



Sammenlægningsundersøgelsen
Rapport 3

**Documentation of the model of
local authority economic activity**

by

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Preface

The report documents the model system used in the report *Local Authority Financial Management and Local Authority Mergers – a study of the trends in local authority spending on the island of Bornholm and in other regions of Denmark* (Madsen 2003). The model system consists of the MLAE model and the LINE model. MLAE is a model of local authority economic activity, whereas LINE is AKF's model for local economic activities.

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1 Introduction

The reform of the local government system on the island of Bornholm on January 1, 2003 raises the question whether the economy of the new Bornholm's unitary region has improved when compared with the economies of the five municipalities and one county, from which the Bornholm's regional authority was formed. In order to answer this question it is necessary to construct an economic model to model the changes in the economy of the six local government units to the merged economy of Bornholm's Region between 2002 and 2003. The reason for using a model is that a number of other changes occurred in the same period, which makes it impossible to claim that the total change observed from 2002 to 2003 expresses the pure impact of the reform. First, prices changed; second, the size and structure of the population changed as well as the taxable income and other sources of finance; third, there are probably secular changes occurring both before 2002 and after 2003. All of these effects must be included in order to capture »other changes« and the impact of the reform.

In addition, there are a number of more general reasons for constructing a sub-model for local government economic activity. First, there is a general interest in identifying and calculating the impacts of local government economic activity, especially on the local economy itself. Second, there is also an interest in describing and modelling the impacts of changes in the local economy on the local government economy. Both areas of interest can be analysed – conceptually and empirically – if a model is constructed.

The first step is identification of the two-way interaction between the local economy and local government. First, the economic importance of

local government economic activity is determined, as can be done for other sectors in the economy, for example, the tourism sector. These local government to local economy impacts can also include analysis of the consequences of more limited changes in economic activity due to changes in local government activities. The second step is to model how local government economic activity changes, if local economic activities change (local economy to local government). Changes in the size and structure of the population have implications for the local government economic activity. If production and income in the local economy change, then the demand for local government services and/or the level of taxation change. If prices of commodities or the wage level for local government employees change then demand for local government services in current prices changes.

In relation to the reform of the local government system of Bornholm it is primarily the local economy to local government impacts which are of interest. Later it might also be of interest to include local government to local economy impacts.

Construction of a sub-model for this two-way interaction leads to a number of studies which are relevant for Danish local authorities, especially when discussing future developments, including a global reform of the Danish local government system. First, the sub-model can be used to analyse the sustainability of local government economic units, in the past, today and in the future. Using a number of exogenous assumptions, different measures of the economic strength of local government economies can be established in order to identify whether specific local authorities or groups of local authorities (such as local authorities in rural areas) face specific economic problems in the future. Analysis of existing strengths and weaknesses can also be undertaken from a historical point of view, in order to establish whether local government economic performance has improved or deteriorated because of earlier changes in the local economy or because of internal decisions in the local government economy. Second, if a global reform of the Danish local government system is implemented, the sub-model (together with AKF's local economic model LINE) can be used to show whether the reform will lead to local authority budget improvements, after corrections for external changes such as changes in population, taxable income etc. have been made.

In this report the sub-model for the local authority economy is presented. First, the concrete project of separating out the impacts of the reform using the model is presented in section 2 together with examination of the concepts of ex-ante and ex-post evaluations of changes applied to the economy of local authorities on Bornholm.

The local authority economy sub-model is part of a more general model for local economic analysis, LINE. In order to illustrate the overall framework for building the sub-model an overview of LINE is presented in section 3. Here, some key concepts related to economic activity which are necessary in order to understand the workings of the local authority economy in the local economy are defined.

In section 4 the structure of the local authority economy sub-model is presented, including a description of the location of the economic activities of the local authority. This includes the function of the local authority as a collective institution with a place of residence where the local authority is located, with demand for its sources, located where the service is provided (the commodity market place) and with the place of production of its production activities (and associated), where the production activities meeting the demand take place.

In section 5 the data sources for constructing the data base used in the Model of local authority Economy are presented.

2 The impact of local government reform on Bornholm

On January 1, 2003 Bornholm's unitary regional authority was established out of five municipalities and one county. Change in the local authority economy is by definition:

$$\Delta y = y_t - y_{t-1} = y_{2003} - y_{2002} \quad (1)$$

where:

Δy is the change for a given variable y from year $t-1$ to year t in the economy of the local authority.

y_t is a variable y in the economy of the local authority. Examples are changes in expenditure, revenue or balances.

In order to evaluate whether the change in the local authority's economy expresses the impact of the local government reform or the impact of other changes, a model MLAE (Model of local authority Economy) is introduced. The change in the local authority economy can be expressed using MLAE:

$$\begin{aligned} \Delta y &= (y_{2003} - MLAE_{2003}) + MLAE_{2003} - (MLAE_{2002} - (MLAE_{2002} - y_{2002})) \\ &= \text{Model error 2003} + MLAE_{2003} - MLAE_{2002} - \text{Model error 2002} \\ &= MLAE_{2003} - MLAE_{2002} \end{aligned} \quad (2)$$

where:

$MLAE_t$ is the result for a given variable y of the economy of the local authority calculated with the MLAE for time t .

Because MLAE is constructed such that MLAE replicates the magnitudes in the budget, then the model of the local authority economy can substitute the calculation of economic change based directly upon the budget (see equation (1)). As can be seen from equation (2), the change in the economy can now be divided into three elements: 1) Model error 2003 (the model takes over from local authority economy budget data), 2) changes in the economy modelled with MLAE and 3) model error 2002 (again the model takes over from local authority economy data). Because the model replicates (the two model error elements being equal to 0), the change in budget from 2002 to 2003 is exactly equal to the change calculated using MLAE.

