management and target-oriented allocation of central state subsidies led to intensive, sometimes controversial debates in the different parliaments and media. This work examines whether - and to what extent - these new incentives have led to behavioral changes at the universities. To test this, the development of efficiency - as an input/output comparison in the university production process - and that of effectiveness - as the degree to which targets formulated in the University Funding Law are achieved - has been analyzed. With respect to input factors the number of students and the expenditures for the academic personnel, with respect to the output factors the number of diplomas and dissertations are used.

Based on the hypothesis that due to increased autonomy in strategic and operational management, efficiency enhancement ought to be possible (better internal organization), the development of efficiency at the individual universities was examined by means of a Data Envelopment Analysis (DEA). The question as to whether increased autonomy for Swiss universities has paid off and the anticipated improvements in efficiency really have been achieved could not be conclusively answered on the basis of the available results. It is true that the number of efficient universities has risen slightly, but this positive development is not significant.

Apart from efficiency, there was an interest form our side to question whether the objectives with respect to target-oriented funding really have been achieved (effectiveness test) and whether the universities have developed in the direction desired by the legislators. To do so, the indicators which are applied to allocate the central state subsidies have been analyzed for the period 2000-2003. Analogous to efficiency, the test of effectiveness also results in a varying picture. On the basis of these results, it has to be concluded that the subsidiary target-oriented funding system on a central state level, has not had a very important influence on university behavior up to now and seems to be only suitable for steering purposes to a limited extent. These results can be linked directly to those of Burke & Minassians, who were also able to determine only a moderate effect of the incentives of performance-oriented funding systems[1].

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1. Performance funding of Swiss universities - success or failure: an ex post analysis

1.1. University policy in Switzerland: Framework conditions

University policy in Switzerland, as in all federally organized states, is a complex matter because numerous parties, often with diverging interests, take part. In Switzerland, the cantons are the legislative bodies for the universities and therefore largely responsible for financing them[2]. This, however, does not apply for the two federal technical universities in Zurich and Lausanne (ETHZ and EPFL): These two universities with the ETHZ being the most famous university in Switzerland are completely financed and kept under surveillance by the Swiss Confederation.

With respect to the cantonal universities the Confederation has merely a secondary allocation function. This is also reflected in the legislation: the cantonal universities are subject to cantonal legislation whilst, at the level of the Confederation, there is only a framework law which mainly regulates the co-operation in the university sector and the central state subsidies which are allocated from the Confederation to the university cantons (University Funding Law)[3].

Due to the different responsibilities and different funding mechanisms with respect to the cantonal and federal universities, the ETHZ and EPFL are not in the sample analyzed in this article.

1.2. A change of paradigms in university policy

In recent years, university policy in Switzerland has undergone a change in paradigms: state governance and control has been replaced by supervision. The universities have been granted a larger degree of autonomy[4], associated with global budgets and contract management (performance funding), and central state subsidies were consistently attuned to targets (performance-oriented in the new University Funding Law from 2000). Largely responsible for this change were new trends in Public Management based on institutional economics and theories of social choice[5]. In view of the heated and emotionally driven debates which preceded the paradigm change and the corresponding legislation, this article concentrates particularly on whether the larger degree of autonomy and the new funding mechanisms did actually lead to a better performance in the university sector. This would imply that efficiency[6] – doing things right – and effectiveness[7] – doing the right things – have increased. From economic literature it is widely known that an increase in autonomy not only produces a better quality but also leads to a higher efficiency due to the fact that motivation is positively affected.

In the first part of this article, the development of efficiency in the last few years will be analyzed with respect to the enlarged degree of autonomy which hypothetically should lead to

efficiency gains. In a second part, there will be a discussion of effectiveness. The task is thus to examine whether the targets associated with the new University Funding Law have been achieved or not (effectiveness test). In the third part a synopsis is given, enabling an assessment of the overall performance defined as efficiency and effectiveness. In order to calculate the efficiency, a Data Envelopment Analysis model was used, enabling the identification of the so-called "organizational slack"[8], while the effectiveness was measured by the change in the most important indicators derived from the targets given by the University Funding Law.

