Cost and performance analysis of land offices

Analýza nákladů a výkonů pozemkových úřadů

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Abstract: Since 1998, the Central Land Office has been monitoring the basic cost and performance parameters of all regional land offices in the republic. Enormous financial resources have been invested in the execution of land consolidation in this six-year period, and land consolidation of relatively vast areas has also begun. The land consolidation scheme involved the implementation of major building and land surveying projects. The time series of financial and cost indicators make it possible to conduct performance analyses, compare productivity between the offices, and/or identify any negative influences on the land consolidation process and eliminate such influences through well-designed interventions on the part of the central policy-making bodies. This article analyses the individual cost and performance categories of land consolidation and assesses the regional influences on price per hectare; the mutual conditionality of basic parameters is analyzed.

Key words: six-year time series of costs and performances, cost per hectare, performances correlations, cost categories, performance category, regional cost dependency, source indicators

Abstrakt: Ústřední pozemkový úřad sleduje od roku 1998 základní nákladové a výkonové parametry na úrovni jednotlivých pozemkových úřadů. Za šestileté časové období byly na provádění pozemkových úprav věnovány obrovské prostředky, a též byly zahájeny pozemkové úpravy relativně na obrovských plochách, došlo k významným stavebním a geodetickým realizacím v rámci pozemkových úprav. Časové řady finančních a nákladových ukazatelů umožňují provádět analýzy výkonů, srovnávat produktivitu jednotlivých úřadů, popř. odhalit negativní vlivy na proces pozemkových úprav a promyšlenými zásahy centrální politiky tyto vlivy eliminovat. Článek analyzuje jednotlivé nákladové a výkonové kategorie pozemkové úpravy a analyzuje regionální vlivy na cenu na hektar, analyzuje se vzájemná podmíněnost základních parametrů.

Klíčová slova: šestiletá časová řada nákladů a výkonů, výkonové a nákladové kategorie, náklady na hektar, výkonové korelace, regionální podmíněnost nákladů, zdrojové ukazatele

INTRODUCTION

The resources invested in the execution of land consolidation are immense (approximately CZK 1 billion a year). The scope of land consolidation projects that have been completed and/or are in progress is also extremely large. In terms of the extent of the completed land consolidation projects, the Czech Republic has shown dramatically different results from those of its Eastern European neighbours. The detailed data from the past decade make it possible to conduct a more in-depth analysis of the factors affecting the completion rate, and the mutual conditionality of some parameters becomes apparent. The dependencies are more or less of a categorical nature (Němec et al. 2005). It becomes clear, however, that it is possible to predict the effects of the centres' alternative financial policies.

Figure 1 shows the magnitude of the resources invested and the scope of the completed and in-progress land consolidation projects in the Czech Republic from 1998 to 2003.