MLAE can then be used to decompose the change in the local authority economy from 2002 to 2003 into a component showing the effects of other changes and the effects of the local government:

$$\begin{aligned}
\Delta y &= MLAE_{2003} - MLAE_{2002} \\
&= MLAE_{2003} - MLAE_{2003}(\text{Other changes}) \\
&\quad + MLAE_{2003}(\text{Other changes}) - MLAE_{2002} \\
&= \text{local governments reform} \\
&\quad + \text{other changes}
\end{aligned} \tag{3}$$

MLAE is an economic model simulating on a number of exogenous variables x determining a number of endogenous variables y . Therefore, the decomposition in equation (3) can be expressed more precisely in the following way:

$$\begin{aligned}
\Delta y &= MLAE(y_{2003}, x_{2003}^{g_1}, x_{2003}^{g_2}, \dots, x_{2003}^{g_5}) - MLAE(y_{2002}, x_{2002}^{g_1}, x_{2002}^{g_2}, \dots, x_{2002}^{g_5}) \\
&= MLAE(y_{2003}, x_{2003}^{g_1}, x_{2003}^{g_2}, x_{2003}^{g_3}, x_{2003}^{g_4}, x_{2003}^{g_5}) - MLAE(y_{2003}, x_{2003}^{g_1}, x_{2002}^{g_2}, x_{2002}^{g_3}, x_{2002}^{g_4}, x_{2002}^{g_5}) \\
&\quad + MLAE(y_{2003}, x_{2003}^{g_1}, x_{2002}^{g_2}, x_{2002}^{g_3}, x_{2002}^{g_4}, x_{2002}^{g_5}) - MLAE(y_{2002}, x_{2002}^{g_1}, x_{2002}^{g_2}, x_{2002}^{g_3}, x_{2002}^{g_4}, x_{2002}^{g_5}) \\
&= \text{local governments reform and other real economic changes in local authority economy} \\
&\quad + \text{other changes in the local authority economy}
\end{aligned} \tag{4}$$

where:

$MLAE_t(y_t, x_t^{g_1}, x_t^{g_2}, x_t^{g_3}, x_t^{g_4}, x_t^{g_5})$ is the result for a given endogenous variable y of the economy of the local authority calculated using MLAE involving five groups of exogenous variables x^{g_i} for time t .

In equation (4), the exogenous variables of MLAE have been divided into five different categories, such as population and population structure (category 1), user shares (category 2) etc. In the equation, the state of the economy in 2003 has been calculated using values (forecasted or actual) of the exogenous variables x . The budget variables y have been calculated on the basis of the values of these five categories of exogenous variables. The first difference then expresses the impact of the local government reform and other real economic changes in local authority economy, whereas the last difference expresses the impact of other changes in the local authority economy.

Ex-ante and ex-post evaluation

Two different types of evaluation can be identified: Ex ante and ex post. In ex-ante evaluation the point of departure is the budget, whereas in the ex-post evaluation the point of departure is accounts data.

In ex-ante evaluations the evaluator looks forward, identifying the share of the forecasted change (as measured in the budget), which can be explained by the reform and the share (the rest), which can be explained by other changes. The changes in the endogenous variables are then the forecasted and compared with changes as determined in the budget. In order to explain the changes in the budget updated data on the exogenous variables are used. In many cases it is, however, also necessary to use forecasted data for the exogenous variables.

In ex-post evaluation the point of departure is the change in the accounts. In this case actual data for both the endogenous variables (changes in the local authority economy) and the exogenous variables influencing the economic development are the data used.

In the case of evaluation of the economy of Bornholm's Region, the variables used are the following:

Table 2.1 Data sources in evaluation of changes in the economy of the local authority

	Ex-ante evaluation	Ex-post evaluation
Carried out	Autumn 2003	Autumn 2004
Endogenous variables:		
Expenditure, revenue, balances	Budget 2003 Account 2002	Account 2003 Account 2002
Exogenous variables:		
Population, size and structure	Current 2003	Current 2003
Users/capacity	Current 2003	Current 2003
Groups of users/capacity	Current 2003	Current 2003
Employed per group of users/capacity	Forecast 2003	Current 2003
Expenditure per employed	Forecast/budget 2003	Current 2003

Long-run evaluation

Finally, long-run changes in the economy of Bornholm's Region can also be analysed using the same model as used for the short-run impacts. The only difference, in the present version of the model, is the data, where data from before 2002 and after 2003 should be included in the long-run evaluation. Again, in principle both ex-ante of ex-post evaluation can be used to explain the long-run impacts, but in most cases, an ex-post evaluation will be based on current data.

3 **LINE: the full model, a graphical presentation**

Here a brief graphical presentation of LINE is made. The full model and its equations are described in detail in Madsen et al. (2001a) and Madsen and Jensen-Butler (2003). The data used in the model, together with the inter-regional SAM, are described in Madsen et al. (2001b).

LINE is based upon two interrelated circles: a real Keynesian circuit and a dual cost-price circuit. Figure B.1 shows the general model structure, based upon the real circuit employed in LINE.

The horizontal dimension is spatial: place of production (denoted R), place of residence (T) and place of commodity market (S). Production activity is related to place of production. Factor rewards and income to institutions are related to place of residence, and demand for commodities is assigned to place of commodity market. The vertical dimension is more detailed and follows with its five-fold division the general structure of a SAM model. Production is related to activities; factor incomes are related to i) activities by sector, ii) factors of production with labour by sex, age and education, iii) institutions: households, iv) demand for commodities is related to wants (aggregates of commodities or components of final demand and intermediate consumption) and v) commodities, irrespective of use.

The real circuit corresponds to a straightforward Keynesian model and moves clockwise in figure 3.1. Starting in cell RE in the upper left corner, production generates factor incomes in basic prices. This factor income is transformed from sectors (RE) to sex, age and educational groups (RG). Factor income is then transformed from place of production (RG) to place of residence (TG) through a commuting model. Employment follows the same path from sectors (RE) to sex, age and educational groups (RG) and

further from place of production (RG) to place of residence (TG). Employment and unemployment are determined at place of residence (TG). Employment refers both to place of production and to place of residence, whereas unemployment and the labour force, by definition only can be related to place of residence. This also explains the relationship of earned income to both place of production and place of residence, whereas other income, transfer incomes and personal taxes, by definition only can be related to place of residence.

