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## Labour Market in Motion - Analysing Regional Flows in a Multi-Account System

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# **Labour Market in Motion - Analysing Regional Flows in a Multi-accounting System**

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## **Abstract**

The analysis of flows is essential for labour market research and policy advice. We develop a flexible analytical tool – a multi-accounting system (MAS) - dealing with flows and stocks on regional labour markets. Combining administrative data of the micro level with various macro data the MAS describes the complete transition process of the 180 local labour market areas in Germany. We use a new method related to entropy optimization, to estimate unknown transitions. Compared with conventional methods, the main advantage of our proceeding is that additional information can be included which is of an inherently fuzzy character.

## **1. Objectives of a multi-accounting system**

The ongoing debate about reducing unemployment in Europe has been focusing on the flexibility of labour markets for a fairly long time. Especially in Germany, a central question is whether there is sufficient labour market dynamics or if there is evidence that the labour market is sclerotic. The “flow approach” (Blanchard/ Diamond 1992) has turned out to be an appropriate tool for analysing labour dynamics. Even in Germany there is considerable movement between different labour market states. If an analysis is concentrated on the stocks, solely the balance of the flows is measured and information about the total size of movements during the year is lost.

Using the concept of job creation and destruction (see e.g. Mortensen/ Pissarides 1994; Davis/ Haltiwanger/ Schuh 1996) is very helpful for understanding trends of unemployment or employment in a comprehensive way; moreover, the complex structure how the labour market is working becomes evident.

There are different ways of describing and analysing labour market flows in a more holistic approach. First of all, you can look at worker flows at the individual level because actually the employees are those who change the labour market state – e.g. by changing their job, becoming unemployed, beginning to study or changing their status, otherwise. The focus of this type of analysis lies on job stability and worker characteristics calculated on the basis of survey data (see e.g. Hall 1982; Winkelmann/ Zimmermann 1998) or register data (e.g. Hernæs 2001). The second category of analyses chooses the establishment perspective to study the cyclical behaviour of employment fluctuation (e.g. Davis/ Haltiwanger 1999; Shimer 2005). Establishment-level data is also used for questions concerning the measurement of job creation and destruction and the determinants of labour turnover (see e.g. Davis/ Haltiwanger 1992; Martin 2003; den Butter/ van Gasteren 2004). An even more differentiated view is encouraged by linked employer-employee datasets. The additional information on individuals allows exploring the relationship between job and worker flows (see e.g. Belzil 2000; Burgess/ Lane/ Stevens 2000; Stiglbauer et al. 2003).

The advantage of these more complex flow approaches to labour markets compared to simple job and labour turnover rates is twofold: firstly, you distinguish between origin and destination accounts of transitions, so that you get information where e.g. the unemployed are coming from and where they are going. But the limitations of previous

work are that due to data restrictions, the majority of researchers concentrate just on some labour market states. Most of the studies dealing with flow figures consider only three different accounts: unemployment, employment and non-employment/ out of labour force (e.g. Hernæs 2001; Bougheas/ Georgellis 2004).

Another branch of literature, dealing with more accounts, uses macroeconomic data to analyse the labour market dynamics (e.g. Schettkat 1992, 1996). Some researchers integrate different data sources on the aggregated level to estimate a national accounting system. They enrich register data on employment and unemployment with several pieces of information about self-employment, vocational training or retirement (e.g. Broersma/ den Butter/ Kock 1998, 2000 for The Netherlands, Sheldon/ Theiss 1995 for Switzerland, Rothe 2006 for Germany). Those national accounting systems represent also multiple transitions between defined labour states during a certain period.

Generally we will follow this approach by using a similar model type integrating very detailed origin and destination accounts. Furthermore we estimate unknown, or not exactly known, flows using all available information with a method related to entropy optimisation. Yet another improvement is the feasibility of regionalisation. Because of the German labour market situation which is marked by persistent regional disparities we transfer the approach to labour market regions. In addition we could interpret different trends according regions of the similar region type.

Thus, compared to the existing flow approaches, we go some steps ahead by developing the multi-accounting system (MAS). We combine the information of administrative data at the micro level with macro data containing pupils, self employed, retired persons because this information is not available on micro level. Embedded in an external framework, which is given by demography (birth, death, moving in and out), the MAS describes the transition process of the labour market in Germany. Further more the MAS operates on the regional level and contains disaggregated information at the labour market areas of 180 local employment agencies in Germany, which are important actors of the labour market. Consequently, this yields to a total account system for the regional population and labour force. Briefly, general object of MAS is to cover the important dynamics of the local labour market in order to make regions comparable and to establish a basis for strategic decisions of active labour market policy.

The paper proceeds as follows. Section 2 describes the labour market flows in Germany and provides some evidence on the regional perspective of labour market policy. The next section explains the structure of the MAS, the data sources and the estimation of a consistent transition matrix. In section 4, we present some application examples referring to the transition from vocational training to the following labour state. Section 5 summarises the results and gives a brief outlook.

## **2. Labour market flows in Germany and decentralisation of labour market policy**

The variation of the labour force structure results from flows of workers, who are in the centre of interest in this study. Extent and direction of those labour flows depend on the economic development (see e.g. Schettkat 1992), where regional factors are as important as sector specific conditions. As mentioned above, the MAS covers a lot of different labour market states in a multiple flow approach.<sup>2</sup> Table 1 gives a review over the stocks at the beginning and the end of the year 2002 (YB and YE) and the sum of all in- and outflows as well as the stayers in different labour accounts for Germany.

