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COMPARING REGIONAL STRUCTURAL CHANGE:

AN APPLICATION OF ECONOMIC INPUT-OUTPUT MODELS

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ECONOMIC INPUT-OUTPUT MODELS

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Abstract:

Efforts in modelling regional economies within Austria in the course of the last three years have resulted in the development of two comparable econometric Input-Output models. While the first model for the state of Styria has already been applied empirically in policy analysis, the development of the second model for the state of Upper Austria was finished only recently. Viewed together the two models offer various opportunities to compare the economic structure of the underlying regions.

The paper aims at presenting the structure of these models and discusses their capabilities and main features in more detail, such as the endogenous change of the underlying input-output coefficients. Preliminary empirical results from applying the models to analyse structural changes in the regional economies are presented.

Keywords: Regional Modelling, Input-Output, Econometrics, Structural Change

JEL Classification: R11, R15

1 Introduction

Over the last five years considerable research efforts have been directed towards developing a regional macroeconomic model to be implemented at the level of Austrian states. The research was motivated not only by academic interest but also by an increasing demand from policy makers for additional empirical insights helpful in evaluating past and current policies and in designing more effective and efficient new policies. Thus while such a model had to be grounded on sound theoretical assumptions, the focus was put on the model's empirical implementation. For that reason, strong emphasis lay on building an extensive regional database as well as accomplishing a high level of sectoral disaggregation.

A first version of the model for the state of Styria was completed in 1999;[1] since then the Styrian model has been considerably extended, not so much in terms of its structure but in terms of its econometric implementation and the underlying data base. The model was also applied in various research and policy consulting projects in the course of the last three years. In addition a second model for the state of Upper Austria was constructed and a preliminary version completed only very recently.[2] Implementing another model proved to extremely beneficial not only in terms of extending the regional scope of model application but also in testing the model characteristics based on two different models of the same structure. Having the same type of model implemented for two different regions also offers the opportunity to use the models for a comparative analysis of the regional economic structures.

This paper aims at presenting the basic structure of these models as well as some specific features which make them very useful especially for analysing regional structural changes over time. A few very preliminary results of such an analysis are provided here. These results are merely presented to illustrate the wide range of analytical opportunities the models offer. However, more research is needed to test and improve the robustness of the models before any comprehensive structural analysis should take place.

The paper is organized as follows: After this introduction a brief summary of the basic model structure and the underlying regional data base is provided. Then the different modules of the model are discussed in some detail. Finally, after a brief discussion of the key characteristics and the recent development of the economies of Styria and Upper Austria, some preliminary empirical results from an analysis of regional structural changes are presented.

[1] The model was developed by a research team of the Institute of Technology and Regional Policy of Joanneum Research.
[2] The second research was jointly carried out by members of the Institute of Technology and Regional Policy and the Austrian Institute of Economic Research.

2 Model Structure and Data Base

This section aims at introducing the basic structure of the model's equation system. As its name implies the type of model introduced here consists of a regional Input-Output module as well as different blocks of econometrically estimated equations. The inclusion of regional I-O tables indicates that the emphasis of the models lies on a sectorally disaggregated view of the regional economies. Therefore both models comprise a total of 36 different industries. The general structure is oriented at the type of system Conway first developed for Washington State in the late seventies (see e.g. Conway, 1990), and is basically top down in nature. That is, a national model provides exogenous inputs for the regional level while there are no feedback effects from the region back to the nation as a whole[3]. An important feature of the models is their capability to implicitly update the regional I-O coefficients and hence, transform the basically static I-O system into a dynamic one. Section 2 will discuss the applied procedure in more detail.

The model structure brings about that forecasting and impact analysis are the main applications of the models at hand; in addition, information on changes in the economic system over time – e.g. changes in the inter-sectoral linkages, sectoral input requirements etc. – can be derived. The overall systems predicts regional output, value added and employment for each of the 36 industries as well as five types of private consumption, two types of investment, public consumption and personal disposable income. Overall the systems each comprise 270 endogenous variables, 144 exogenous variables, 228 stochastic equations, 36 input-output equations as well as 6 accounting identities.

The 36 sectors roughly correspond to the two-digit NACE-code industries. A full description of these industries and their NACE components can be found in the Appendix. For each of these sectors time series for value added, output as well as employment were constructed. The historical period that the estimates of the structural relationships are based on runs from 1976 up to 1999, the forecast horizon currently goes up to 2010. In addition, so called synthetic series of final demand were derived from national per capita values, assuming the same per capita values for the components of final demand on the regional level as given nationwide. This rather restrictive assumption had to be made since regional data on final demand were not available.

The regional time series at the industry level needed in order to calibrate the econometric part of the model were not readily available from the Austrian national statistical office (Statistics Austria) but for the most part had to be constructed by the research team itself.[4] There were mainly two issues which complicated setting up of the time series database.