2 Have the universities become more efficient?

2.1 Method and data (for the technical details see annex)

A major advantage, repeatedly discussed during the reforms in the Public Management sector is improved efficiency associated with a higher level of autonomy and with an increased financial flexibility. The improved efficiency is defined as a higher output with respect to a certain input level and should primarily be due to the notion that a specific organization, armed with the necessary financial and organizational freedom, is better motivated and able to regulate its internal matters than a distant ministry. As the universities have enjoyed this new freedom since the nineties, it should be possible to make efficiency gains visible over the course of time. Due to the fact that public expenditures have increased about 23.4% in the university sector in the last eight years, we can assume a comparable ability of the different universities to increase efficiency.

To analyze the assumed efficiency gains a method belonging to the Data Envelopment Analysis (DEA)[9] methods is used. The DEA methods calculate the efficiency - defined as a relation of different input and output factors - based on an optimization process.[10&11] If teaching and research are defined as the main activities of a university, the so-called university production function must comprehend input and/or output factors from both, teaching and research. With respect to this, the number of diplomas and the number of dissertations were selected as output factors. The diplomas are considered to be the most important factor describing the teaching while the dissertations count for the research activities. As input factors the number of students and the expenditure for the scientific personnel (costs in CHF) were chosen, whereas the number of students represents primarily the teaching activities, whilst the expenditure for the scientific personnel counts for teaching and research. There is of course a whole row of further factors which could be used on the input as well as the output side. But in the DEA method, with respect to combinatory considerations, the number of input and output factors must be restricted in relation to the number of test units.[12]

Because the DEA methods allocate optimal weights to all input and output factors, the maximal weights are placed on those factors in which a university does better in comparison with other universities. The prime advantage of the DEA method is that the weights of the input and output factors do not have to be determined ex ante and therefore subjective weightings are excluded. Due to the optimization of weightings the DEA methods are very benevolent which means that inefficiencies calculated by this kind of methods cannot be denied: inefficient universities de facto have efficiency problems!

Test units: All the ten cantonal universities in Switzerland were examined. Unfortunately, a sub-division into academic disciplines was not possible because the corresponding data is not available. This will only be possible in 2006 at the earliest. Therefore there might be compensation effects between different disciplines.

2.2 Results

According to Table 1, the universities of Fribourg, Neuenburg and Lausanne had efficiency problems in 2002 and 2003, whilst all the other universities can be described as efficient. Since this efficiency can be considered as a so-called "soft efficiency", it has to be assumed that those universities which are shown in Table 1 as inefficient really do demonstrate inefficiencies in comparison with other, comparable universities, and those inefficiencies cannot be glossed over. Particularly noteworthy in Table 1 is the behavior of the University of Lausanne which has been gone through a major restructuring process for several years (closing some departments and transferring them to the EPFL). This process appears to be paying off because the University of Lausanne has been able to enhance its efficiency in the last years. With respect to the universities of Fribourg and Neuenburg a possible explanation for the efficiency problems could be their size and the number of programs they offer: Both universities are rather small and are so-called full universities offering studies in humanities as well as in technical and/or life sciences. But both of them have difficulties to cope with the fast growing expenditures demanded by those disciplines to be state-of-the-art. Due to that they attract not so many students in the corresponding disciplines. This results in a weak efficiency based on relatively high expenditure for the scientific personnel coupled with a low number of students on the input side and a few diplomas and dissertations on the output side. Besides that, the University of Fribourg offers medical studies only for the first two years, which additionally lowers its efficiency due to the fact that these students do not pass a final exam in Fribourg. In contrast to the Universities of Lausanne, Fribourg and Neuenburg, the University della Svizzera Italiana has shown a unique inefficiency number in the year 2000 due to the growth of this young university, accredited in 2000. In the following years there was no further inefficiency to be observed.