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<sup>2</sup> Vacancies are not integrated because the MAS is designed as a consistent system where each person is belonging to one account at every point in time. As a vacancy – by definition – is not connected to a person, it is not possible to integrate this parameter. Den Butter/ Van Dijk (1998) deal with job flows, which enable them to consider vacancies.

**Table 1: Labour market flows in a national accounting system for Germany 2002\***

	YB	inflows	outflows	stayer	YE
Population	82,502	1,916	1,821	80,681	82,597
Children < 6 years	4,695	795	866	3,798	4,624
Students in general education	10,089	941	1,006	9,021	10,024
University students	1,828	321	255	1,562	1,893
In-school training	691	339	301	386	729
Apprentice	1,786	626	675	1,129	1,737
Employment subject to social security	25,471	6,687	7,203	20,294	24,955
Marginal employment	4,079	2,617	2,661	2,705	4,036
Civil service, soldiers	2,263	88	127	2,121	2,224
Self-employment	4,028	540	562	3,483	4,006
Active labour market policy (ALMP)	851	1,575	1,563	497	863
Unemployment	3,922	4,994	4,750	2,182	4,166
Job seekers	433	1,047	1,086	187	393
Other non-employment	5,212	5,289	5,057	3,294	5,444
Retirement	17,153	1,069	719	16,439	17,503

\* Results of the national accounting system, estimated as a basic matrix for the regional MAS.  
Source: Rothe (2006); own calculations.

The flow approach - described in section 3.1. - covers every transition between the accounts listed in table 1 and some more sub-accounts e.g. for economic sectors and four types of active labour market policy (ALMP, see appendix).

It is quite evident that changes in labour market stocks are relatively small compared to the worker flows. Some accounts e.g. unemployment, non-employment or ALMP, show in- and outflows which exceed the stock at the beginning of the year. However, this does not mean that people exchange completely during the year. Firstly we can see that there is a huge part still staying in the same account – the stayers. For example we find two million persons remaining unemployed during the whole year, which is nearly fifty per cent of the year-beginning stock. Secondly it is possible to re-enter the same account within a year, e.g. to get unemployed again and find another new job.

In order to point out the additional use of a MAS covering multiple transitions on the labour market, we are going to take a closer look at the unemployment accounts of East and West Germany. We have shown in table 1 that the labour market is in motion, but now we are interested in the destinations of all the movers leaving unemployment. Table 2 shows the transition out of unemployment into 13 possible target accounts for East and West Germany.

**Table 2: Transitions out of unemployment in East and West Germany 2002\***

Destination accounts	East Germany		West Germany	
	in 1000	in %	in 1000	in %
University students	11	0.7	43	1.3
Apprentice/ in-school training	14	0.9	43	1.3
Dependent employment (incl. civil service, soldiers)	391	26.5	1,123	34.3
Marginal employment	40	2.7	128	3.9
Self-employment	6	0.4	20	0.6
Second labour market	135	9.2	40	1.2
Subsidized employment	118	8.0	102	3.1
Subsidized self-employment	31	2.1	63	1.9
Qualification and training	275	18.6	420	12.8
Job seekers	175	11.9	286	8.7
Retirement	55	3.7	204	6.2
Other non-employment	206	14.0	755	23.0
Removals/ death	18	1.2	49	1.5
Sum of outflows	1475	100.0	3276	100.0

\* Results of the national accounting system, estimated as a basic matrix for the regional MAS.  
Source: Rothe (2006); own calculations.

More than a decade after the reunification of Germany in 1989, we still find differences between the eastern and western part of Germany concerning the probability to find an unsubsidised job. The turnover rate from unemployment to dependent employment is only 26.5 per cent in East Germany, but 34.3 per cent in the western part. Otherwise there is much more transition into subsidised employment, qualification measures and the second labour market in East Germany. The economic situation in this area is still worse than in West Germany and therefore active labour market policy has been extended in the eastern part.

But what is the benefit of our detailed accounting system compared to an analysis with only three labour market states that is frequently used for the examination of labour market flows? If we aggregate the outcomes of table 2 to “employment” and “non-employment”, we get some surprising results.



**Table 3: From unemployment to employment or non-employment in East and West Germany 2002**

Destination accounts	East Germany		West Germany	
	in 1000	in %	in 1000	in %
Employment	735	49.8	1,519	46.4
Non-employment	740	50.2	1,757	53.6
Sum of outflows	1,475	100.0	3,276	100.0

Source: own calculations, based on table 2.

“Employment” is the sum of the following accounts: apprentice, dependent and marginal employment, self employment, subsidized self-employment, second labour market and subsidized employment.

“Non-employment” is the sum of all the other accounts.

As shown in table 3, the transition rate into employment seems to be higher in East Germany than in West Germany, whereas more than 50 percent of the unemployed change into non-employment in both parts of Germany. This common kind of flow approach neglects some ways out of unemployment, which is important information for labour market policy and advice. Similar drawbacks can be shown for other accounts as well, which encouraged us to develop a more elaborated accounting system with multiple accounts – the MAS.

The structures of the national accounting systems for East and West Germany are used as basic matrices for the estimation of the regional MAS. The stocks and flows of some central accounts of the labour market - vocational training, marginal employment, employment subject to social security, unemployment and job seeking - are taken directly from micro-data of the employment agency.