Disposable income is calculated in a sub-model where taxes are deducted and transfer and other incomes are added. Disposable income is distributed from factors (TG) to households (TH). This is the basis for determination of private consumption by type of household in market prices, by place of residence (TW). Private consumption is divided into tourism (domestic and international) and local private or residential consumption. Private consumption is assigned to place of commodity market (SW) using a shopping model for local private consumption and a travel model for domestic tourism. Private consumption, together with intermediate consumption, public consumption and investments constitute the total local demand for commodities (SV) in basic prices through a use matrix, including information on the commodity composition of demand and commodity tax rates and trade margin shares. In this transformation from market prices to basic prices (from SW to SV) commodity taxes and trade margins are subtracted. Local demand is met by imports from other regions and abroad in addition to local production. Through a trade model exports to other regions and production for the region itself are determined (from SV to RV). Adding export abroad, gross output by commodity is determined (RV). Through a reverse make matrix the cycle returns to production by sector (from RV to RE).

The stylised version of the model with the real circle illustrated, as well as the price concepts used, is shown in figure 3.1, where the price level of real circle variables (constant/current) is shown.

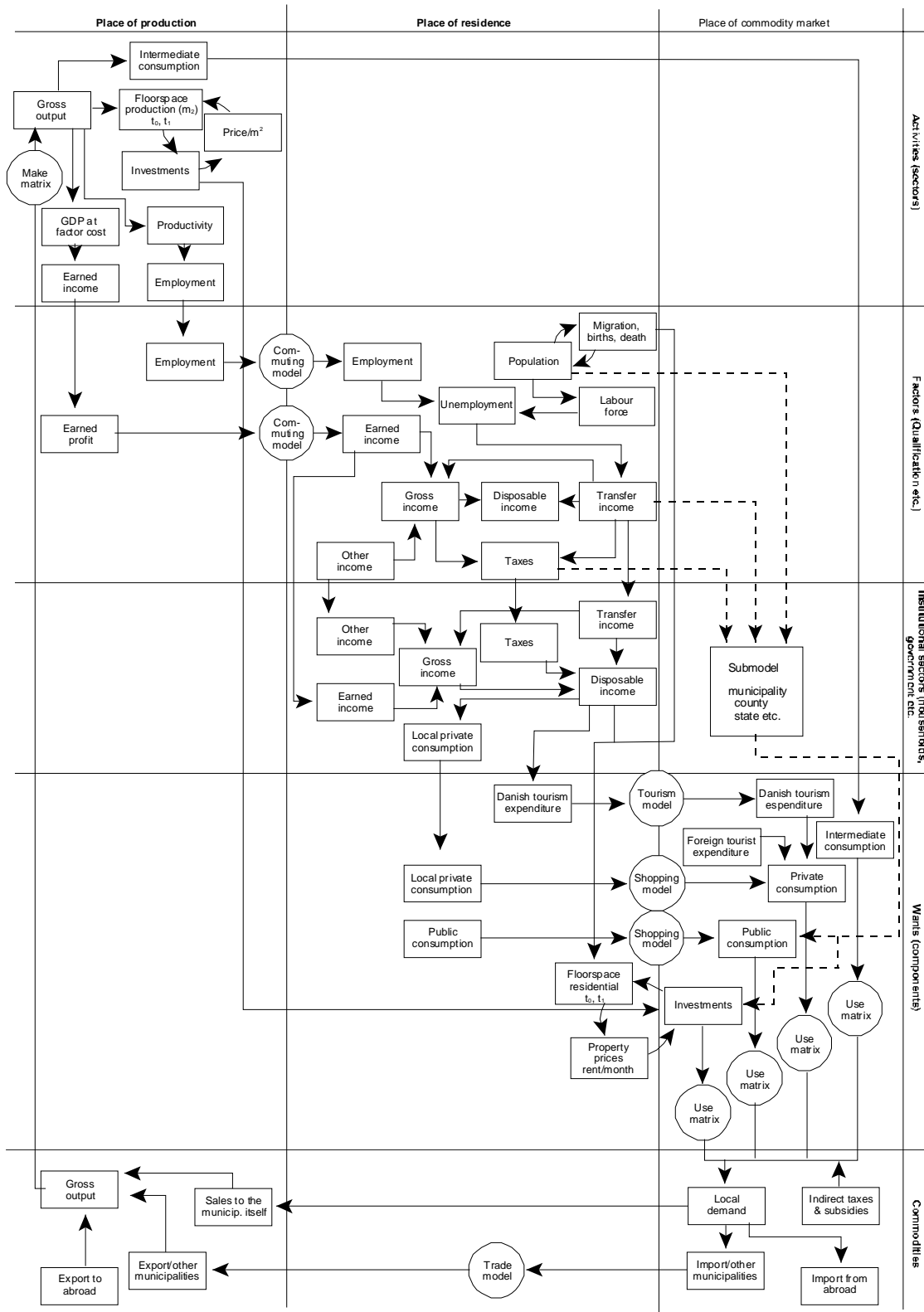
Figure 3.1 A simplified version of LINE: the real circle

	Place of production (R)	Place of residence (T)	Place of commodity market (S)
Activities (sectors) (E)	Gross Output Intern. consumption GVA GDP at factor prices Earned income (RE)		Intermediate consumption (SE)
Factors of production (education, sex, age) (G)	Earned income Employment (RG)	Earned income Employment Unemployment Taxes and transfers Disposable income (TG)	
Institutions (households, firms, public sector) (H)		Earned income Taxes and transfers Disposable income (TH)	
Demand components (W)		Local private consumption Tourist expenditure (TW)	Intermediate consumption Local private consumption Tourist expenditure Public consumption Investments (SW)
Commodities (V)	Local production Exports to other municipalities Exports abroad (RV)		Local demand Imports from other municipalities Imports from abroad (SV)

————— Constant prices

- - - - - Current prices

Figure LINE, the full model
3.3



Using again the stylised version of the model shown in figure B.1, the anti-clockwise cost/price circuit shown in figure 3.2 corresponds to the dual problem. In the cost-price circle, production and demand are calculated in current prices, which in turn are transformed into relevant price indices. In cell RE gross output by sector in basic prices (current prices) is determined by costs (intermediate consumption, value added and indirect taxes, net in relation to production). Through a make matrix, gross output by sector is transformed into gross output by commodity (from RE to RV). These are then transformed from place of production to place of commodity market (RV to SV) and further into market prices through inclusion of retailing and wholesaling costs and indirect taxes (from SV to SW). This transformation takes place using a reverse use matrix. Finally, intermediate consumption is transformed from place of commodity market to place of production, likewise, private consumption is transformed from place of commodity market to place of residence in market prices (from SW to TW). Figure 3.3 shows the structure of LINE in more detail.