First, while regional time series (running from 1976 to 1994 and 1995 to 1999) for agriculture and forestry, mining and quarrying, manufacturing as well as trade and transport industries were available, this was not the case with respect to service industries, the government and related sectors. Up to 1995 only four annual data points (1976, 1983, 1988 and 1995) existed for the latter industries and various secondary statistics (from social security sources, trade associations etc.) had to be used to fill the data gaps.

The second complication arose due to a change in the industrial classification system in 1995, which implies that data from 1976 until 1994 are available in one classification (Betriebssystematik 1968), while time series from 1995 onwards are classified differently (ÖNACE 1995). Since the two classifications do not exhibit a unanimous correspondence at any level of disaggregation, bridge matrices had to be estimated for the year

[3] The national model providing the exogenous forecasts is the disaggregated model MULTIMAC, which was developed at the Austrian Institute of Economic Research (WIFO), see Kratena and Zakarias (2001).

[4] The support of the Department of Statistics of the Government of Styria in order to obtain the necessary data is gratefully acknowledged.

1995 (the only year in which data in both classifications are available); these matrices were kept constant while transforming the older series into the new classification.

The construction of the **regional input-output tables** for the year 1995 followed the make-use approach and was based both on primary and secondary statistical data as well as the national input-output table of 1995; the tables are thus so called mixed survey tables or hybrid tables. The missing information on regional exports to other regions in Austria as well as abroad was gained from a rather extensive survey among firms in the two regions. Characteristics of sectoral input requirements and final demand structure by commodities were mostly derived from the national input-output table; the availability of new data sources will make it possible to include additional regional information in the future.

3 The Structure of the Applied Regional Models

The main part of the model is the one determining regional output which at the same time performs an updating mechanism to alter the I-O coefficients in use according to their long run behaviour. The first part of this section aims at describing the parts of the regional I-O tables that are incorporated within each model and will furthermore explain this quantity adjustment process that forms the basis for the endogenous change of coefficients in the regional matrices over time.

The other blocks of equations – those determining regional value added, regional employment as well as the components of final demand – will be discussed in the second part of this section along with a description of the econometric specifications employed.

3.1 DETERMINATION OF REGIONAL OUTPUT AND THE ENDOGENOUS UPDATING OF I-O COEFFICIENTS

The issue of updating[5] I-O coefficients has had a long tradition in economics. The reasons for this can be found in the very nature of the construction of input-output tables and their coefficients: First, I-O coefficients represent averages of the underlying industry levels. The regional I-O-tables incorporated within the models discussed here comprise of 36 industries or goods; this high level of aggregation implies that the coefficients represent averages of rather distinct activities. Changes in the sectoral mix within one sector thus invalidate the estimated coefficients rather quickly. Second and more importantly, the tables describe input-output relations between sectors at a certain point of time. Since survey-based I-O tables rely on a vast amount of data and their complexity usually entails a long construction period, I-O tables get published with a considerable time lag. The high cost of setting up such a table furthermore prohibits more frequent construction such that a time interval between the publication of two successive national tables of at least 5 years exists. The 1995 I-O table for Austria (see Statistics Austria, 2001) for example was released in summer of 2001 and was hence already 6 years old at the date of its publication. This problem is of course aggravated at the regional level.

It therefore does not come as a surprise that mainly the static nature of input-output tables was often criticised, since changes in the structure of the underlying economy over time might invalidate the direct usage of comparatively old tables. As a corollary many researchers have dealt with non-survey and partial survey methods for constructing more up-to-date input-output tables and thus overcome at least in part this lack of timeliness. The seminal work in this field of partial survey techniques was done by Stone and Brown (1962) who for the first time applied the so-called RAS approach to economic data. The basic idea of RAS is to utilize (usually more frequently available) data on the row and column sums of a matrix in order to update the structure of the matrix itself via an iterative procedure. Assuming an $n \times n$ matrix, RAS hence tries to accomplish the updating of n^2 coefficients using $2n$ data points (i.e. the row and column sum, respectively) which is clearly an underdetermined system once $n > 2$. Therefore, the approach relies on the concept of closeness, that is, those coefficients are obtained, that are closest to the original ones while at the same time obeying the new row and column sums (see e.g. Lecomber, 1975).

The RAS methodology, however, cannot directly be implemented within disaggregated econometric models mainly because information needed to make the approach work (i.e. sectoral row and column sums) has to be derived from the models which in turn rely on input-output tables. In the literature only a few applications of updating procedures within econometric I-O models can be found. Among those is the work of Conway

[5] The term 'updating' here refers to the inclusion of recent data to obtain a better approximation of any matrix at time t than the same matrix at some earlier point in time (t-k) can provide.

(1990), which is described and applied also in Israilevich et. al. (1996) and which forms the basis of the updating procedure applied in the models described here. Ciaschini (1983) and Nyhus (1983) provide a slightly modified methodology of updating coefficients which was adopted within the family of INFORUM models built in the early 1980s.