### **Decentralisation of labour market policy**

Since the introduction of the Social Security Code (SGB III) at the beginning of 1998, local employment agencies in Germany have higher discretion and responsibility concerning the strategy of active labour market policy. The reason is that regional specifics of the local labour market affect challenge and effectivity of labour market policy, because the match efficiency differs strongly from region to region. For example Ilmakunnas/ Pesola (2003) found that excess job reallocation in a region deteriorates matching efficiency. Furthermore the financial situation of the community limits the options for active labour market policy.

The creation of regional input - output tables shows an example of further development of models on the national level (e.g. Okuyama et al. 2002; Israilevich et al. 1997).

Ramos (2003) demonstrates that information about regional linkage of intermediate inputs and final products is fundamental for comprehending generating clusters. A social accounting system was developed by Roberts (2003), which distinguishes between cities and periphery by analysing disposable income. A common results of this kind of study is that the information of indicators and multipliers at the regional level is limited. So the total amount of inflows and outflows at the regional level gives a clear picture of the local labour market. The regional perspective is rather important for local labour market policy, and also the “Länder” (States) have notable influence on education and labour market policy.

Next, we are going to introduce some important facts about the vocational training in Germany, which plays a crucial role in the labour market system. Vocational training may be considered as a way of improving the matching quality between job applicants and employers. A vocational training certificate sends a clear signal about the productivity of a job applicant. For young people, the apprenticeship is a common way for labour market entry in Germany. The special feature of the so called dual system is the combination of 2 - 4 years of class room training in public vocational schools with firm based on the job training. A specific advantage of the dual system is that it generates skills that are rather mainly portable than firm-specific and can be used on many different jobs. Werwatz (2002) analysed occupational mobility and found evidence for the effectiveness of the German apprenticeship system which provides general skills that are valued by the labour market.

In principle, firms participation is voluntary, but there are some rules and regulations, which need to be fulfilled to offer an apprenticeship training position. There are more than state-approved 350 different occupations. For example, in 2002 626,000 young people started apprenticeship training. In comparison 321,000 persons began a course of studies. Even though more and more young people decide for university or polytechnic, the large majority prefer an apprenticeship after leaving school. There is relatively low unemployment among labour market entrants having finished apprenticeship, although transitions have become more difficult recently (Ryan 2001).

For the employment agency it is central to know how many young people are leaving the schooling system and are searching for vocational training. On the other hand it is important how many persons are leaving vocational training and looking for jobs in the labour market of a region. The mobility after apprenticeship is relatively high because

the local labour market situation plays a crucial role for the chance to get a job (see Winkelmann 1996, Riphahn 2002, Franz et al. 2000 and for the European perspective see Gangl/ Müller/ Raffé 2003 or Ryan 2001). The dimension of the local agency as smallest unit has some advantages given the aim of the MAS. First the local labour agency is a sufficiently small scale, to cover regional disparities. Second it is the same level at which labour market policy is applied. Therefore the comparison of different focuses by applying labour market programs is possible. The MAS also gives you the opportunity to analyse at different aggregate level, like the “Länder” in Germany or types of local employment agencies (e.g. Blien et al. 2004).

### **3. Structure and functionality of the multi-accounting system**

The dynamics of the labour market can be measured and represented in different ways. First we need to define what is meant by a transition into another account. In principle we have the choice either to count changes of the stocks between two points of time or to count all multiple movements within a certain period of time. A fundamental decision is whether to analyse labour market transitions only on the individual level, or are there arguments to consider aggregate flows as well (see chapter 3.1)

The next question arise, which data sets are suitable for measuring of labour market transitions, and which data sources are available for the required data range. For the purpose of the regional MAS transition-matrix, we use different data-sources, which leads us to some methodical features considered in chapter 3.2.

Finally not any transition can be counted or computed using those micro-data-sets. This is why an estimation procedure for the unknown or not well-known flows was developed. The algorithm ADETON used for the estimation of consistent matrices is presented in chapter 3.3.

#### **3.1 The flow approach of the multi-accounting system**

The MAS refers to defined time points - here beginning and the end of a year - and shows the stocks in the individual status types at these time points (see also Table 1). In principle, the movements (flows) between the individual stocks, divided by accounts, can be represented in two different ways: based on either a *person/point-in-time approach* or a *case/period-of-time approach* (Sheldon/ Theiss 1995). Where the focus is on the development of persons of different status types, a *person/point-in-time*

*approach* is more appropriate. The states at the time points  $t_0$  and  $t_{0+1}$  are compared and a transition is defined in each case. “That leads to an underestimation of flows in any case were multiple transitions have occurred, especially if a person has returned to the same labour force status he/she had the year before” (Kruppe 2001). However, the person/point-in-time approach does not allow the identification and thus the analysis of active labour market policy measures taken during the year. This means that the objective of the MAS to represent movements in the regional labour market and develop an instrument to analyse the flows on this basis would be missed inevitably.

The *case/period-of-time approach* includes all transitions between the accounts occurring during the observation period. Several changes between the defined status types are possible between  $t_0$  and  $t_{0+1}$  since the flows are listed in their entirety and therefore permits the total flows to exceed the stock if the stayers are included. Therefore we prefer the *case/period-of-time* variant for the MAS, providing the data of both stayers and the stock at the beginning and at the end of a year.