MATERIAL AND METHODS

During the ten last years, the basic parameters characterising the land consolidation process were gathered. To measure the performance of the land consolidation process is a very complex process. The aim of the article was to identify the influences on the dynamics of the land consolidation process (Rutherford 2002). With the available information on this process, with its specificities as time inertia and long duration character, only methods of categorical dependencies proved to be useful.
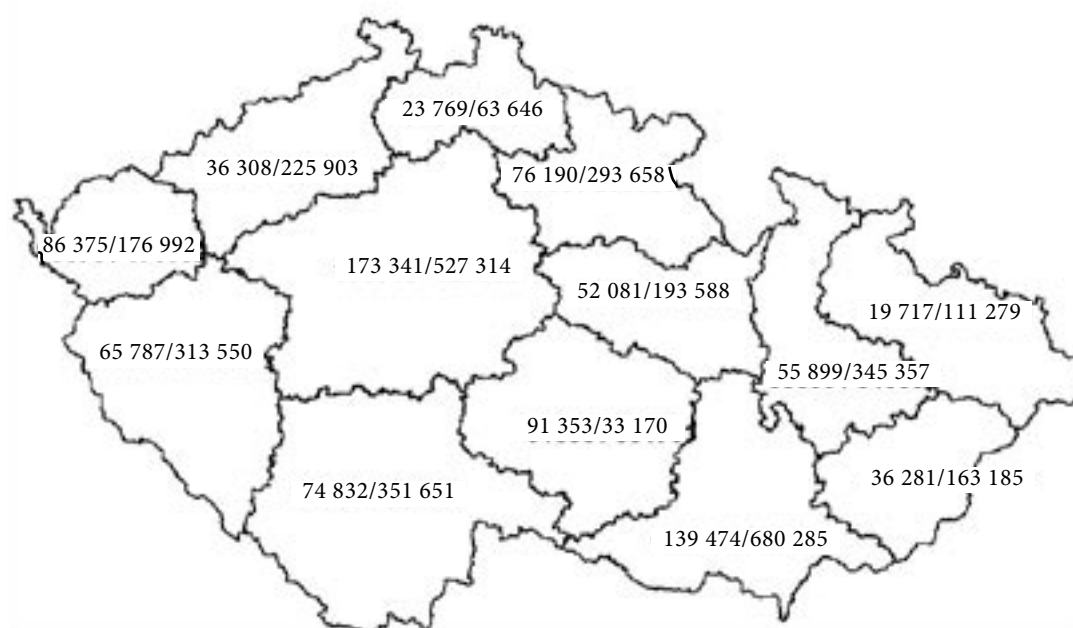
Figure 1. Processed and completed areas (hectares) per resources invested (thousand CZK) in regions

The basic information was obtained from the annual performance statistical reports submitted by the land offices and from the accounting statistics of the Ministry of Agriculture. Also the special investigations were effectuated.

The most important analyses in terms of statistical significance were conducted on the so-called aggregate sample, which contains accumulated information related to one land office for a six-year period. The calculations in this paragraph will always relate to the whole of the six-year period.

In this sense, a land office may be seen as a basic information unit, whose uniqueness is conditioned by geographical, administrative and historical factors. It is natural to ask about outcomes, such as the cost-effectiveness (if we filter out geographical and developmental impacts) and productivity of the individual offices. The aggregate sample indicates higher correlation dependencies; the random volatility of the annual data time series has been smoothed. In conducting analyses, it is sensible to ask about the causes of singular phenomena, the reasons for extreme deviations in the offices' finances and results. Such

Table 1. Investment in land consolidation process (thousand CZK, total 1998–2003)

	N	Minimum	Maximum	Total	Mean per office	Deviation	i.e. %
Preparatory works	76	0	42 824	389 051	5 119	6 503	10.3
Surveying	76	0	53 740	793 234	10 437	8 631	21.0
Designing	76	0	57 364	811 681	10 680	10 985	21.5
Setting-out	76	34	80 266	560 431	7 374	9 887	14.8
Roads	76	0	48 597	974 642	12 824	10 411	25.8
Environment	76	0	16 543	101 032	1 329	2 748	2.7
Water	76	0	13 376	87 705	1 154	2 317	2.3
Erosion	76	0	6 357	32 159	423	1 168	0.9
Others	76	0	3 253	29 046	382	680	0.8
Land consolidation total	76	166	199 550	3 778 109	49 712	34 044	100.0

Source: Ministry of Agriculture CR

offices may only be identified using the analyses of the aggregate data.

Basic financial indicators

Table 1 shows the financial resources invested in basic activities involving land consolidation. The table indicates high financial demands of land surveying operations (36% of all the costs) and the significance of land consolidation in terms of the renovation of dirt roads.

Table 2 shows the mean and standard deviation for costs per hectare of area subject to land consolidation (complex and simple, completed or in-process), with the costs of building projects not being considered.

Figure 2 shows the completed hectares dependent on the resources invested in land consolidation projects (points in the chart correspond to the of-fices). The chart indicates a relatively strong regression dependency between the resources invested and the hectares.