The starting point of the analysis is the regional intermediate demand matrix $\mathbf{V^r}$, which is a quadratic *goods by industry* matrix with dimension 36x36. Each element v^r_{ij} can be interpreted as the regionally produced amount of good *i* that goes into the production process of industry *j*. From $\mathbf{V^r}$ the matrix of regional purchase coefficients $\mathbf{A^r} = [a^r_{ij}]$ is derived as:

$$a^r_{ij} = v^r_{ij}/x^r_j{}', \qquad (1)$$

where the $x^r_j{}'$ are the elements of the row vector of total regional output by industry, $\mathbf{x^r}$. In matrix notation, (1) can equivalently be written as:

$$\mathbf{A^r} = \mathbf{V^r} * \mathrm{diag}(\mathbf{x^r})^{-1}. \qquad (2)$$

The second term on the right hand side denotes the inverse of the diagonal matrix formed out of $\mathbf{x^r}$. Furthermore the regional final demand matrix, $\mathbf{FD^r} = [fd^r_{ik}]$, is considered, which contains the absolute values of final demand from the 1995-table. The components of this matrix include private consumption (**pc**), government consumption (**gc**), both investment in construction (**ic**) and other investment (**io**), exports (**ex**) as well as inventory and statistical difference (**in**). Hence, $\mathbf{FD^r}$ is of dimension 36x6 [6]. Out of $\mathbf{FD^r}$ a coefficient matrix $\mathbf{AF^r} = [af^r_{ik}]$ is formed, whose elements are computed in the following way:

$$af^r_{ik} = fd^r_{ik}/ f^r_k{}', \qquad (3)$$

where $[f^r_k{}']$ are the elements of the transposed summation vector of final demand. That is, each element of $\mathbf{FD^r}$ is divided by its column sum, and hence one element $[af^r_{ik}]$ gives the share of (regionally produced) good *i* delivered to final demand category *k* in total regional deliveries to that category. Again, writing relationship (3) in matrix notation yields:

$$\mathbf{AF^r} = \mathbf{FD^r} * \mathrm{diag}(\mathbf{f^r})^{-1}. \qquad (4)$$

Given matrices $\mathbf{A^r}$ and $\mathbf{AF^r}$ the following basic input-output relationship can be stated:

$$\mathbf{A^r} * \mathbf{x} + \mathbf{AF^r} * \mathbf{f^r} = \mathbf{x}. \qquad (5)$$

[6] See section 3.2.3 for a discussion of how the components of final demand are treated within STYRIO.

In order to account for changes in both matrices $\mathbf{A^r}$ and $\mathbf{AF^r}$ over time, their coefficients serve as equilibrating forces in the quantity adjustment process of the models. The basic idea is to form a deterministic predictor of regional output $\mathbf{x}$ over the entire historical period out of equation (5). To do this time scripts are introduced to the notation and (5) is restated as:

$$\mathbf{A^r_{95}} * \mathbf{x_t} + \mathbf{AF^r_{95}} * \mathbf{f^r_t} = \mathbf{z_t}. \qquad (6)$$

In (6) the regional output vector $\mathbf{x_t}$ is replaced by a corresponding deterministic predictor $\mathbf{z_t}$, which is termed *predicted* or *hypothetical* regional output. It becomes immediately obvious from the notation that the time series of hypothetical regional output is obtained by inserting the actual values of regional output and final demand while the coefficient matrices $\mathbf{A^r}$ and $\mathbf{AF^r}$ remain constant at their 1995-levels. It follows that the values of $\mathbf{x_t}$ and $\mathbf{z_t}$ will coincide in 1995 – the base year of the I-O table at hand – but are likely to diverge from each other in every other year. This is because the variation of regional output and final demand will not be able to explain the entire variation in (6) due to unobserved changes in both coefficient matrices involved. In that sense, the differences between regional output and its hypothetical counterpart can be attributed to the alteration taking place in the coefficients of $\mathbf{A^r}$ and $\mathbf{AF^r}$. Now, considering the relationship of $\mathbf{z_t}$ and $\mathbf{x_t}$ over time,

$$\mathbf{R_t} * \mathbf{z_t} = \mathbf{x_t}, \qquad (7)$$

where $\mathbf{R_t}$ is a diagonal matrix. The aim is to alter (and hence update) $\mathbf{A^r}$ and $\mathbf{AF^r}$ such that the entire variation in (6) is explained. Pre-multiplying both sides of (7) with $\mathbf{R_t}^{-1}$ and inserting the result for $\mathbf{z_t}$ into (6) yields:

$$\mathbf{A^r_{95}} * \mathbf{x_t} + \mathbf{AF^r_{95}} * \mathbf{f^r_t} = \mathbf{R_t}^{-1} * \mathbf{x_t},$$

and

$$\mathbf{R_t} * \mathbf{A^r_{95}} * \mathbf{x_t} + \mathbf{R_t} * \mathbf{AF^r_{95}} * \mathbf{f^r_t} = \mathbf{x_t}. \qquad (8)$$