For displaying the potential transitions of a person in the labour market, a multidimensional matrix is a suitable instrument to represent the different status types in the MAS account system. The source accounts represented in the MAS are shown in the rows for time point  $t_0$  and the target accounts in the columns, for time point  $t_{0+1}$ . The fields  $x_{ij}$  of the matrix quantify the transitions between the status types, whereas the main diagonal of the matrix includes the persons who stay in a certain status (stayers).<sup>3</sup> At time point  $t_0$  all persons are accounted in the main diagonal of the matrix. When a person change the status e.g. from 1 to 2, follows a decrease of  $x_{11}$  and an increase of  $x_{12}$ , one unit each. If the same person returns to status 1 again results an increase of  $x_{21}$  oby one unit, while the values of  $x_{11}$  and  $x_{12}$  remain unaffected. This implies that the initial values of the main diagonal can only decrease or remain unchanged – if no change occurs between status types in the considered time period. If all persons exhibit just *one* change between  $t_0$  and  $t_1$  then the opening and final stocks are calculated as row and column sums  $b_r$  and  $b_c$ , respectively. But in reality there are several account changes per person and so, the row or column sum will exceed the stocks of the respective year (cf. 4.1).

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<sup>3</sup> It's obvious that the number of stayers decreases the more we distinguish between specific states. So the definition of “stayer” is specific to our requirements and includes moves we are not particular interested in (e.g. job-to-job movers without changing industry section).

**Table 4: Structure of the MAS for a specific employment agency**

	Status at $t_{0+1}$ (target account)				$\Sigma$
Status at $t_0$ (source account)	$x_{11}$	$x_{12}$	.....	$x_{1J}$	$b^r_1$
	$x_{21}$	$x_{22}$	.....	$x_{2J}$	$b^r_2$
	$x_{31}$	$x_{32}$	.....	$x_{3J}$	$b^r_3$
	...				...
	$x_{I1}$	$x_{I2}$	.....	$x_{IJ}$	$b^r_J$
$\Sigma$	$b^c_1$	$b^c_2$	.....	$b^c_I$	$b^{rc}$

A two-dimensional representation (see Table 4) can be computed for an employment agency, an aggregate of agencies or for the Federal level. The examination of all employment agencies would be a third dimension of the transition matrix and could be represented as individual layers of matrices.

Now we turn to the different data sources which are needed to estimate a consistent model where the final stock of an account is defined by initial stock plus inflows minus outflows.

### 3.2 Data sources

Creating the MAS, we try to represent the total dynamics of the job market by showing all transitions between defined accounts within one year as far as possible. Thus our concept differs fundamentally from studies analysing job creation and destruction at the firm level (e.g. Davis/ Haltiwanger/ Schuh 1996) or using linked employer-employee data sets (e.g. Belzil 2000; Martin 2003). In principle, individual data, e.g. from representative surveys or large micro-data sets of the Federal Employment Agency, is especially suited for our research interests. For with individual data the employment states of a person can be illustrated in detail and it is possible to identify the source and target accounts almost exactly, which is very favourable for our purpose. However, not all transitions are available in the requested detail; for some accounts, we didn't even find any micro data at all. In those cases, we used aggregated data of the Federal

Statistical Office or information of regional Statistical Offices or we made use of robust findings of other studies already published.

To be able to estimate multi-accounting systems at the level of the employment agencies, it is necessary to create basic matrices for East and West Germany which are based on a matrix for whole Germany. The data sources and the basic procedure of data analysis using individual data from the Federal Employment Agency and the employee database are briefly explained in the following (see Appendix for a detailed list of accounts). Where regional data cannot even be obtained from state statistical offices, Federal data need to be re-estimated to the employment agencies, taking into account the proportion in the whole population or the employed population.

In a first step, we determine the stocks at the beginning and at the end of the year for population, schools and universities, civil servants, soldiers, judges, and retired persons registered by the Federal Statistical Office. For these groups no individual data from Federal Employment Agency is available. In some cases the total in- and out of individual accounts can be derived from official statistics or other published research results. There is data about births, deaths and migrations, school beginners and leavers, new on-the-job and off-the-job training contracts, new retirements, new self-employed persons and business terminations.

These stocks for all accounts of the monitoring year and the previous year including the total inflows and outflows between those points in time are recorded in a database at the level of the employment agencies. This information is included as constraints in the subsequent estimation of the matrix using ADETON.

In addition to these aggregated data, individual data from the Federal Employment Agency and the employee database is available for the definition of the employment status (subject to social insurance contributions) of a person. Dependent employment is defined as unsubsidised employment subject to social insurance contributions without marginally employed persons (less than 15 hours a week) and vocational training on the job, because we have separate accounts for these groups (for more details see appendix). This concerns all accounts that relate to unemployment<sup>4</sup>, programs for active labour

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<sup>4</sup> Here we use the definition of unemployment of Federal Employment Agency, which differs from ILO measure concept of unemployment. A person is unemployed if seeks for an employment subject to social insurance contribution at least 15 hours a week. Registration at the Employment agency is

market policy (second labour market) or vocational training. Concerning vocational training and dependent employment, we distinguish industry affiliations. All these accounts contain daily information by employers and the Local Employment Agency.