In the adequate analysis on the regional level, an even stronger interdependence of the costs and the area of completed or in-process land consolidation is observed; the regression lines indicates the homogenization effect of regional aggregation. It implies certain price specificities in the regions.

Total land offices' financial sources and financial means spent on land consolidation

The costs of both types of land consolidation and the land offices' total financial sources show a very high correlation (0.92) in six-year aggregation (1998–2003). Table 3 presents the total financial sources for the six-year period (CZK 5.01 billion), specifying the resources invested directly in land consolidation (CZK 3.77 billion). Figure 3 indicates the significantly linear nature of the dependence of financial resources invested in land consolidation on the total financial resources available to the land offices; if any deviation occurs, it is in the area of the higher proportion of investment in land consolidation. This suggests that in financial terms, land consolidation projects are the foremost priority of the land offices, while the other activities are insignificant from the financial perspective.

Table 2. Costs of land consolidation per hectare

Price (CZK) per ha of area under land consolidation without implementation work (simple complex land consolidation)		
	Mean	3 608
	Median	2 985
	Standard deviation	2 422

Source: Ministry of Agriculture CR

Table 3. CZK invested in land consolidation (in thousands CZK)

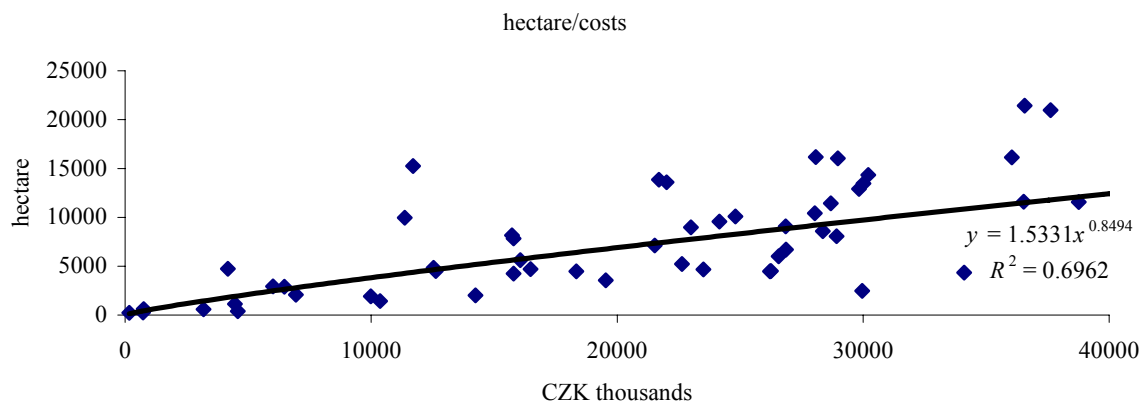|	N	Minimum	Maximum	Total amount	Mean per office	Standard deviation
CZK invested in land consolidation	76	166	199 550	3 778 109	49 712	34 044
Land offices' total sources	76	11 695	219 805	5 019 662	65 190	31 308