That is, the coefficients of both matrices are updated at time *t* with a fixed factor along the rows derived from matrix $\mathbf{R_t}$. Note, that this 'correction matrix' $\mathbf{R_t}$ can be seen as a pendant to the first component of the RAS-approach of updating I-O-coefficients. Following the interpretation given by Stone and Brown (1962), it can be said that because $\mathbf{R_t}$ pre-multiplies $\mathbf{A^r}$ and $\mathbf{AF^r}$, the unexplained variation from (6) is attributed to the technology of producing the output (row-wise multiplication with a constant, see also Snower (1990), p.32).

To further illustrate this point the following graph depicts the two series of actual and hypothetical regional output for industry *Mining and Other non-metallic mineral products* in the Upper Austrian model.

Figure 1: Actual and hypothetical output for Mining and Other non-metallic mineral products

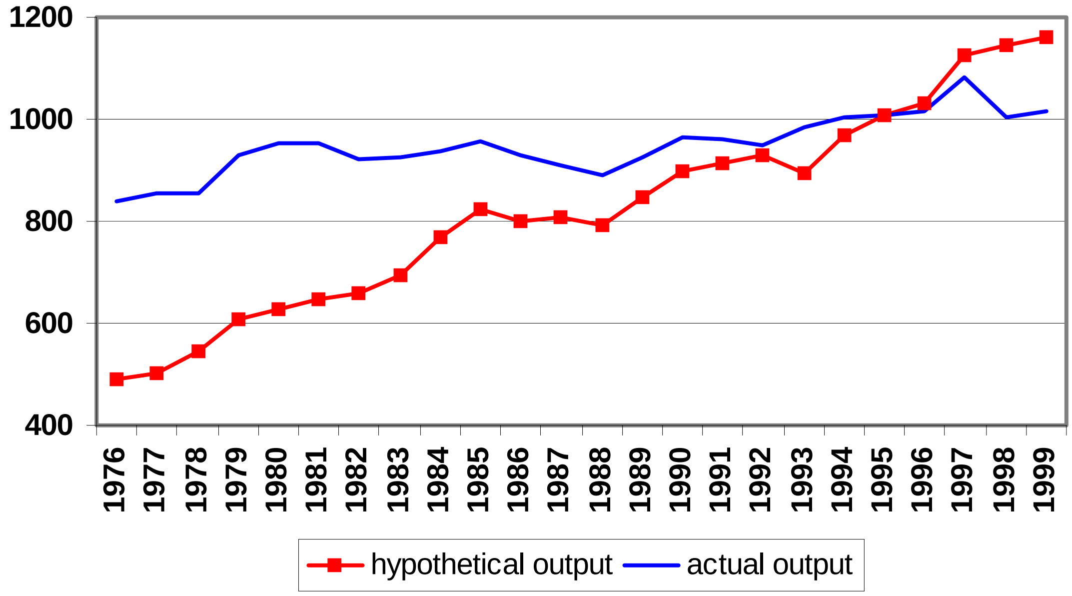


Figure 1 shows a rising series of hypothetical output, which is smaller than actual output before 1995 and larger thereafter. In interpreting the picture, the year 1976 should be considered. The values of both series reveal, that only slightly more than half of the actually produced amount of output would have been necessary to satisfy regional demand for products of the respective industry in Upper Austria - had the technological linkages been the same as in 1995 (which is exactly what the hypothetical output series assumes). Hence (and not surprisingly), the importance of *Mining and Other non-metallic mineral products* gradually decreased over time since an ever decreasing share of total regional output needs to be produced by this sector to match the other industries intermediate demand.

Estimation of elements of the adjustment matrix $\mathbf{R}_t$ is achieved within an extra block of econometric equations within the models at hand. That is, one equation linking the corresponding values of $\mathbf{x}_t$ and $\mathbf{z}_t$ is introduced for each industry:

$$\mathbf{x}_t = f(\mathbf{z}_t). \tag{9}$$

As far as estimation of (9) is concerned, different approaches can be found in the literature. The approach as summarized in equation (8) implies a permanent change in the coefficients along each row of the matrix in every year. This is likely to yield problems in the very long run, since there is no saturation point for the coefficients to converge to. The methodology adopted within the INFORUM models (Ciaschini (1983), Nyhus (1983)) suggests to use logarithmic functions to determine the relationship between actual and hypothetical output. Combined with exogenously determined saturation points the logarithmic specification ensures that the system is in equilibrium in the very long run in that each coefficient has reached his saturation point.