To model status changes a non-intersecting data set is required for each person. In the case of parallel spells, only the most interesting state is examined. The “dominant” status or account is selected using a priority list. Our ranking criteria are appointed by content objective of the employment agencies combined with the priority for higher data quality. This yields to the fact that accounts associated with employment generally dominate unemployment and non-employment accounts. However, marginal employment ranks behind unemployment since unemployment may be accompanied by marginal employment. This rule ensures that unemployment duration is not interrupted by marginal employment. Accounts relating to the second labour market and subsidised types of employment have the highest priority (cf. Appendix). A more precise analysis showed an implausible large number of short spells for the “non-employment” status, so that gaps were filled with the respective low-priority account. A closer checkup yield to the result that too many short time spells belong to the status “nonemployment”: Thus we fill it up under certain requirements.<sup>5</sup>

The stocks at 31st December can be determined directly. The stock of persons in the “non-employment” account, on the other hand, is a residual (from subtracting all other accounts from the population). The transitions are also subtracted from the resulting account, whereby each change of a person is defined as a transition. This means, for example, that a direct job change (without unemployment) is registered in the MAS only if that change takes place across industry boundaries.<sup>6</sup> In the framework of the case/period-of-time approach, all transitions are calculated separately by source and target account, and stored in a database in an aggregate form.

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also required. But an unemployed person is allowed to work up to 15 hours a week without losing unemployment status.

<sup>5</sup> We filled gaps up to 30 days. An exception was the gap due to illness, which by definition is filled up to 42 days. For the remaining gaps in the data set, it was attempted to draw on reasons for outflow from the previous spell or reasons for inflow into the following spell. This made it possible to fill some of the unknown gaps, which may be the account preceding or following the gap. This procedure was chosen because it can be assumed that the times stated are more precise for higher-priority accounts. Our rule for non-intersecting data set and for dealing with gaps was tested for stability of results.

<sup>6</sup> A change of employment can be analyzed on the basis of individual data e.g. using the IAB Employment Sample (IABS). However, only changes concerning the defined accounts (e.g. changes of employment structure relating to industries) are interesting for the objective of the multi-accounting model, which adopts an aggregate approach.

Such analyses are also feasible for employment agencies since the employment agency (for clients of the Federal Employment Agency) or the place of work (for non-clients) is recorded in each case. Moves across agency boundaries are then shown in addition, taking into account whether the employment status has changed due to the move.

Due to the necessity of integrating different data sources and the complexity of the estimation, the MAS has been created with a delay of about two years. A delay of 18 months has to be considered for data from employment statistics because company reports often come in at the end of the year and changes are in many cases reported before the end of the subsequent year. Regional statistics relating to schooling and retirement are not created immediately either.

Largely automated data preparation and data storage in special databases facilitate data collection, but do not accelerate the process to a major extent. As an alternative to the procedure used to far, small core multi-accounting systems are conceivable, which only represent that part of the labour market which is affected by unemployment or promoted using active labour market policy measures. As the respective data is prepared on the basis of the statistics of the Federal Employment Agency, it is available very rapidly, and estimations could be dispensed with because a high degree of validity could be assumed. On the other hand, such a reduction of the data basis would also mean a considerable reduction of the analysis possibilities.

### **3.3 Dealing with incomplete information - estimation of a consistent matrix using ADETON**

A problem which frequently occurs at the regional level is that certain data is only available at a higher aggregation level. In the multi-accounting system, this concerns transitions which are not known from the individual data or other statistical sources. Moreover, in some cases in which detailed stock data exists, we miss the corresponding flow data. This means that a portion of the data matrix has to be estimated. As a classical solution procedure, the RAS algorithm, would be suitable, which calculates a two-dimensional table on the basis of given row and column sums. Often additional information (apart from the marginal sums) is available, which may stem from different sources so that its validity differs. Given this kind of data information often the ENTROP procedure is chosen because it allows the integration of any linear



combinations in a target function, such as constraints that improve the efficiency of the estimation. Moreover given values can also be entered as upper and lower limit values (cf. Blien and Graef 1992 and 1998). In this way, the problem of inconsistent information from different sources is at least partially circumvented. This problem would occur in the case of fixed bandwidths, which would prevent any possible solution. The basic idea of entropy optimization is to make optimum use of existing information transformed into constraints without defining a fixed structure. We estimate a new table which is similar as possible to a given basis table, but follows the given constraints. If no information about the basic matrix is available, all states are considered equally probable or improbable.

Admitting of fuzzy constraints has the advantage that in the case of inconsistent constraints, it is not necessary to adapt constraints until a solution exists. The requirements should only be met as closely as possible. For this purpose, we formulate a constraint distance as a weighted sum of the weighting factors, which dispenses with the need for bandwidth constraints.

Graef (2003) developed the so called ADETON tool for the Institute for Employment Research (IAB). Compared this procedure used here has the additional merit compared to the ENTROP procedure that constraints can be formulated in a fuzzy way rather than exactly. Basic principle is the following Chi-Square function:

$$\text{Chi}^2 = \sum_i \sum_j \frac{(p_{ij} - q_{ij})^2}{q_{ij}}, \quad \text{where } p_{ij} = x_{ij}/N \quad (1)$$

Here,  $p_{ij}$  and  $q_{ij}$  are the elements of the flow matrix to be estimated by using the basic matrix. These elements are normalised by the table totals (N).