Table 1: Efficiency data for the years 2000-2003

Efficiency				
University	Year			
	2000	2001	2002	2003
Basel	1	1	1	1
Berne	0.927	1	1	1
Fribourg	1	1	0.966	0.814
Geneva	1	1	1	1
Lausanne	0.830	0.924	0.917	0.947
Lucerne	1	1	1	1
Neuenburg	0.946	0.902	0.882	0.925
St. Gallen	1	1	1	1
Zurich	1	1	1	1
USI*	0.749	1	1	1

* Università della Svizzera Italiana

The question as to whether autonomy for the Swiss universities has paid off cannot be answered based on the efficiency calculated in this paper. Taken as a whole, the behavior of the universities is too heterogeneous and the results are not significant. If the year 2003 is compared with the year 2000, it can be seen that in 2000, four universities were inefficient, whilst in 2003 only three universities were battling against inefficiencies. This leads to the assumption that efficiency gains are possible. But, even though autonomy has increased everywhere 30% of the universities still show inefficiencies.

3. Have the universities become more effective?

In testing the effectiveness, the focus is primarily on examining the change of the so-called performance indicators derived from the targets given by the University Funding Law. The task is to determine whether the objectives associated with the target-oriented funding are achieved or not. Since the objectives of the University Funding Law are, however, not explicitly available the effectiveness can be tested only in an indirect way. We therefore assume a quasi effectiveness test in which it is analyzed whether the individual universities have developed in the direction desired by the legislators.

3.1. Targets and performance indicators

In order to determine the behavior of the universities, the relative changes in the individual universities over the last four years – for each year and for the whole period - were identified. To do so, the most important indicators are derived from the main targets of the University Funding Law such as:

1st target: reducing the study times (see 3.2)

indicator: number of students in the norm study time

2nd target: increasing the number of foreign students (see 3.3)

indicator: number of foreign students

3rd target: intensifying research activities (see 3.4)

indicator: research months per professor granted by state research promotion institutions

4th target: increasing the acquisition of private funds (see 3.5)

indicator: private funds acquired in CHF

All the calculations were made on the basis of the data-set used by the Federal Statistical Office and the State Secretariat for Education and Research to allocate the central state subsidies for the individual universities[13].

3.2. Reducing the study times

The University Funding Law foresees that expenditure for teaching is to be compensated by student-related amounts, i.e. that contributions are calculated according to the number of students. However, as the duration of studies in Switzerland (completion at on average 27.3 years of age)[14] has been criticized as being too long, only those universities should be financially rewarded that succeed in educating students in a so-called norm study time. The norm study times are 16 semesters for medicine and 12 semesters for all other academic disciplines.

Table 2: Success in teaching: percentage of norm-time students for the years 2000 – 2003

number of norm-time students / total number of students					
University	Year				Change in %
	2000	2001	2002	2003	2000 – 2003
Basel	85.6	85.9	86.3	87.6	2.3
Berne	84.3	85	86.3	88.5	5
Fribourg	86	86.8	87.1	86.9	1
Geneva	91.4	92.3	92.8	93	1.8
Lausanne	94.4	94.7	95	94.5	0.1
Lucerne	-	-	-	-	-
Neuenburg	86.2	86.5	85.7	85.9	-0.3
St. Gallen	94.6	95.1	94.7	94.6	0
Zuerich	81.9	82.6	80.4	80.4	-1.8
USI*	-	-	-	-	-

* Università della Svizzera Italiana

Table 2 shows the percentage of students that were studying within the so called norm study time compared to the total number of students. Looking at the figures, it becomes clear that for the period from 2000 until 2003 most of the universities achieved an increase in students studying within the norm study times, although the increase is rather small. Only the universities of

Neuenburg and Zuerich show a decrease in the percentage of norm-time students and an increase in long-term students. Since the Universities of Lucerne and the Università della Svizzera Italiana were newly founded, they are excluded at this point. In comparison with the overall number of students in the individual years 88% of all students were within the norm study times in 2000, in 2003, there were 88.8%. This slight increase in students studying within the norm study times or decrease of long-term students means that the incentive system in the University Funding Law is not very effective. That is even more astonishing due to the fact that the inter-cantonal financial compensation system[15] - money the university cantons receive from the non university cantons - is similarly structured: universities only receive money for those students who study within the norm study times. It can be therefore assumed that either the universities are still hesitating in imposing regulations with regard to norm study plans and times (higher study fees for long-term students) or that the regulations have not yet been able to show any effect due to the short period of time considered in this study.