Given the main fields of application for the regional models at hand – which do not entail long term forecasting exercises – emphasis here is rather placed on a clear and simple treatment of (9), whose estimation has proved very influential in terms of the overall model results. Therefore, the two step Engle – Granger procedure (see Engle and Granger, 1987) - in which the long run relationship can be expressed in just one parameter - was applied. Hence, the first step consists of estimating a long run relationship between the two variables (the cointegrating vector):

$$\log\left(x_{i,t}^{r}\right) = \alpha_{i}^{x} + \beta_{i}^{x} \log\left(z_{i,t}^{r}\right) + \varepsilon_{i,t}^{x}, \qquad (10)$$

where $\varepsilon^{x}_{I,t}$ is the residual and the subscript *i* denotes the industry under consideration. The estimated parameter β^{x}_{i} determines rising or falling importance of the sector over time: with the estimated parameter being smaller than 1, the overall importance of the industry will be declining over time, and vice versa. To capture short run fluctuations around the long run trend estimated in (10) the following standard and well known error correction specification is estimated:

$$\Delta\log\left(x_{i,t}^{r}\right) = \phi_{i}^{x} + \gamma_{i}^{x}\Delta\log\left(z_{i,t}^{r}\right) + \lambda_{i}^{x}\left(\log\left(x_{i,t-1}^{r}\right) - \alpha_{i}^{x} - \beta_{i}^{x}\log\left(z_{i,t-1}^{r}\right)\right) + \delta_{i}^{x}\Delta\log\left(x_{i,t}^{n}\right) + \mu_{i,t}^{x}, \qquad (11)$$

where the superscript *n* denotes the respective variable on the national level. The coefficient of the error correction term, λ_{i}^{x} , must of course be negative to make the adjustment process towards equilibrium work. Both (10) and (11) enter the model block determining total output and updating the I-O coefficient matrix as described above. The theory of cointegration of course requires certain properties of the underlying time series to be fulfilled. First, actual and hypothetical output must be non-stationary, moreover they must be of the same order of integration. An augmented Dickey-Fuller unit root test was performed on the series for each industry, revealing non-stationarity for each and every time series (regardless of the specification of the unit root test, namely whether a constant, a time trend or different time lags were included). The results of testing for integration of order 1 (I(1)) were only little less significant; while all series for actual output are were found to be I(1), the hypothetical output series in industry 3 and 16 were found to be I(2) in both models. To test whether (10) actually is a cointegrating relationship, the residuals $\varepsilon^{x}_{i,t}$ were furthermore tested for stationarity, which was confirmed for each residual series in both models with highly significant test statistics.

Even though the results from the unit root tests would theoretically prohibit the estimation of equation (10) and (11) in industries 3 and 16 in both models, some doubts about the validity of these tests in the present context arise. First of all, the length of the time series at hand is clearly insufficient with only 25 data points, where usually at most 60 data points for annual series is required to get reliably estimates. Secondly the data at the regional level are of less quality than their counterparts on the national level. Therefore, the estimation procedure was continued also in those two sectors showing I(2) behaviour along the lines discussed above, even more so since the aim in this empirical application is to implement a specification which shows the long run behaviour in just one parameter (which can also be adjusted exogenously, if its value is either insignificant or clearly out of a economically meaningful range).

3.2 MODELLING BLOCKS FOR VALUE ADDED, EMPLOYMENT AND FINAL DEMAND

This second subsection will present the econometric specifications employed in estimating the sectoral equations for value added and employment and the equations for final demand.

3.2.1 Value Added

The equations for value added are set up again following the Engle-Granger two step procedure with the dependent variable being value added per employee. Due to the top down approach inherent in the structure of the regional models, the estimated long run relationship here will be established between the regional and the national level of value added per employee. Denoting regional value added in industry *i* at time *t* by $y^r_{i,t}$ and regional dependent employment[7] by $ed^r_{i,t}$ the long run equation then takes the following form:

$$\log\left(\frac{y^r_{i,t}}{ed^r_{i,t}}\right) = \alpha^y_i + \beta^y_i \log\left(\frac{y^n_{i,t}}{ed^n_{i,t}}\right) + \varepsilon^y_{i,t}\,, \qquad (12)$$

In (12) the superscripts *n* denote national variables. The standard error correction model is supplemented by a term relating regional and national value added per employee, such that the following equation is estimated in each sector:

$$\begin{aligned}\Delta\log\left(\frac{y^r_{i,t}}{ed^r_{i,t}}\right) &= \phi^y_i + \gamma^y_i \Delta\log\left(\frac{y^n_{i,t}}{ed^n_{i,t}}\right) + \lambda^y_i\left(\log\left(\frac{y^r_{i,t-1}}{ed^r_{i,t-1}}\right) - \alpha^y_i - \beta^y_i \log\left(\frac{y^n_{i,t-1}}{ed^n_{i,t-1}}\right)\right) \\ &+ \delta^y_i \Delta\log\left(\frac{y^r_{i,t}}{ed^r_{i,t}}\Big/\frac{y^n_{i,t}}{ed^n_{i,t}}\right) + \mu^y_{i,t}\,.\end{aligned} \qquad (13)$$

The properties of the time series underlying (12) and (13) are similar to the ones stated for actual and hypothetical output in the previous section, the same arguments for proceeding even though the requirements of the theory are not fully met apply.