The generalisation of ADETON should enable both “hard” constraints (i.e. equality and inequality constraints) for the matrix to be estimated and “weak” constraints, for which certain weights are specified. This procedure is described in more detail in the following paragraphs in order to motivate the derivation of the target function (see also Appendix and Graef 2003).

Assume that there are  $m$  given constraints, which either define an exact value for a cell or relate to other table fields.  $T(x)$  shall be a table aggregate, which can be understood as a function that allocates a weighted sum to a table  $x = (x_k)$ , and let  $t_k$  be a known weighting

factor. Finally  $k$  describes the position of the cell in the table and  $x_k$  describe the pertinent value.

$$T(x) = \sum_{k \in K} t_k x_k \quad (2)$$

The constraints may be formulated as follows, where  $b$  is a known value, given by additional information:

$$T(x) = b_j, \quad T(x) \geq b_j, \quad T(x) \leq b_j \quad \text{or} \quad b_{j1} \leq T(x) \leq b_{j2}$$

Now the optimisation task is to implement a projection in such a way as to ensure the greatest possible structural similarity to a certain base table  $u = (u_k)$ . This can be done by minimizing a structural distance of table  $x$  from base table  $u$ . The structural distance is defined as follows:

$$D_T(x, u) = \sum_{k \in K} w_k h \left( \frac{x_k}{u_k} \right) \quad (3)$$

where  $h(\cdot)$  is a strictly convex function with minimum 0 at  $t = 1$  and  $w_k$  is the pertaining weighting factor.

The distance function can be specified as using e.g. the chi-square function [see (1)] or the modified cross-entropy, which is particularly suitable here since the solution set is restricted to non-negative values.

$$D_T(x, u) = \sum_{k \in K} w_k \left( x_k \ln \left( \frac{x_k}{u_k} \right) - x_k + u_k \right) \quad (4)$$

This function stems from stochastics, where cross-entropy is employed as a distance measure for discrete probability distributions.

Now let us return to the constraints. In order to use fuzzy constraints it is necessary to define a deviation, since although the constraints need not be adhered to strictly, the deviation from the given values should be as small as possible.

For this purpose, the following constraint distance for the restrictions is defined as a weighted sum:

$$D_R(x,b) = \sum_{j=1}^m w_j Q_j(T_j(x) - b_j) \quad (5)$$

where  $w_j$  are the weighting factors for the strictness with which the constraints are adhered to and  $Q_j$  are the distance functions for the individual constraints. The most appropriate functional form of  $Q_j$  is quadratic, as they best meet the properties of the structural distances described above.

Now the two elements are combined to form the target function  $Z(x)$ : The table to be estimated should minimise the structural distance  $D_T(x, u)$  to the base table  $u$  (cf. equations (4) and (5)) while keeping the constraint distance  $D_R(x, b)$  small (cf. equation (6)). A possible form of  $Z(x)$  is the following, which has to be minimized:

$$\min Z(x) = g_T D_T(x,u) + g_R D_R(x,b) \quad (6)$$

which is a linear combination of the two competing targets  $D_T$  und  $D_R$  and which is to be minimised. The weighting of these two targets can be controlled by the users themselves, through the parameters  $g_T$  and  $g_R$ .

#### **4. Application example: from vocational training to employment**

In the following, three German employment agencies (Ingolstadt, Memmingen in West Germany, Halle in East Germany) are used as an example to illustrate some elementary results of the MAS concerning transitions from vocational training to the following labour market status. The relatively high decomposition of some accounts increases both the information content and the complexity of the model. As the complete model is based on a table with 60 x 60 fields, it is appropriate to examine partial matrices separately.

Although the variance over the time is an important application of the MAS, we concentrate on the transitions in 2002 and take a closer look at the flows out of vocational training in three German employment agencies and the probability of changing from vocational training to employment differentiated by economic sector.

The general remarks about vocational training in Germany given so far (see Chapter 2) have already shown that the transitions of young apprentices are of particular importance for the regional labour market.

Table 5 shows the number of outflows from vocational training in three selected employment agencies during the year 2002. The employment agencies Ingolstadt and Memmingen are comparable because they are both in the southern part of West Germany and belonging to the same type of employment agency (see Blien et al. 2004). Whereas Halle, which is an area in East Germany with high unemployment illustrate the significant disparities between labour market regions in Germany.

**Table 5: Flows out of vocational training in Ingolstadt, Memmingen und Halle (2002)**

	INGOLSTADT			MEMMINGEN			HALLE		
	abs	in % of YB	in % of outflows	abs	in % of YB	in % of outflows	abs	in % of YB	in % of outflows
<b>Year-beginning-stock (YB)</b>	<b>10.540</b>			<b>10.961</b>			<b>12.613</b>		
<b>Stayers</b>	<b>6.673</b>	<i>63,3</i>		<b>6.790</b>	<i>61,9</i>		<b>6.669</b>	<i>52,9</i>	
<b>to employment</b>	2.721	25,8	58,9	3.125	28,5	60,2	2.120	16,8	30,0
<b>to unemployed/ job seeker</b>	845	8,0	18,3	912	8,3	17,6	2400	19,0	34,0
<b>to active labour market policy (ALMP)</b>	62	0,6	1,3	57	0,5	1,1	132	1,0	1,9
<b>to non-employment</b>	479	4,5	10,4	481	4,4	9,3	1469	11,6	20,8
<b>moves</b>	514	4,9	11,1	617	5,6	11,9	942	7,5	13,3
<b>total outflows</b>	4.621	43,8	100,0	5.192	47,4	100,0	7.063	56,0	100,0
<b>Year-end-stock (YE)</b>	<b>10.594</b>			<b>10.703</b>			<b>11.269</b>		

Source: Own calculations.