3.3. Increasing the number of foreign students

The costs for foreign students must be carried primarily by the universities because the universities do not charge cost-covering study fees and the inter-cantonal financial compensation plays no role at all for the foreign students. Due to various parliamentary interventions in the passing of the University Funding Law, the consequence is that now, the Confederation is participating in the financing of foreign students and even more favors an increase in its number. If the development of foreign students in Switzerland is analyzed in the period 2000-2003, the number of foreign students has increased by 20% (4,028 students)[16]. In the year 2003 21.4% of all students were foreign students. The most successful universities were those of Zurich and St. Gallen, whereas the universities of Berne and Lucerne have relatively few foreign students. The highest percentage of foreign students are found in the university della Svizzera Italiana and the universities of Geneva and St. Gallen. On the whole this aim – to increase the attraction for foreign students - can be regarded as achieved in the sense of the University Funding Law (see table 3).

Table 3: Success in teaching: foreign students in Switzerland in the years 2000 - 2003

number of foreign students / total number of students					
University	Year				Change in %
	2000	2001	2002	2003	2000 – 2003
Basel	18.8 %	19 %	20.4 %	20.1 %	7.4 %
Berne	7.7 %	8.1 %	8.3 %	8.2 %	6.5 %
Fribourg	16.8 %	17.4 %	18 %	17.8 %	5.9 %
Geneva	34.9 %	36.3 %	37.6 %	38.3 %	9.5 %
Lausanne	20.7 %	20.4 %	20.8 %	21 %	1.1 %
Lucerne	18.4 %	13.1 %	9.8 %	8.9 %	- 51.4 %
Neuenburg	22.9 %	22.9 %	22.6 %	22.9 %	0 %
St. Gallen	26.1 %	27 %	29.1 %	31.5 %	20.5 %
Zurich	11.6 %	11.8 %	12.6 %	12.9 %	11 %
USI*	41.6 %	42.7 %	43.1 %	45.7 %	9.8 %

* Università della Svizzera Italiana

3.4. Intensifying the research activities

As basis for the calculation of the *research performance* serves the research activity granted from the official state research promoting institutions (Swiss National Science Foundation, EU research programs or from the Innovation Promotion Agency [CTI]) and calculated in terms of research months per professor (see table 4). To visualize the research efforts of a university, the activity figure is a better indicator than the financial streams resulting from research funding because those can differ considerably depending on the focus of a university[17]. Due to that reason we focused in this paper on the activity and not on the financial streams.

Table 4: Success in research for the years 2000-2003

number of months (SNF, EU, CTI) / professor					
University	Year				Change in %
	2000	2001	2002	2003	2000 – 2003
Basel	17.0	15.0	15.2	18.0	5.9 %
Berne	19.8	19.3	18.7	18.0	- 9.1 %
Fribourg	8.3	8.0	7.7	8.2	- 1.2 %
Geneva	18.1	17.8	18.1	19.0	5.0 %
Lausanne	13.3	13.1	12.6	13.2	- 0.8 %
Lucerne	3.2	1.8	0.8	2.9	- 9.4 %
Neuenburg	12.1	11.8	13.8	13.5	11.6 %
St. Gallen	3.1	3.5	4.2	5.8	87.1 %[18]
Zurich	15.7	16.7	16.2	16.2	3.2 %
USI*	3.5	3.5	4.5	6.8	94.2 %[19]

* Università della Svizzera Italiana

In table 4 the activities of the individual universities are shown and it can be seen that at the universities of Berne, Fribourg, Lausanne and Lucerne[20] there is a decrease in research activity and an increase at the universities of Basel, Geneva, Neuenburg, St. Gallen, Zurich and USI. The

highest increase is at the University della Svizzera Italiana, albeit at a very low and below-average level. The leaders in terms of research activity in the year 2003 are the Universities of Geneva, Basel, Bern and Zurich. They can be described as the most active research universities in Switzerland with regard to the sample chosen. However, the most famous and internationally best-ranked university of Switzerland is the federal technical university in Zurich (ETHZ) which has not been analyzed (see chapter 1.1).