3.2.2 Employment

The estimation of employment is very similar to the treatment of value added. Again, a long run relationship is established between the regional and national level, this time output per worker is the dependent variable:

[7] Since the national model providing the forecasts incorporates wage employees only, this is also true for the regional models for consistency reasons.

$$\log\left(\frac{x_{i,t}^{r}}{ed_{i,t}^{r}}\right)=\alpha_i^{ed}+\beta_i^{ed}\log\left(\frac{x_{i,t}^{n}}{ed_{i,t}^{n}}\right)+\beta_i^{x}\log\left(\frac{x_{i,t}^{r}}{x_{i,t}^{n}}\right)+\varepsilon_{i,t}^{ed}\,. \quad (14)$$

The error correction model itself is specified as follows:

$$\Delta\log\left[\frac{x_{i,t}^{r}}{ed_{i,t}^{r}}\right]=\phi_i^{ed}+\gamma_i^{ed}\Delta\log\left(\frac{x_{i,t}^{n}}{ed_{i,t}^{n}}\right)+\lambda_i^{ed}\left(\log\left(\frac{x_{i,t-1}^{r}}{ed_{i,t-1}^{r}}\right)-\alpha_i^{ed}-\beta_i^{ed}\log\left(\frac{x_{i,t-1}^{n}}{ed_{i,t-1}^{n}}\right)\right)$$
$$+\delta_i^{ed}\Delta\log\left(\frac{x_{i,t}^{r}}{x_{i,t}^{n}}\right)+\mu_{i,t}^{ed}\,. \quad (15)$$

The parameter of the last term on the right hand side, which represents the region's share of the (total) national output of commodity i and can (meaningfully) take values between 1 and 0 is crucial in impact analysis when it comes to translate the effects of output changes into changes in employment. Omitting this term – that is, with δ_i^{ed} being zero – the whole system would follow a Leontief production technology, in which twice as much output needs twice as much employment to be produced. The closer the estimated parameter is to 1, the higher is the gain in productivity in response to the change in output. In the extreme case of δ_i^{ed} being equal to 1, the entire additional amount of output can be produced with the same amount of employment as before. The parameter is included in both the short- and the long run equation, but has slightly different interpretations: in the short run, it can be assumed that additional output (a positive output shock) can be accommodated by two simultanious responses: by working existing employees harder and by expanding employment. The closer the parameter to one, the more pronounced is the first response; conversly, a parameter of close to zero would imply the dominance of the second approach. However, it must be assumed that it is not possible to indefinitely maintain the "productivity pressure" on the employees. In the long run, therefore, to keep up a larger share of output, it is necessary to add to (total) productivity by improving capital productivity, i.e. by investing. The last argument can also be reversed: if a region is able to expand its share of output, it must have a comparative advantage, which should manifest itself as superior labour productivity.

3.2.3 Final Demand

The components of final demand are again estimated following the Engle-Granger two step procedure. Due the similarity of the econometric specification of the final demand equations with the specifications described for regional output, value added and employment, the equations are not explicitly shown here. Regional output serves as the independent variable in modelling the investment series, while both private and government consumption are regressed on regional value added. At this stage no national variables enter the determination of the final demand components. Given the importance of final demand components within the overall system, their comparatively simple treatment constitutes a considerable weakness of the current modelling process, and further improvements have to be made in future modelling steps.

4 Comparing Structural Change

Upper Austria and Styria are the third and fourth largest states in Austria, measured by their total population, and are of great economic importance as well. Together they account for 28% of Austria's total value added (1999) and 32% of national employment (2001, without self-employed). The states can also be seen as the country's manufacturing strongholds: no less than 40% of all manufacturing workers are employed in firms located in Upper Austria or Styria.

The relative economic performance of the states differed over the last 25 years: Up to the end of the 1980s Upper Austria was the more dynamic region among the two, in terms of value added its economy expanded at rates above the national average. Styria on the other hand was mostly lagging behind and developed at a slower pace than the national economy. This picture, however, changed in the 1990s, less to the worse of Upper Austria than to the better of Styria, which experienced above average growth differentials. Upper Austria slowed down somewhat at the beginning of the 1990s but could regain its dynamic development later on. A similar pattern turns up when one looks at employment figures: Up to the early 1990s Styria lay markedly below the national employment growth levels while Upper Austria could be found above. Then the Styrian economy turned around and both states have experienced above-national growth rates ever since; Upper Austria has expanded its employment (again without considering self-employed) rather considerably especially in the last three years.