Source: Ministry of Agriculture CR

hectare/costs

Figure 2. Relation: area consolidated per costs

Source: Ministry of Agriculture CR
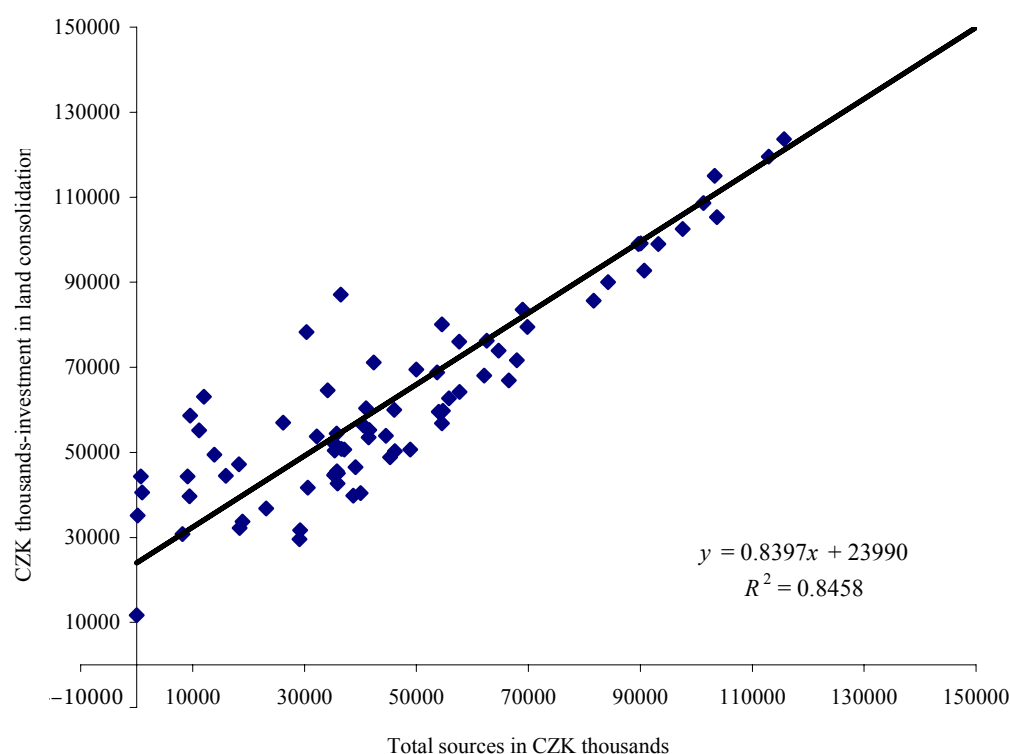
$$y = 0.8397x + 23990$$
$$R^2 = 0.8458$$

Figure 3. Regression – land consolidation investment per total resources of land offices (1998–2003)

Source: Ministry of Agriculture CR

Land consolidation funding and investment categories

The dependencies and relations under consideration are of a categorical nature. The land offices may be categorized according to different aspects, including geography, costs and local companies' productivity. In our case, the regression analysis may only indicate trends.

The aggregated sample of land offices was categorized into tertile classes with respect to their total financial sources and the land consolidation investment (the first tertile includes those offices with the lowest levels of finance). Table 4 shows numbers and percentages for offices in each category.

It is sensible to consider the offices in Groups 1–2 and 1–3, i.e. the offices featuring higher categories

Table 4. Frequency table of land consolidation investment categories versus resource categories

Land consolidation investment category		Financial sources category			
		1	2	3	total
1 tertile	number	16	8	1	25
	%	64	32	4	100
2 tertile	number	8	13	5	26
	%	30.8	50.0	19.2	100
3 tertile	number	0	5	20	25
	%	0	20	80	100
Total	number	24	26	26	76
	%	31.6	34.2	34.2	100

Source: Ministry of Agriculture CR

Table 5. Frequency table of performance categories

Land consolidation cost category without implementation projects		Hectares category (completed, in-progress)			
		1	2	3	total
1 tertile	number	19	4	2	25
	%	76	16	8	100
2 tertile	number	6	12	8	26
	%	23.1	46.2	30.8	100
3 tertile	number		10	15	25
	%		40	60	100
Total	number	25	26	25	76
	%	32.9	34.2	32.9	100

Source: Ministry of Agriculture CR

of total sources and lower categories of investment in land consolidation.

Land consolidation cost and performance categories

Table 5 shows the frequency of the numbers of offices in each financial and performance category – implementation costs are deducted from total costs (tertile 1 – the first third – includes the offices with the lowest levels of finance and performance).

There is an interdependence between the performance category and the financial cost category, in this table we get an extremely strong categorical dependency (χ^2 = 37.05, p = 0.001). This means that we can refer to the overall homogeneity of performance and land consolidation cost. Of course, the question may be raised why two offices from the lowest cost category also belong in the highest performance category.

Land consolidation cost related to regions

Table 6 shows cost per hectare (in CZK) of areas subject to land consolidation (without cost of the implementation of building projects) for each region.