Through the period 2000-2003, the average research activity of the cantonal universities has risen slightly from 11.4 months in 2000 to 12.2 months per professor in 2003. The critical question with regard to the effect of the incentive system conceived within the University Funding Law can therefore be regarded as positive.

3.5. Increasing the acquisition of private funds

As the finances of the public sector are likely to become tighter in the future, one of the aims of the Confederation was that the acquisition of private funds should be especially rewarded. If the figures in table 5 are compared, it becomes clear that over the period 2000-2003 all universities with the exception of the University of St. Gallen have followed this aim: practically all of them have succeeded in raising their share of private funds. In defense of the honor of the University of St. Gallen, it must be added that St. Gallen has the highest proportion of private funds (about 33% of its budget) of all the Swiss universities. This is not really astonishing due to the fact that the University of St. Gallen could be basically considered as a business school with important activities in the executive education.

In Switzerland, the average financing with private funds amounts to 9.2% in the year 2003. Particularly successful in increasing the acquisition of private funds were the young universities of Lucerne and USI as well as the universities of Geneva, Zurich and Basel.

Table 5: Success in the acquisition of private funds 2000-2003

private funds acquisition in thousand CHF					
University	Year				Change in %
	2000	2001	2002	2003	2000 – 2003
Basel	25384	28559	30482	33276	31.1 %
Berne	33549	32486	34256	37412	11.5 %
Fribourg	10938	10619	11307	11768	7.6 %
Geneva	57065	73105	82988	73203	28.3 %
Lausanne	40997	43911	42950	43197	5.4 %
Lucerne	373	604	1033	1280	243.2 %
Neuenburg	12251	16661	12743	13000	6.1 %
St. Gallen	20404	19660	18392	18780	- 8.0 %
Zurich	55464	64570	70474	72441	30.6 %
USI*	604	0	695	1015	68%

* Università della Svizzera Italiana

In total, private funds have risen throughout Switzerland by 18.8% (CHF 48,343,000) in the time period 2000-2003. In this sense, the incentive system has been successful and the aim of the legislators has been achieved.

3.6. Overall development of effectiveness

If the development of the universities in recent years as shown in table 6 is considered, most of the universities have developed positively in the sense of the original objectives of the legislators:

- all universities, except Lucerne, achieved an increase in the number of foreign students,
- more than half of the universities developed positively in research activities and
- all universities, except St. Gallen, have been able to record successes in the acquisition of private funds.

The only goal which was not achieved to a satisfactory extent was the reduction of long-term students. Almost all universities, except Berne, show no major increase in the norm-time students: If it is considered, that this indicator goes into the calculation of state subsidies with a weight of 60%, the effectiveness of the target-oriented incentive system must be provided with a question mark.

In order to better visualize the overall development of effectiveness, the individual universities are given points for the achievement of the different targets mentioned in the University Funding Law such as:

- for a small change of -2% <=x<= +2% — 0 points
- for a change of -10% <x< -2% or +2% <x< +10% — -0.5 or +0.5 points
- for an important change of -10%>=x or x>=+10% — -1 or +1 point

Table 6: Overall development of effectiveness

Overall development: number of points					
University	Fields				Total Points
	Long term study	International students	Research	Private Funds Acquisition	
Basel	0.5	0.5	0.5	1	2.5
Berne	0.5	0.5	- 0.5	1	1.5
Fribourg	0	0.5	0	0.5	1
Geneva	0	0.5	0.5	1	2
Lausanne	0	0	0	0.5	0.5
Lucerne	-	- 1	- 0.5	1	-0.5
Neuenburg	0	0	1	0.5	1.5
St. Gallen	0	1	1	- 0.5	1.5
USI*	-	0.5	1	1	2.5
Zurich	0	1	0.5	1	2.5