If we look at the numbers of stayers and the corresponding stocks at the beginning of the year, it is quite obvious that one third of all apprentices in Ingolstadt or Memmingen (the half of those in Halle) finished their vocational training during 2002. This rate appears comprehensible because of the common apprenticeship takes three years in average. But in the Eastgerman region we find more training off-the-job-programms that often take one year or two. After leaving apprenticeship most young people in Ingolstadt and Memmingen start a new job (about 60 per cent of all outflows), while (direct) transitions into employment are very rare in Halle (only 30 per cent).

Comparing the transition rates of Ingolstadt and Memmingen we find only little differences. The transitions into relative precarious labour market states as unemployment/ job-seeker, non-employment or measures of active labour market policy (ALMP) are more frequent in Ingolstadt, whereas we observe more changes to employment or regional moves in Ingolstadt. In comparison with the regions in

Westgermany transitions from vocational training to unemployment or non-employment are widespread in Halle. It becomes apparent that the prospects on the labour market in Halle are anything but bright, which also leads to a high rate of movements into other regions. Finally, we will examine the chances for trainees to be employed in the same economic sector after completing their vocational training. For this purpose, we calculate the transition rates into dependent employment for the area of Ingolstadt (cf. Table 6).

**Table 6: Stocks and transitions from vocational training into dependent employment in the Ingolstadt employment agency in per cent (2002)**

		Transitions into dependent employment									Total outflows	Year-end stock
		Year-beginning stock	SEC1	SEC2	SEC3	SEC4	SEC5	SEC6	SEC?			
Source account on-the-job/ off-the-job training	<b>Sector 1.</b> Agriculture and forestry	124	<b>30,4</b>	1,3	1,3	2,5	1,3	1,3	11,4	79	125	
	<b>Sector 2.</b> Manufacturing	3.740	0,2	<b>59,0</b>	0,5	3,0	0,6	0,5	1,9	1.284	3.775	
	<b>Sector 3.</b> Construction	1.363	0,2	1,1	<b>42,9</b>	3,5	2,0	0,7	3,5	538	1.326	
	<b>Sector 4.</b> Trade and transport	2.553	0,2	1,5	0,4	<b>43,6</b>	0,6	1,7	2,2	982	2.601	
	<b>Sector 5.</b> Financial, renting and business service activities	997	0,2	2,0	0,4	4,6	<b>47,8</b>	1,3	2,2	456	1.007	
	<b>Sector 6.</b> Other service activities	1.626	0,2	2,2	0,7	2,1	5,0	<b>36,9</b>	1,8	937	1.673	
	Sector unknown	137	0,3	2,3	1,2	4,3	3,5	3,8	2,3	345	87	

Source: own calculations. For details on the economic sectors, see the Appendix.

For the purposes of this representation, the transitions into employment were calculated as a proportion of all outflows from training in the respective economic sector and can thus be interpreted as transition probabilities. The probability of obtaining work in the same economic sector after vocational training was 59 per cent in the manufacturing sector, i.e. nearly twice as high as in the agriculture sector. Good prospects were also offered in financial, renting and business service activities. In “other service activities” the transition rate was surprisingly low (37 per cent). The MAS allows us to take a closer look at this specific sector. We calculate the transition rate in unemployment of 11 per cent which is below the average of all sectors (15 per cent). Furthermore in many cases there are transitions in additional vocational training (5 per cent) or university studies (7 per cent). In addition we found out that trainees are more mobile than in other sectors, because 14% of them moved from Ingolstadt into other regions.

The examples presented here served to underline the particular advantage (usefulness) of the multi-accounting system for analysing regional problems and to illustrate some represent results.

## **5. Results and implication of the system**

Recent research points out the fact that there is no way of analysing the development of regional labour market by considering stock flows. Hence the flow approach is an adequate tool, for improving the labour market analysis on the aggregate level. Up to now - due to data restrictions - the analyses have been covering only three states like employment, unemployment and non-employment. This simplification seems to be not useful if we want to answer more detailed questions. The MAS offers a tool for combining different data sources of different their reliability in one consistent table so complex transition matrices could be estimated. Because of the different pattern of regional dynamics and the local labour market policies differ between regions, we constructed a model for all 180 Employment Agencies. The main goal is to obtain more detailed information on regional labour markets and highlight the risk and chances for specific transitions in a comparable manner.

The different ways of representing results and focusing on subaccounts create a high level of transparency in the complex area of regional labour markets. Depending on the focus of the analysis, it is possible to choose different reference points for comparisons (East or West Germany or agencies of the same reference type). We believe that the analytical potential of this instrument is not yet exhausted. In any event, it is already clear that the information content of this model by far exceeds that of a system of individual indicators. Details and relations of the regional labour market become apparent which show a high-resolution image of possible decrepit structures or increasing labour market dynamics, above all if we will build up the MAS over more years. The system thus helps clarifying the scope and limits of active labour market policy. Comparing transitions gives hints where flows on the labour market are congested or dynamics is getting under way. Complicated transition processes can be made more transparent and split up in detailed labour market accounts. Further research is needed to combine the information with individual micro data analysis. Compared to mobility and transition analyses for Germany our approach can be interpreted as

metaanalyses on an aggregate regional level. We conclude that for labour market policy advice, the MAS is a helpful instrument dealing on the meta-level.