3.1 **The dimensions of LINE**

In the standard version of LINE the dimensions of the axes are normally the following (though these dimensions are not used in the local authority economy study):

Sectors:

12 sectors aggregated from the 133 sectors used in the national accounts.

Factors:

7 age, 2 sex and 5 education groups.

Households:

4 types, based upon household composition

Needs:

For private consumption and governmental individual consumption 13 components, aggregated from the 72 components in the detailed regional national accounts. For collective governmental consumption, 8 groups. For gross fixed capital formation, 10 components.

Commodities:

20 commodities, aggregated from 131 commodities used in the national accounts.

Regions:

277 municipalities, including one state-owned island and one unit for extra-regional activities, this being the lowest level of spatial disaggregation. Regions are defined either as place of production, place of residence or as place of commodity market. It is possible to aggregate the (277) municipalities into any regional unit. Standard regions are the (17) counties and (46) labour-market districts, both including one unit for extra-regional activities.

The data base for LINE is a Social Accounting Matrix for economic activity in Danish regions called SAM-K. For a documentation of SAM-K see Madsen et al. (2001b).

3.2 **Model flexibility**

LINE has been designed with a high degree of flexibility so that different elements of the model can be either used in different types of analysis, or they can also be removed by aggregation. The remaining dimensions and categories can be aggregated in different ways. Also, different sub-models (such as the local authority economy model) can either be included or excluded. The aggregation of activities, commodities and regions used in the local authority economy study is shown in appendix 1.

4 **MLAE – a sub-model of Danish local authority economic activity**

4.1 **Introduction**

The model of local authorities' economic activity (municipalities and counties) is called MLAE. It can be described in the framework of LINE and SAM-K, which is the database used for LINE. SAM-K is a system of social accounting matrices for Danish municipalities. In the process of building up MLAE as an integrated part of LINE, SAM-K is extended with accounts for local governments.

4.2 **MLAE: the full model, a graphical presentation**

An overview of the structure of MLAE is shown in figure 4.1. The local authorities are institutional units in LINE and SAM-K and are as such in figure 4.1 located horizontally at place of residence. Vertically, the local authorities (municipalities and counties) are classified as institutions and divided into level of local government (as the households are divided into type of households).

First, government revenue (local authority taxes etc.) is calculated on the basis of taxable income of the inhabitants by their place of residence. Taxable income is transformed from the regional division used in LINE to the regional division used in the municipal and county economic models. In the project on the local government reform on Bornholm, taxable income is transformed from the regional division used in LINE (for example

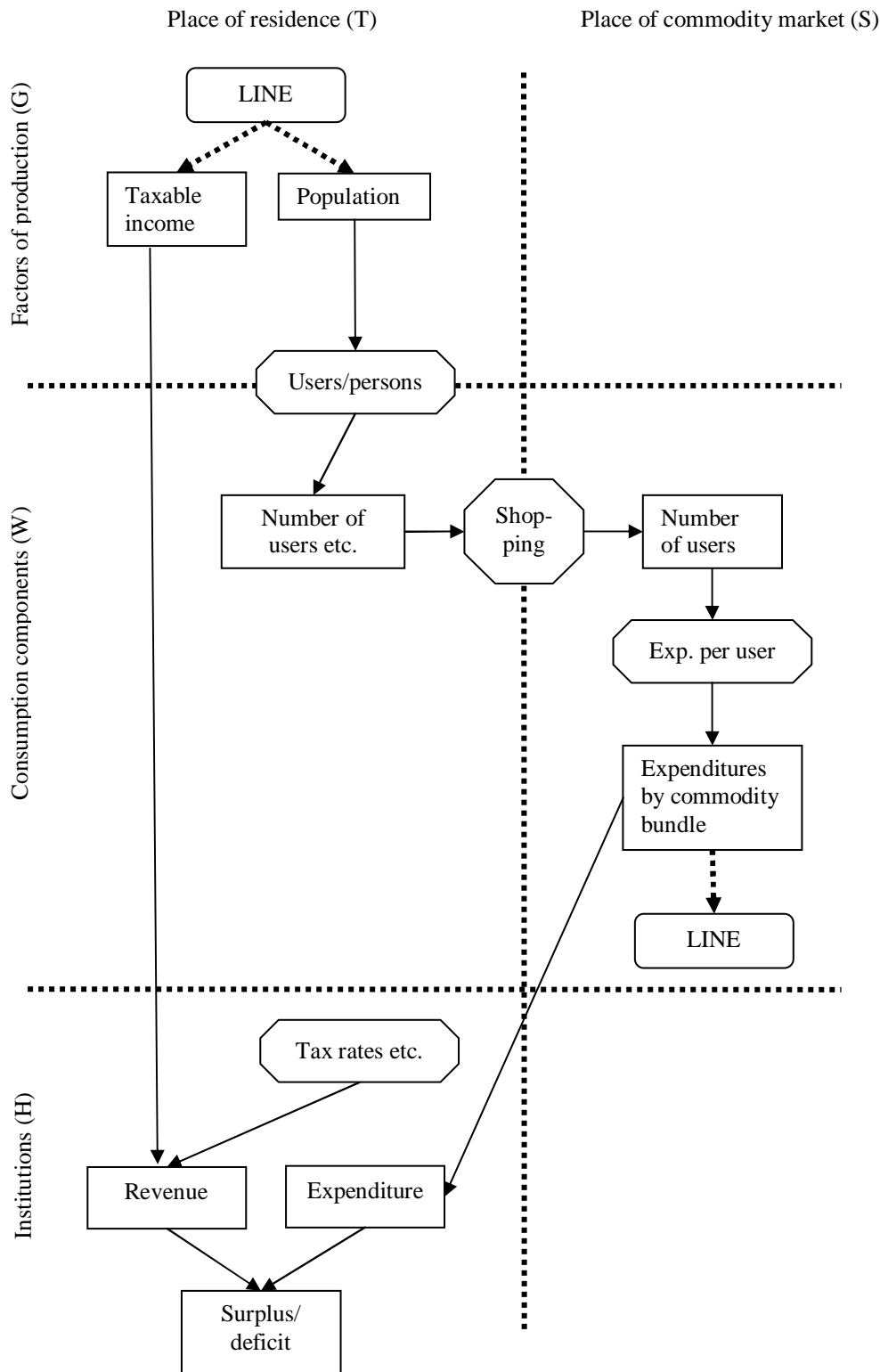
the 16 counties in Denmark plus a further sub-division of Bornholm into the five municipalities – see appendix 1) to the level of municipalities and counties (275 municipalities and 16 counties, before the reform). Taxes are then calculated by multiplying by the tax rates determined by the local authorities.