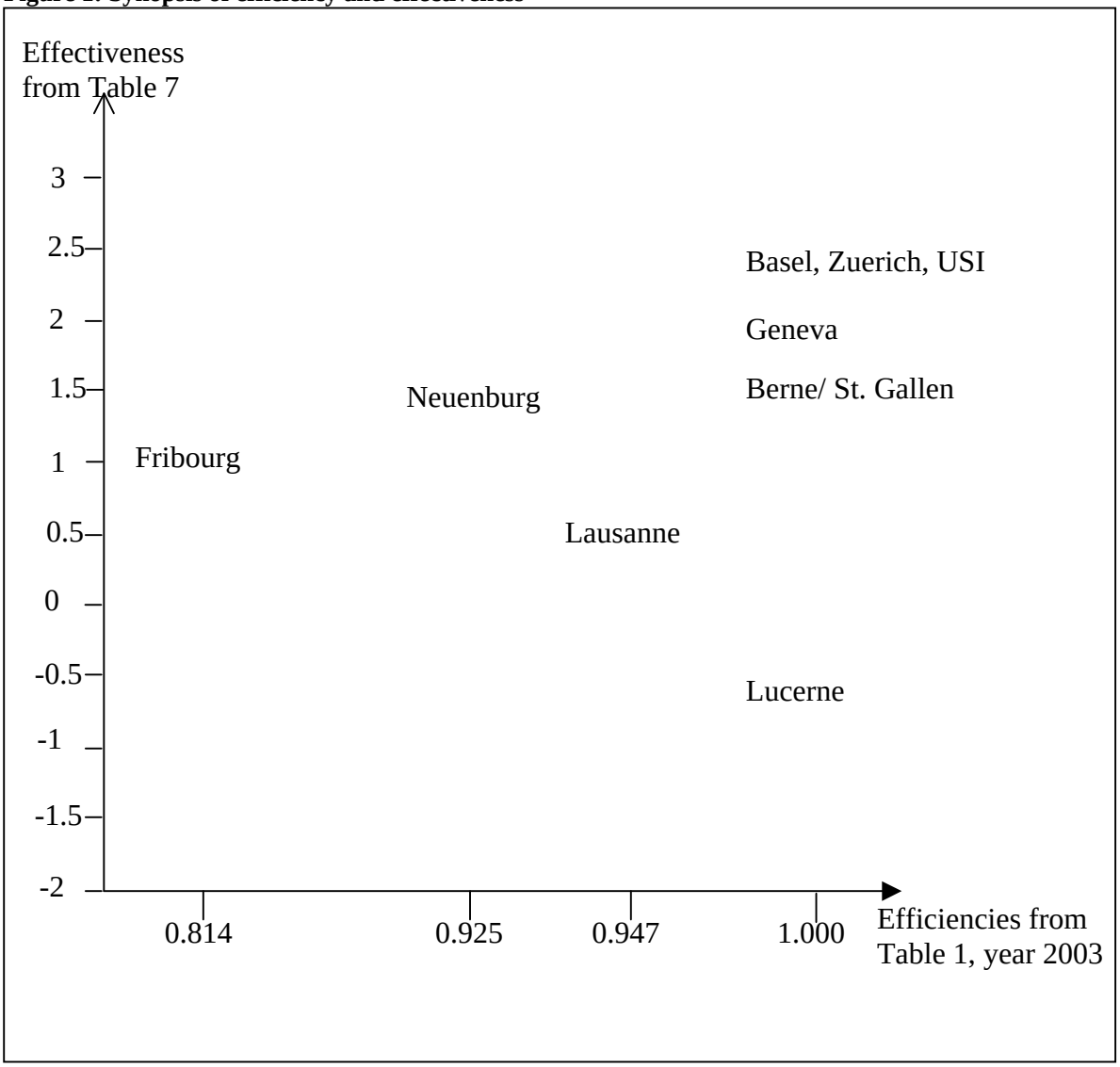
* Università della Svizzera Italiana

The maximum points the universities of Basel, Berne, Fribourg, Geneva, Lausanne, Neuenburg, St. Gall and Zurich can get is four. The University of Lucerne and the University della Svizzera Italiana (USI) can only get 3 points due to the fact that there are very young universities and are not yet confronted with the problem of long-term students. The most effective universities according to the University Funding Law were the USI and the universities of Zurich and Basel, followed by the university of Geneva. The lowest degree of success in terms of fulfilling the aims of the University Funding Law was recorded by the University of Lucerne, which is the youngest university among all Swiss universities and still has to cope with the difficulties of a newcomer (set up new structures, chairs etc.).