Their recent economic performance is thus an indication that Styria and Upper Austria were rather successful in coping with the economic challenges that certainly arose in the past. Both states had to undergo significant structural changes in the last two decades, not to the least caused by their large share in Austria's nationalised manufacturing industry which concentrated on basic manufacturing activities: metals and metal products, machineries as well as mining (Styria) and chemicals (Upper Austria). Due to various (economic, political) reasons, the nationalised industry plunged into a deep crisis in the 1980s, which finally led, after reorganization and restructuring efforts had failed, to the split up and partial privatisation of the large conglomerates. Some of the once highly competitive regions locating these firms were thus drawn into a negative economic spiral, Upper Styria became known as an old industrial region.

The stylised facts that describe the changes in the sectoral composition in both regions can be summarized as follows:

As expected, when looking at sectoral employment data regional service activities became increasingly important over the years at the expense of manufacturing: while in 1980 only 51% (Styria) and 45% (Upper Austria) of total employment was service based, in 2001 almost up to two thirds of all dependent employees (66% in Styria, 62% in Upper Austria) could be assigned to the service sector. Manufacturing employment, on the other hand, declined from 42% to 27% (Upper Austria) and 35% to 23% (Styria). The trends towards services and away from manufacturing as observed in the two regions were quite similar in extent to the corresponding national trends. This also implies that Upper Austria and Styria kept their above average economic orientation towards manufacturing; employment in market-oriented services in particular still remains relatively low, even when compared to a national share excluding the metropolitan region of Vienna. A relatively large share of the Styrian work force is engaged in public services, including health and education.

Those manufacturing activities which were once carried out by the large nationalised firms are still economically relevant for the regions. This concerns, for instance, metals (in both regions) and also chemicals (in Upper Austria). Other industries lost importance, which is most of all true for the textile industry (esp. in Upper Austria), characterised by low cost / low skill labour requirements. Some industries, actively supported by regional economic policy, have strived: Both regions are proud to have established so called automobile clusters: large multinational automobile producers located in the regions (Chrysler in Styria, BMW in Upper Austria) and are now surrounded by supplying firms. Sectors producing technology-oriented products (like electronics) are still underrepresented in Upper Austria, while taking an average employment share in Styria. In general, within manufacturing the activities have shifted towards final products away from basic activities, more so in Styria than in Upper Austria.

4.1 COMPARING THE STRUCTURE OF THE UNDERLYING REGIONS

This section aims at providing some preliminary results concerning the structural development of the two regions over time. The means of investigation will be twofold. At first, the estimated coefficients from the long run equations determining actual regional output will be presented, since they indicate whether an industry shows a rising or declining pattern in interregional importance. Empirical derivation of I-O tables at different points in time directly from the models will be the second approach adopted to facilitate the comparison.

4.1.1 Long term trends in regional importance by industry

The estimated long run parameters β_i^x from the output equation (10) indicate which industries in the respective regional economy are growing in importance and which do not. Parameter values around 1 are obtained whenever actual and hypothetical output are moving close to each other, indicating, that the importance of the underlying industry does not change over time. Estimated values larger than one refer to rising importance and vice versa. Table 1 below provides an overview over these coefficients in both models. Whenever economically nonsensical results were obtained from estimating (10) above, the long run coefficient was set to a meaningful level, given the course of the two time series over time. The affected industries can be identified in Table 1 since no standard error is given for their respective coefficients.

In Styria 17 out of 36 industries show estimated values significantly[8] smaller than one, while 12 are not significantly different from 1. This is in contrast with the 24 declining industries in Upper Austria, where only 4 industries are not changing at all. The number of coefficients being larger than one is almost the same (7 in Styria and 8 in Upper Austria).

The coefficients for the primary sectors are similar and of course smaller than 1. For the manufacturing industries coefficients are generally smaller or at best equal to one, with exceptions being the manufacturing of *motor vehicles, trailers and other transport equipment* in Styria as well as *manufacturing of fabricated metal products* in Upper Austria. While the former coefficient is mainly due to the recent intense Cluster activities in Styria which started affecting the Styrian economy from the mid 1990s onwards, the latter is influenced by a growing importance in the earlier years of the sample.

The service sectors – confirming the presumptions - generally show parameter values above one. Especially high coefficients can be found in *Post and telecommunications* as well as *Research and development and other business activities*. The estimated values of the trade industries are close to one or even above one, reflecting the influence of final demand (especially private consumption) within the models. It must, however, again be stressed that those results should be viewed with caution, and should not be given too much interpretation.

[8] The boundary chosen is +/- 2 times the standard error.