Second, institutions purchase bundles of commodities called consumption components. Vertically, the government expenditures are transformed from factor of production (population by age group) to consumption component. Consumption components are bundles of commodities or areas of expenditure, which later in the modelling process are transformed into specific commodities. Each bundle of commodities is either determined by size and structure of population, variables for productivity or standards (current expenditure) or is fixed exogenously (expenditure on gross capital formation expenditure). For each bundle of commodities (or area of expenditure) the current demand is typically measured in production units (such as kindergarten capacity or number of users) or as population size in a given age group.

The consumption of the local governments' consumption bundles (for example measured in number of clients) originates from the place of residence, but is transformed to the place of commodity market. On the commodity market at the place of commodity market local authorities purchase commodities from the local authority itself or from other local authorities as services for its own citizens, produced by the local authority itself or by other local authorities. They also receive revenue from sales to their own citizens and to other local authorities. Expenditures are therefore calculated both at the place of commodity market, where gross expenditure is demand for the local authority's services, and also at the place of residence, where net expenditure is included in the institutional account for local government. As such, local government consumption is very similar to local private consumption and domestic tourism, which also originates from the place of residence of the institution (households or type of nights) and is spent at the place of commodity market for the consumption. Technically, the shopping model for governmental consumption is similar to that of local private consumption and domestic tourism, except that the units used in the local government economic model and for domestic tourism are in

physical units, whereas the units used for local private consumption are in monetary values.

Figure 4.1 Overview of the economic model of local authorities in LINE



From the shopping model the sales of services to other local authorities are determined implicitly, and net expenditure at place of residence is determined. Total revenue and net expenditure generate the surplus/deficit in the local authority's current budget. A deficit or surplus is financed through changes in the assets and liabilities of the local authority.

Now, moving to the modelling in LINE of the impacts on local economy (see figure 3.1) from the supply point of view demand for local government commodities is met by local government production. In a traditional demand driven model demand creates its own supply. Seen from the supply side, local authorities sell commodities to the local authority itself and to other local authorities. Local government production of commodities will be equal to the regional demand for the following reasons: First, local governments produce immobile commodities, which are produced in the same region as they are consumed. Hospital services are produced in the same region they are consumed. Gross output is, therefore, by definition equal to regional demand in basic prices. Second, local governments produce commodities which normally are not taxed and which do not require any wholesaling and retailing activities. Finally, there is often a unique one-to-one relation between the bundles of commodities and the basic commodities which local government produces. This relation between demand for local government commodities at place of commodity market, to production at the place of production can be seen from the LINE diagram figure 3.1 bearing the specification of these commodities in mind.

From gross output in the local authority sector, different measures of local government economic activity, such as employment and intermediate consumption, can be derived.

The local government model of production and employment follows the structure of the models for other sectors in the economy. Local authority production activities can also be divided into a number of commodities and sectors (such as hospital activities) which is both a commodity and a sector and which can be produced in both the government and the private institutions. Therefore, this part of the local authority economic model has not been presented in figure 4.1, and the presentation only covers the local economy to local government impacts and the implication for finance of expenditure and balances in the local authority economy.

4.3 Model equations

The equations of the local authority economic model are as follows. Starting with the real circle, the point of departure is the population and income variables determined in LINE. These variables determine local authority's revenue and expenditures.

4.3.1 The revenue model

Current revenue

In the first step, taxable income from LINE is used to model tax revenue in MLAE. Taxable income is transformed from the regional division in LINE (R1) to the regional division in MLAE (RM/RC):

$$yub_{RM/RC} = \sum_{R1} YUBtoBQ \cdot yub_{R1}$$

where:

$yub_{RM/RC}$: taxable income by place of residence b, either at the municipality level (RM) or at the county level (RC)

$YUBtoBQ$: Taxable income in municipality RM or county RC as share of taxable income in R1, by place of residence b (RM or RC)

yub_{R1} : taxable income by place of residence b, at R1

Then tax revenue is calculated:

$$s \langle \rangle b_{RM/RC} = S \langle \rangle BQ_{RM/RC} \cdot yub_{RM/RC}$$

where:

$s \langle \rangle b_{RM/RC}$: the local government tax revenue by level of the local authority (municipality or county) by place of residence b, either municipality level <RM> or county level <RC>

$S \langle \rangle B_{RM/RC}$: the local government tax rate by the level of local government (municipality or county), by place of residence b, either municipality level <RM> or county level <RC>.

Other sources of revenue such as

- interest
 - local authority income equalisation grants and the state grant system are, in the present version of the model, exogenously determined, whereas sources like
 - other current finance
- depend either on population or are exogenously given.

Balance and financial movements

Changes in the wealth of the local government such as

- loans
 - repayments of loans
- are treated exogenously.