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## Appendix I

### Extrapolation with ADETON given a basic matrix<sup>7</sup>

The algorithm ADETON makes use of the principle of optimising entropy. The basic idea is choosing that type of distribution that maximizes the entropy given a certain level of information. One has to search for these elements of a matrix, which represent the level of information in the most adequate way. Macro states defined as row and column sums of the data matrix (see Table 1) have to be compatible with feasible micro states. These estimated values should be in line with the information given by row and column sums. For this procedure an iterative algorithm is used. We start with the given matrices for West and Eastern Germany. Then all elements of the matrix are adjusted by multiplying with adjustment factors for column and row sums until consistence has been reached.

Its starting values are:

$$x_m = u_m \text{ for all } m, \text{ and } \mu_k = 0 \text{ for all } k.$$

Every step in the iteration process includes the following three operations:

1. Computation of the entropy projection on restriction k: compute  $\gamma$  in that way that holds

$$\sum_{i=1}^I \sum_{j=1}^J a_{kij} x_{ij} e^{\gamma a_{km}} \leq b_k \quad (1)$$

2. Correction of the sign: If  $\gamma > \mu_k$ , set  $\gamma = \mu_k$

3. Updating the values for  $x_m$  and  $\mu_k$ :

$$x_m = x_m e^{-\gamma a_{km}} \text{ for all } m$$

$$\mu_k = \mu_k - \gamma \text{ for all } k$$

Using extra information of part of the matrix or aggregate cells as constraints

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<sup>7</sup> See in more details Graef 2003.

Let  $T(x)$  be a table aggregate which can be understood as a function that allocates a weighted sum to a table  $x = (x_k)$  and let  $t_k$  be known weighting factors. Let  $k$  describe the position of the cell in the table and let  $x_k$  describe the pertinent value.

$$T(x) = \sum_{k=1}^n t_k x_k \quad (2)$$

Let there be  $m$  given constraints which either define an exact value  $b$  for a cell or relate to certain related table fields. Then constraints can then be formulated as follows:

$$T(x) = b_j, \quad T(x) \geq b_j, \quad T(x) \leq b_j \quad \text{or} \quad b_{j1} \leq T(x) \leq b_{j2} \quad (3)$$

this yields that

$$\frac{x_k}{u_k} \approx \gamma$$

$u$ : reference table (matrix for Germany)

The estimated elements  $x$  should be proportional to the corresponding elements of the basic matrix  $u$

Now the problem of extrapolation consists in a simultaneous minimization of the following target function, choosing the optimal  $\lambda$

$$F_\lambda(x) = (1 - \lambda)D_1(x, u) + \lambda D_2(x, b) \quad (4)$$

Using (1), (3) this yields to following expression:

$$F(x) = \alpha^2 \sum_{k=1}^n \left( \frac{x_k - u_k}{\sqrt{u_k}} \right)^2 + \sum_{j=1}^m c_j^2 \left( \sum_{k=1}^n a_{jk} x_k - b_j \right)^2 \quad (5)$$

So it could be shown how the target function depends on the basic matrix  $u$  and the given constraints.

## Appendix II

Division of economic sectors for employment subject to social insurance contributions and on-the-job/off-the-job training

MAS Code	Sector	Description
1	A	Agriculture and forestry
	B	Fishing, operation of fish hatcheries and fish farms
2	C	Mining
	D	Manufacturing
	E	Electricity, gas and water supply
3	F	Construction
4	G	Trade
	H	Hotels and restaurants
	I	Transport, storage and communication
5	J	Financial intermediation
	K	Real estate
6	L	Public administration and defence
	M	Education
	N	Health and social work
	O	Other service activities
	P	Private households with employed persons
9	-	Other, unclassifiable

Priorization of the MAS accounts for individual data and employment history (BeH)

Priority	Account designation	Account Code	Description of sub-accounts
1	Second labour market	1400	4 customer groups
2	Subsidized employment	1500	4 customer groups
3	Subsidized self-employment	1600	4 customer groups
4	Qualification through training and continuing training	1700	4 customer groups
5	Employed persons subject to social insurance contributions, persons doing military or alternative civilian service (excluding marginal and subsidized employees)	0710 to 0790	Divided into 6 economic sectors
6	Officers and civil servants, regular and professional soldiers	0900	
7	Trainees (on the job/off the job/in school)	0600 0610 to 0690	In-school training Divided into 6 economic sectors
8	Unemployed	1200	4 customer groups
9	Self-employed and unpaid family workers	1000	
10	Marginally employed persons including practical trainees and working students	0800	4 customer groups
11	General education schools/ universities	0511	~ Extended elementary schools (Hauptschule)
		0512	~ Secondary modern schools (Realschule)
		0513	~ Grammar schools (Gymnasium)
		0524	~ Technical colleges (Fachhochschule)
		0525	Universities

<b>12</b>	Retirements	1810 1820 1830 1840	Retirements (Rente) Part-time retirements Early retirements Retirements (Pension)
<b>13</b>	Job seekers	1300	
<b>14</b>	Non-employed persons	1100	
<b>15</b>	Moves	1910-1930 2010-2030	Moves out Moves in