4. Synopsis: efficiency and effectiveness

In order to visualize the efficiency calculated in Chapter 2 and the effectiveness from Chapter 3, the figure 1 shows a synopsis of both.

Figure 1: Synopsis of efficiency and effectiveness



Following a period of time averaging seven years after introduction of the cantonal university laws, which gave universities more autonomy on the whole, one can note that the transfer of certain decision-making power and the introduction of contract management and global budgets have not, per se, led to significantly higher efficiency at the universities. Based on the data which has been examined, the education authorities in Switzerland can evidently not be held responsible for inefficiencies which were perceived (or believed to have been perceived) in the past. One explanation for the absence of efficiency gains could be the failure to implement the necessary change management process at the universities. In order to achieve efficiency gains, not only autonomy and global budgets are necessary but also internal organizational reforms, which affect both processes and structures and, last but not least, demand a change in the university culture. These changes must, however, come from the universities themselves and cannot be imposed from outside.

Whether the target-oriented (performance) funding by the Confederation - the new incentive system with ideas taken from Public Management - really can prove to be effective, cannot be conclusively judged today because of the relatively brief period of time since the new University Funding Law was put into effect (four years). Of particular note is that payment according to norm study times has not brought a significant reduction of long term studies, although both the Confederation and the non-university cantons use the same types of incentive system. One reason for the failure of this incentive could be that the universities have been hesitant to introduce the necessary regulations - for example significantly higher study fees for long-term students to support this target. Whether the noted, slight increase in research activity really is attributable to the incentive system in the University Funding Law is not evident, further analyses would be necessary.

Due to the tightness of public finance, the universities are forced, up to the level of individual professorship chairs, to procure additional money above and beyond the ordinary resources. A possibility in this regard is the procurement of private money. In all universities this possibility has been actively used, as shown in this article. But, due to the tightness of public finance it has to be assumed that the higher private funding ratio cannot be attributed only and exclusively to the incentives given by the target-oriented funding in the University Funding Law, but is also due to external political pressure.

Although the introduction of target-oriented financing has not led to major changes in the university sector, this kind of financing is, despite everything, preferable to input-oriented funding because it is based on targets or objectives to be achieved and not on ownership level guarantees.

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5. Endnotes

[1] Burke, J.C., Minassians, H. (2002).

[2] The cantons, as responsible authorities, finance an average of about 52% of the budget [Source: Federal Statistical Office (Hrsg. /1)].

[3] The Confederation partly compensates the university cantons for their operating expenditure (basic contributions). These contributions are allocated target-oriented (indicator based). They reach an average of about 15% of the annual operating costs of the universities.

[4] The following universities received new laws or ordinances:
Basel on 8.11.1995, Berne on 5.9.1996, Fribourg on 19.11.1997, Geneva on 10.12.1998, Lausanne on 20.02.1997, Lucerne on 17.01.2000, Neuenburg on 15.05.1996, St. Gallen on 03.11.1997, Zurich on 4.12.1998, Svizzera italiana on 3.10.1995

[5] See Schenker-Wicki (2004) p. 107

[6] Efficiency is defined as an input-output relation and can serve as a measure for the output to be achieved with a given input.