4.3.2 **The expenditure model**

The model has been divided into a number of different bundles of commodities or areas of expenditure:

Table 4.1 Population and production variables used in the local authority economic model by local government's areas of expenditure

Bundle of commodity/areas of expenditure (W) (1)	Expenditure codes ¹⁾ (2)	Population by age group (g) (3)	Number of users/age group population (4)	Average unit size (users) (5)	Employment per unit (6)	Wage and intermediate cons. costs per employee (7)	Purchase and sales in other local authorities (8)
Municipality and county expenditure areas							
Urban dev., Housing etc.	0.01-0.40	Pop	-	-	-	Pop	Pop
Environment protection	0.41-0.95, 1.09-1.55	Pop	-	-	-	Pop	Pop
Utilities	1.01-1.06	Pop	-	-	-	Pop	Pop
Transportation and infrastructure	2.01-2.97	Pop	-	-	-	Pop	Pop

Bundle of commodity/areas of expenditure (W)	Expenditure codes ¹⁾	Population by age group (g)	Number of users/ age group population (4)	Average unit size (users)	Employment per unit	Wage and intermediate cons. costs per employee (7)	Purchase and sales in other local authorities
(1)	(2)	(3)		(5)	(6)	(7)	(8)
Primary schools	3.01-3.04, 3.06-3.13	Pop 7-14 years	Pupils	Classes	Teacher hours	Teacher hours	Pupils
High schools	3.40,3.42	Pop 15-17 years	-	-	-	-	-
Commercial colleges etc.	3.20-3.33, 3.43-3.45, 3.48-3.49	Pop 15-17 years	-	-	-	-	-
Education, adults	3.37	Pop 18-29 years	-	-	-	-	-
Libraries, cultural activities	3.50-3.79	Pop	-	-	-	-	-
Social assistance	5.01-5.09, 5.32	Pop	-	-	-	-	-
Day care	5.11	Pop 0-2 years	Number of users	-	Employed	Employed	Number of users
Nurseries	5.12	Pop 0-2 years	Number of users	-	Employed	Employed	Number of users
Kindergartens	5.13	Pop 3-6 years	Number of users	-	Employed	Employed	Number of users
Age integrated institutions	5.14	Pop 3-6 years	Number of users	-	Employed	Employed	Number of users
Recreation centres	3.05, 5.15	Pop 7-14 years	Number of users	-	Employed	Employed	Number of users
Clubs	5.16	Pop 15-17 years	Number of users	-	Employed	Employed	Number of users
Other activities for children and youth	5.10, 5.17-5.19	Pop 7-14 years	Number of users	-	-	Pop 7-14 years	Number of users
Placement outside home children and young persons	5.20-5.29	Pop 15-17 years	-	-	-	-	-
Dwellings for elder people	5.30-5.31, 5.33, 5.36-5.39	Pop 75-89 years	Number of dwellings	-	-	Pop 75-00	Pop 75-00

Bundle of commodity/areas of expenditure (W) (1)	Expenditure codes ¹⁾ (2)	Population by age group (g) (3)	Number of users/ age group population (4)	Average unit size (users) (5)	Employment per unit (6)	Wage and intermediate cons. costs per employee (7)	Purchase and sales in other local authorities (8)
Nursing and day homes	5.34	Pop 75-89 years	Number of users	-	Employed	Pop 75-00	Pop 75-00
Rehabilitation	5.40-5.99	Pop	-	-	-	-	-
Political org.	6.01-6.43	Pop	-	-	-	-	-
Administration	6.50-6.70	Pop	-	-	-	-	-
County expenditure areas							
High schools	3.41	Pop 15-17 years	-	-	-	-	-
Health and social assistant educations	3.46-3.47	Pop 18-29 years					
Hospitals	4.01	Pop 75-89 years	-	-	-	-	-
Psychiatric hospitals	4.02	Pop 75-89 years					
Hospital services	4.05-4.41	Pop 75-89 years					
Sickness protection schemes	4.70-4.74	Pop 75-89 years	-	-	-	-	-

Note: A »-« means that the same variable has been used as the one on the immediate left. For example »pop« means that the population has been used for all factors (3)-(8).

1 Indenrigsministeriet (2003).

From the table it can be seen that in this version of the MLAE model, 30 areas of expenditure (column 1) have been used. The first 24 have been used for both municipalities and counties, whereas the last 6 have been used for counties. No areas are used for municipalities only. The areas of expenditure have been defined using the accounting indices in the accounting system determined by the Ministry of the Interior (Indenrigsministeriet 2003) (column 2). The aggregations of the areas of expenditure have been

applied in both the municipality and the county model in order to make it possible to add the results from the two models.

Current expenditure

In the current expenditure model it is assumed that current expenditure for each expenditure area is a function of the size and structure of the population and a number of productivity variables. Expenditure, purchases and sales are modelled in six steps:

First, population is transformed from

- a) the age division in LINE (in LINE 15 year age groups are used (G_1)) to the age groups used in the MLAE model (0-2 years, 3-6 years, 7-14 year, 15-17 years, 18-29 years, 30-44 years, 45-59 years, 60-66 years, 67-74 years, 75-89 years and 90 and more years old (G_2)) and
- b) the regional division in LINE (R1) to the regional division in the local authority economic model (RM/RC).

The age division transformation is the following:

$$ubg_{G_2,R_1} = \sum_{G_1} UBGtoGQ \cdot ubg_{G_1,R_1}$$

where:

ubg_{G_2,R_1} , ubg_{G_1,R_1} : population by place of residence b and by age group G2 (age groups as in MLAE) or by age group G1 (age groups in LINE)

$UBGtoGQ$: population by age G2 (age groups as in MLAE) as share of population by each age group G1 (age groups as in LINE which are 15 year age groups), by place of residence b (as in LINE)

Second, the regional division is changed from that used in LINE (for example the county level) to the division used in the two types of MLAE model – the municipality in the municipality economic model and the county in the county economic model:

$$u \diamond bg_{RM/RC} = \sum_{R_1} U \diamond BtoBGQ \cdot ubg_{R_1}$$

where:

$u \langle \rangle bg_{RM/RC}$: population by place of residence b and age group g (age groups as MLAE G2) ($\langle \rangle$ can be municipality (RM) or county (RC))

$U \langle \rangle BtoBGQ$: population by place of residence b as share of population by place of residence used in LINE, by age group g (age groups as in MLAE G2) ($\langle \rangle$ can be municipality (RM) or county (RC))

In the third step, for each bundle of commodities or area of expenditure (for example kindergartens) a population variable in relevant age group (number of 3-6 years) is assigned:

$$u \langle \rangle bw_{RM/RC} = \sum_{R1} U \langle \rangle BGtoWQ \cdot u \langle \rangle bg_{RM/RC}$$

where:

$u \langle \rangle bw_{RM/RC}$: population related to area of expenditure w by place of residence b used in MLAE ($\langle \rangle$ can be municipality (RM) or county (RC))

$U \langle \rangle BGtoWQ$: population by area of expenditure w and by age group g (age groups as in the local authority economic model), by place of residence b used in the local authority economic model ($\langle \rangle$ can be municipality (RM) or county (RC)) (0 or 1-variable)

In column 3 in the table B.1 the population variables for the different area of expenditures are shown.