The ANOVA test ($p < 0.001$) does not indicate statistically significant differences in price per hectare across the regions (Meloun, Milický 1994).

Analysis of aggregate sample of yearly totals

The sample of yearly totals includes yearly data aggregated for the entire republic. Each parameter is assigned a six-year time series (e.g. areas subject to simple land consolidation for the whole repub-

Table 6. Costs per hectare by regions

	Number	Mean	Standard deviation
Středočeský	13	2 099	947
Jihočeský	7	2 909	1 004
Plzeňský	7	3 467	1 088
Karlovarský	3	4 813	4 322
Ústecký	7	4 972	4 236
Liberecký	4	3 869	2 865
Královéhradecký	5	2 371	1 237
Pardubický	4	2 320	352
Vysočina	5	3 634	2 171
Jihomoravský	7	5 206	3 283
Olomoucký	5	5 008	2 655
Moravskoslezský	5	4 464	1 968
Zlínský	4	3 619	2 323
Total	76	3 608	2 422

Source: Ministry of Agriculture CR

lic during the years under consideration). Figure 4 visualizes the areas of completed and in-progress land consolidation, while Figure 5 shows the total financial resources invested in land consolidation in the Czech Republic.

Basic relations in the sample of yearly totals

The dependencies between variables were analyzed using the Spearman correlation coefficient (the assumptions for more robust methods were not fulfilled). When correlation is mentioned, it is referred to a statistically significant correlation at the 5% level.
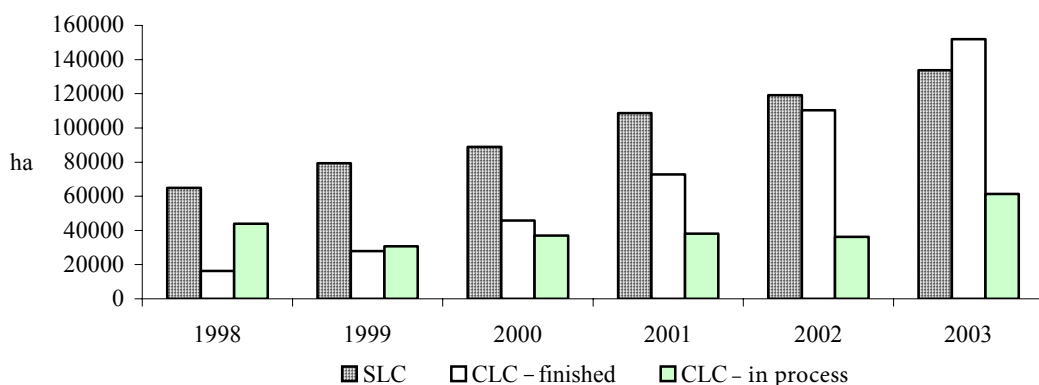

Figure 4. Finished simple land consolidation (SLC) and complex land consolidation (CLC)
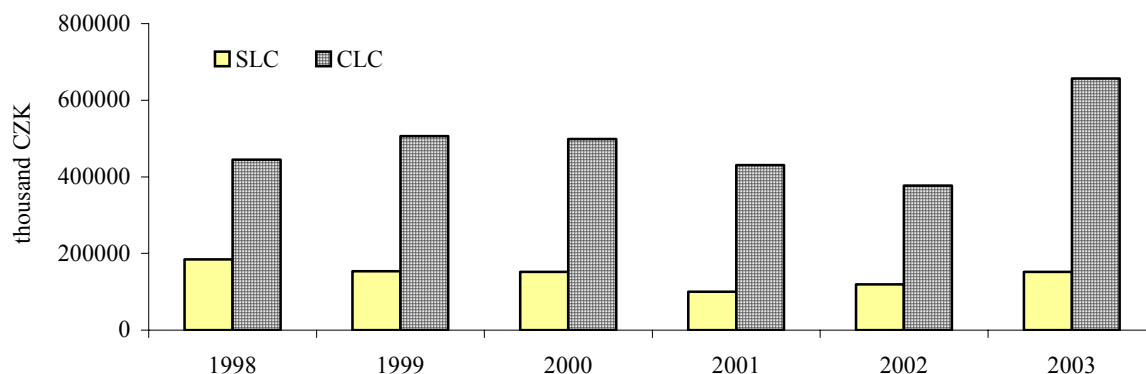
Source: Ministry of Agriculture CR