[7] Effectiveness is defined as a measurement for the targets reached

[8] See Backes-Gellner, Zanders (1989) p. 275

[9] See Charnes, Cooper, Rhodes (1978):output achieved with a given input

[10] See Farrell (1957)

[11] See Cooper, Seiford, Tone (1999)

[12] In this work, a total of four factors were chosen for input and output. This number must be seen in relation to the decision-making units reviewed. As we only have a total of ten universities in our sample, the application of input and output factors is limited. As soon as too many factors are chosen, one enters into the risk that through the exponentially rising number of factor combinations, every decision-making unit becomes efficient and it is therefore no longer possible to make a clear distinction of efficient and non-efficient universities. (Cooper, Seiford, Tone (1999) p. 252)

[13] See University Funding Law and the Ordinance regarding the University Funding Law

[14] Federal Statistical Office (Hrsg./2)

[15] As part of an inter-cantonal financial compensation, the non-university cantons pay a fixed sum per student from their canton to the relevant university cantons.

[16] Federal Statistical Office (http://www.bfs.admin.ch/bfs/portal/de/index.html)

[17] A university which offers not only art and social sciences but also natural sciences and medicine can show a higher sum with a lower activity because the research equipment in natural sciences and medicine is considerably more expensive than that used in the social and art sciences.

[18] The number is so high due to the fact that the University of St. Gallen nearly doubled the number of research months in the near 2003 compared to the year 2000 albeit at a very low level (underperformance).

[19] The number is so high due to the fact that the University della Svizzera Italiana nearly doubled the number of research months in the year 2003 compared to the year 2000. The reason for this increase, albeit at a very low level, is the rapid growth of this very young university accredited in the year 2000.

[20] Of special note is that the University of Lucerne is a very young university, and that makes itself noticeable in terms of research activity because the teaching staffs are busy with the development of study courses and professorship chairs, and for this reason, the research activity is pushed into the background.

6. Appendix: technical description

The model used in this work belongs to the Data Envelopment Analysis (DEA) methods which allow to determine the so-called technical efficiency of a certain decision-making unit. Since it is very difficult to fix a theoretical standard for efficiency ex ante, Farrell estimated an efficiency line (see Farrell 1957) from the inputs and outputs of a set of decision-making units. If the assumption applies that the efficiency line is convex, that the slope is always negative and that the input-output combinations are equivalent on this efficiency line, the efficiency line can be regarded as a pessimistic estimate for the technical efficiency of the decision-making unit in question.

The DEA methods are primarily optimization processes. The weighting factors u_r and v_i of the various input and output factors y_{ri} and x_{ij} respectively of a defined decision-making unit (DMU) are maximized under the pre-condition that with an appropriate weighting, all the other decision-making units show an efficiency of less than 1. The whole calculation is based on an estimated, partly linear production function which covers the entire efficient frontiers and is fixed by the best-practicing units (see Backes-Gellner, Zanders 1989). They build a kind of benchmarking envelope. Using this process, the weighting is determined for each decision-making unit which, in the end effect, leads to the highest degree of efficiency and therefore presents the relevant decision-making unit at its best.

In order to calculate the efficiency, there are the following models of the DEA family, among others: the CCR model which is based on constant return to scales and the BCC model (see Banker, Charnes, Cooper (1984)) which foresees a variable return to scales (increasing, constant, decreasing). With the CCR model, no size effects are taken into consideration; the output always changes in proportion to the input. Thus, it is assumed that a certain increase of the input automatically leads to a corresponding increase of the output.

In analogy to Fandel (see Fandel (2003) p. 40), we have decided in favor of an input-oriented BCC model (see Table 1) which enables the modeling of various realities and statements with regard to size effects. The major disadvantage of this model is, however, the relatively weak efficiency calculated. The reason is that the BCC model is a very benevolent model which not only varies the weightings of the input and output factors but also varies returns to scales (increasing, decreasing, constant) in favor of a decision-making unit – university – being tested. Returns to scales are defined as an attribute of a production function with the following categories to be distinguished:

Increasing Returns to Scale

When inputs are increased by *x* and output increases by more than *x*, the returns to scales are increasing.

Decreasing Returns to Scales

When inputs are increased by *x*, but the output increases by less than *x*, the returns to scales are decreasing.

Constant Returns to Scales

When inputs are increased by *x*, and output increases by exactly *x*, the returns to scales are constant.

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