Fourth, from population in relevant age groups the number of users for each area of expenditure (for example number of users in kindergartens) with residence in the municipality or the county is derived:

$$p \langle \rangle bw_{RM/RC} = PU \langle \rangle BWQ_{RM/RC} \cdot ubw_{RM/RC}$$

where:

$p \langle \rangle bw$: Number of users by bundle of commodity w and by place of residence b , used in the local authority economic model ($\langle \rangle$ can be municipality (RM) or county (RC))

$PU \langle \rangle BWQ$: Number of users per age group population, by bundle of commodity w and by place of residence b , used in MLAE ($\langle \rangle$ can be municipality (RM) or county (RC)).

Number of users is shown as column 4 in table 4.1. If there are no statistics for number of users, the relevant population has been used.

The number of users with residence in the municipality or county is not the same as the number of users receiving services from the local government. Some authorities purchase services from other local authorities and some local authorities from outside also purchase services from the local authority itself. For each area of expenditure a (geographical) market for government services can be identified as the fifth step. In the case of kindergartens most children use the kindergartens in the municipality itself, a few children residing in the municipality use kindergartens outside the municipality and a few children who are not residents use the kindergartens in the municipality.

The demand for services within each area of expenditure of the local government, measured by the number of users, is transformed from place of residence to place of commodity market through the shopping model:

$$p \langle \rangle bdw_{RM/RC} = P \langle \rangle BDWQ_{RM/RC} \cdot pbw_{RM/RC}$$

$$p \langle \rangle dw_{RM/RC} = \sum_b P \langle \rangle BDWQ_{RM/RC} \cdot pbw_{RM/RC}$$

where:

$p \langle \rangle bdw$: number of users bought by the local authority at place of residence b , at the place of commodity market d , by area of expenditure w either at the municipality level $\langle RM \rangle$ or at the county level $\langle RC \rangle$

$P \langle \rangle BDWQ$: number of users by place of commodity market d as share of demand, by place of residence b and by area of expenditure w , either at the municipality level $\langle RM \rangle$ or at the county level $\langle RC \rangle$

$p \langle \rangle dw$: number of users by place of commodity market d by area of expenditure w either at the municipality level $\langle RM \rangle$ or at the county level $\langle RC \rangle$.

Sixth, at the place of commodity market, for each area of expenditure – measured by number of users – the following basic model has been used to determine different types of current expenditure:

$$xuu \langle dw := XU \langle DWQ \bullet QK \langle WDQ \bullet KP \langle WDQ \bullet p \langle dw$$

$$xu \langle dw := XU \langle DWQ \bullet p \langle dw$$

$$xir \langle dw := XIR \langle DWQ \bullet \left(\sum_b p \langle bdw - p \langle bdw_{b=d} \right)$$

$$xiu \langle dw := XIU \langle DWQ \bullet \left(\sum_d p \langle bdw - p \langle bdw_{b=d} \right)$$

where:

$xuu \langle dw$: gross wage and intermediate consumption expenditure, by area of expenditure w and by place of commodity market d (\langle can be municipality or county)

$xu \langle dw$: other expenditure, gross, by area of expenditure w and by place of commodity market d (\langle can be municipality or county)

$xir \langle dw$: gross revenue sold to other local governments by area of expenditure w and by place of commodity by market d (\langle can be municipality or county)

$xiu \langle dw$: gross cost purchased in other local governments by area of expenditure w and by place of commodity market d (\langle can be municipality or county) [the variable is technically converted from place of residence to place of demand in order to calculate deficit/surplus for the local authority]

$XUU \langle WDQ$: wage and intermediate consumption expenditure, gross per employee by area of expenditure w and by place of commodity market d (\langle can be municipality or county)

$XU \langle WDQ$: other expenditure, gross per employee by area of expenditure w and by place of commodity market d (\langle can be municipality or county)

$KP \langle WDQ$: units per number of users by area of expenditure w and by place of commodity market d (\langle can be municipality or county)

$QK \langle WDQ$: employee per unit of users by area of expenditure w and by place of commodity market d (\langle can be municipality or county)

$XIR \langle WDQ$: gross average revenue, per number of users sold to other local governments by area of expenditure w and by place of commodity market d (\langle can be municipality or county)

$XIU \langle WDQ$: gross average cost, per number of users purchased in other local government by area of expenditure w and by place of commodity market d (\langle can be municipality or county).

Four types of equations for each area of expenditure can be identified for different types of expenditure or revenue. The first type of model equation is normally used for wage costs and intermediate consumption, which are directly dependent on production volume. This type of model equation normally also covers other costs, which are not directly dependent on the structure of production, which are assumed to be dependent on production variables alone (number of users/capacity). The first type takes into account the influence of factors determining wage and intermediate consumption cost such as:

- the number of users by age group population,
- average unit size,
- employment per unit,
- expenditure per employee.

For different areas of expenditure the chain of factors included in the equation for wage cost etc. differs. It depends upon which factors are assumed to determine the level of expenditure, but of course also whether or not data are available. For wage expenditure and intermediate consumption in the local government production process, it is assumed that expenditure is determined by a chain of factors, whereas other expenditures and revenue are assumed to depend directly upon population in the relevant age group.

In table 4.1 the form of the chain of factors included in modelling wage cost and intermediate consumption by area of expenditure are shown in columns (3) to (7). If the cell is empty, no correction has been made.

The second type only takes into account the number of users.

In column (8) the variable factors used to determine purchase and sales (shopping) and variable used in determining shopping activities. The third type of equation is used to model purchases from other local authorities. The fourth type of equation models sales of services to other local authorities. These expenditures and sales depend on the volume of purchases to other local governments and sales from other local governments and the average price.