Figure 5. Financial resources invested in land consolidation (thousand CZK))

SLC – simple land consolidation, CLC – complex land consolidation
Source: Ministry of Agriculture CR

– The numbers of simple land consolidation projects (SLC) are correlated with the numbers of complex land consolidation projects (CLC). This means that an office dealing intensively with SLC is most likely also to deal intensively with CLC.

– The numbers of completed CLC correlate with the numbers of CLC currently in progress, which means that the offices which did not complete anything in previous years have not commenced anything in the current year either, and the offices which completed a lot of projects have also begun working on a large number of them.

– The numbers of completed CLC significantly correlate with the completed hectares; the numbers of completed CLC may be used to make a very accurate prediction of the numbers of completed hectares (ha = numbers * 370.5 – 1 222, $R^2 = 0.99$).

– The area of completed CLC in the given year correlates with the costs incurred in the geodetical works.

– The area of newly started CLC does not correlate with any of the cost indicators. This points to other influences, such as the office's labour force.

– The area of the total of CLC in progress also correlates significantly with the financial resources of the Land Fund of the Czech Republic (LF CR), which indicates that the LF's money contributes a great deal to the number of CLC projects that are in progress.

– The land offices submit their plans for the commencement of land consolidation in the next year. It is interesting in this respect that these data correlate strongly with the number of CLC projects commenced in the given year and with the number of CLC projects registered in the given year. Thus, the correlation coefficient confirms rather the psychology of expectations than a more rational fact.

– The costs of roads, environment and water systems do not correlate with area of land consolidation, which means that these projects are dealt independently of the intensity of the land consolidation implementation. On the other hand, a strong relation between the numbers of both CLC and SLC projects in the given year on one hand, and the costs of anti-erosion activities on the other, indicate that the anti-erosion measures and land consolidation go hand in hand and condition each other.

– Between the cost and the numbers of the completed hectares of different categories, there are statistically significant non-zero correlation.

– The correlations imply that the resources from the SAPARD programme have an impact on the finance dedicated to road construction; the LF's resources correlate with the resources intended for geodetical works and the funds provided by the Ministry of Environment affect the implementation of water projects.

In the frequency table of the category of the land consolidation costs (the lowest, medium and highest), and areas subject to land consolidation, the dependence between the cost and performance categories are significant. For example, in Table 7, for 1998 we receive a statistically significant chi-square test value ($p = 0.002$). For all the other years under consideration it is $p < 0.003$. Thus, we arrive at similar conclusions as in the aggregate sample.

Between the yearly samples, there are no significant differences in the covariant matrices of cost and performance categories, which imply a certain

Table 7. Frequency table of performance categories in 1998

		Cost categories			Total
		1	2	3	
Performance categories	1	18	8	5	31
	2	7	9	7	23
	3	3	6	14	23
Total		28	23	26	77

Source: Ministry of Agriculture CR

structural similarity of the cost and performance categories for each year.

CONCLUSION

The cost and performance analysis makes it possible to predict expectations concerning the area of completed land consolidation projects with respect to regional differences and to determine certain performance "norms" for the land offices. A certain structural inertia in the relations of the cost and performance categories becomes explicit. The length of the time series does not allow for a more robust time series apparatus to be deployed, but the nature of the dependencies presented makes it possible to partly disclose the structure and power of the influences affecting the land consolidation processes in the country. The land consolidation process is a financially demanding process, the possibilities of budgeting are limited, the rational planning and evaluation of use of resources could enhance the overall productivity.

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