Expenditure, purchase and sales are defined by type of cost:

Table 4.2 Type of equation for different types of expenditure/purchases/sales

	Variable	Cost-/revenue-type classification ¹⁾
Wages and intermediate costs	xuu	1.0-3.9
Other costs and revenues	xu	4.0 – 5.9 excl. 5.7, 6.0 – 9.5 excl. 7.3
Expenditure for service purchased from local governments	xir	5.7
Sales to other local governments	xiu	7.3

1 Indenrigsministeriet (2003).

4.4 Flexibility – also in MLAE

In the municipality economic model 275 municipalities (after 2003 271 units have been used) and in the county model 14 counties are used as the default division. The municipalities of Copenhagen and Frederiksberg are modelled as municipalities. However, the economic models can be aggregated flexibly, for example to take into account the consequences of a division reform of local authority structure. In the analysis of Bornholm's Region the economy of the five former municipalities and one former county has been merged and is modelled as a municipality.

5 **Data sources used in the model of local authority economic activity**

The three main data sources for MLAE are

- accounting and budget data from Statistics Denmark
- data on users, capacity, employment etc. from the Ministry of the Interior and Statistics Denmark
- data from LINE/SAM-K.

Appendix 1

Aggregation in SAM-K and LINE

The database for LINE is a detailed and extended regional national account for each municipality, called SAM-K. Before using it in LINE, data are aggregated with respect to

- a. regions
- b. sectors
- c. factors of production
- d. institutions
- e. component of final demand
- f. commodities.

Regions have been aggregated into counties except for Bornholm, which has not been aggregated and consists of five municipalities and the island of Christiansø.

In the table A.1 below the aggregation by sectors is presented. An aggregation by commodities, which is much similar to the one for sectors, has been applied. Like in the basic version of SAM-K/LINE (Madsen et al. 2001a) factors of production in the individual database on employment and income are divided by educational levels, sex and age. Type of households has not been aggregated like in the basic version of SAM-K/LINE. Finally, components of final demand have been aggregated in the same way as the basic version of LINE.

Table Activities (sectors) in SAM-K/LINE

A.1	Sectors – Text	Detailed sector code	Sector code in LINE
	Agriculture, fishing and quarrying	011009-050000	011009
	Extr. of crude petroleum, natural gas etc.	110000	230000
	Manufacturing industry	140009,151000-370000	011209
	Utilities	401000-410000	014000
	Construction	450001-450004	020000
	Wholesaling, retailing, hotels, restaurants etc.	501009-553009	050000
	Transport	601000-640000	110000
	Housing	702009	702009
	Financial intermediation and insurance etc.	651000-748009	140009
	Public administration	751100-752000	151000
	Education	801000-804002	152000
	Health care activities	851100-851209	153000
	Social work activities	853109-853209	154000
	Sewage and refuse disp. and similar act.	900010-900030	155000
	Activities of membership organiza. n.e.c. and other service activities	910000-950000	156009
	Imputed unpaid for financial intermediary services	990050	990050
	Production of unspecified products	000001	000001
	Production of unspecified repairs	000002	000002

Literature

Indenrigsministeriet (2003): *Budget- og regnskabssystem fra kommuner og amter*. København.

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Madsen, B. (2003): Kommunaløkonomi og kommunesammenlægning – En undersøgelse af den kommunale udgiftsudvikling på Bornholm og i landets øvrige regioner. AKF Forlaget, Copenhagen.

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Sammenfatning

Dokumentation af den kommunaløkonomiske budgetmodel

Udgivet december 2003

af Bjarne Madsen

I rapporten *Kommunaløkonomi og kommunesammenlægning – En undersøgelse af den kommunale udgiftsudvikling på Bornholm og i landets øvrige regioner* (Madsen 2003) er præsenteret resultater af en analyse af udviklingen i Bornholms Regionskommunes økonomi fra 2002 til 2003 samt udviklingen i bornholmske kommuners og Bornholms Amts økonomi fra 2000 til 2002. I analysen er anvendt et modelsystem bestående af:

- a. MLAE, som er en model for kommuners og amters økonomiske aktivitet, og
- b. LINE, som er AKF's lokaløkonomiske model, og som MLAE er linket til med henblik på analyser af samspillet mellem den kommunale økonomi og den lokale økonomi.

I denne rapport beskrives MLAE-modellen og linkene mellem MLAE og LINE. I analysen (Madsen 2003) er anvendt en begrænset version af modelsystemet, fordi analysen alene fokuserer på udgiftssiden (kortsigtsanalyse) og er en ex ante-analyse. I senere analyser kan benyttes de udbyggede sammenhænge, som er beskrevet i dette report, og som vil gøre det muligt at isolere mere langsigtede konsekvenser af sammenlægningsreformen.

Om sammenlægningsundersøgelsen

Indenrigs- og Sundhedsministeriet har taget initiativ til en forskningsmæssig belysning af den bornholmske kommunesammenlægnings forløb og konsekvenser for det bornholmske samfund. AKF, Amternes og Kommunernes Forskningsinstitut, står sammen med Institut for Statskundskab på Syddansk Universitet i Odense for opgaven.

Projektet forløber frem til midten af 2006. Der vil løbende blive fremlagt rapporter fra projektets forskellige undersøgelser. En sammenfattende rapport bliver udarbejdet ved projektets afslutning.

Der foreligger følgende rapporter fra undersøgelsen:

- Rapport 1 Henrik Christoffersen, Knud Klaudi Klausen og Svend Lundtorp: Central styring – decentral ledelse. En undersøgelse af den administrative organisering i Bornholms Regionskommune. December 2003.
- Rapport 2 Bjarne Madsen: Kommunaløkonomi og kommunesammenlægning. En undersøgelse af den kommunale udgiftsudvikling på Bornholm og i landets øvrige regioner. December 2003.
- Rapport 3 Bjarne Madsen: Documentation of the model of local authority economic activity. December 2003.
- Rapport 4 Ulrik Kjær: En ø en kommune. Politisk reorganisering på Bornholm. April 2004.
- Rapport 5: Henrik Christoffersen: Regional udvikling og kommunesammenlægning. En undersøgelse af den regionale udvikling på Bornholm og i landets øvrige dele. April 2004.