Table 1: Estimated long run coefficients for each industry ***(standard errors in parenthesis)***

No.	Description	Styria	Upper Austria
01	Agriculture, forestry and fishing	0.70 [0.085]	0.66 [0.051]
02	Mining and Other non-metallic mineral products	0.20 [exog]	0.22 [0.020]
03	Food and beverages, tobacco	0.31 [0.064]	0.44 [0.044]
04	Textiles	0.30 [exog]	0.30 [exog]
05	Leather	0.28 [0.061]	0.68 [0.150]
06	Wood and products of wood	0.50 [0.040]	0.58 [0.118]
07	Paper and paper products	0.74 [0.044]	0.63 [0.017]
08	Printing and Publishing	0.96 [0.084]	0.90 [0.123]
09	Chemicals and allied products	0.93 [0.064]	0.63 [0.041]
10	Rubber and plastic products	1.00 [0.071]	0.65 [0.026]
11	Manufacture of basic metals	0.57 [0.114]	0.43 [0.027]
12	Manufacture of fabricated metal products	0.76 [0.050]	1.46 [0.035]
13	Machinery and equipment	0.55 [0.032]	0.72 [0.216]
14	Office, accounting and computing machinery; Electrical machinery; radio, television and communication equipment	0.78 [0.032]	0.68 [0.053]
15	Medical, precision and optical instruments	0.39 [0.045]	0.67 [0.026]
16	Motor vehicles, trailers and other transport equipment	1.07 [0.164]	0.70 [0.095]
17	Furniture, manufacturing n.e.c., Recycling	0.82 [0.049]	0.53 [0.122]
18	Electricity, gas, steam and hot water supply;	1.18 [0.039]	0.86 [0.035]
19	Construction	0.81 [0.032]	0.81 [0.089]
20	Sale, maintenance, repair of motor vehicles and motorcycles	0.30 [exog]	0.58 [0.087]
21	Wholesale Trade	1.18 [0.198]	1.05 [0.094]
22	Retail Trade	1.00 [exog]	0.85 [0.035]

Table 1 (cont.): Estimated long run coefficients for each industry

No.	Description	Styria	Upper Austria
23	Hotels and restaurants	1.08 [0.029]	0.61 [0.034]
24	Land, water and air transport	0.85 [0.218]	0.67 [0.029]
25	Supporting and auxiliary transport activities	0.95 [0.046]	1.08 [0.661]
26	Post and telecommunications	1.21 [0.089]	1.33 [0.039]
27	Financial intermediation and auxiliary activities; Insurance, pension funding and auxiliary activities	1.14 [0.056]	1.22 [0.035]
28	Real estate and renting of machinery and equipment	1.37 [0.077]	1.04 [0.018]
29	Computer and related activities	1.06 [0.054]	1.27 [0.090]
30	Research and development; other business activities	1.40 [0.037]	1.30 [exog]
31	Public administration and defence	1.10 [0.047]	1.20 [exog]
32	Education	0.57 [0.032]	0.94 [0.017]
33	Health and social work	0.53 [0.029]	1.21 [0.051]
34	Sewage, refuse disposal and sanitation; other service activities; private households with employed persons	0.62 [0.430]	0.92 [0.023]
35	Activities of membership organizations n.e.c.	1.04 [0.032]	0.81 [0.019]
36	Recreational, cultural and sporting activities	0.99 [0.303]	0.81 [0.067]

4.1.2 Investigating derived I-O tables over time

One simple method to assess the overall linkages between the industries in the respective region is provided by the value of the global intensity, which is simply defined as the sum over all elements of the Leontief inverse matrix. While the global intensity in the original I-O table for 1995 in Upper Austria amounts to 44,8, this value increases in the I-O table derived from the regional econometric model in 1995 to 49,8. This difference is of course due to the inclusion of final demand, which is accounted for endogenously in the econometric model. The respective values for the I-O table of Styria show an increase from 45,0 up to 50,8, which is only slightly different from the results in Upper Austria[9]. More interestingly, however, is the development of the values for the global intensity over time; in this respect the differences between the two regions appear to be more pronounced. While the intensity is more or less stable in Upper Austria between the time period 1980 to 2000, it is clearly reducing in Styria, as can be seen from Table 2 below.

Table 2: Global intensity in Upper Austria and Styria over time

	1980	1990	2000
Upper Austria	49,8	50,0	49,7
Styria	56,1	52,8	50,1

[9] Given the derivation of the final demand series, which are synthetically derived from national per capita values, this is not an surprising result.

Furthermore the so-called Multiplier Product Matrix (MPM) is derived, which is defined via the row ($B_{i.}$) and column sums ($B_{.j}$) of the Leontief inverse matrix (derived from the model) as follows:

$$\mathrm{MPM} = \frac{1}{V}\begin{pmatrix} B_{1\bullet} \\ B_{2\bullet} \\ \vdots \\ B_{42\bullet} \end{pmatrix}\left(B_{\bullet 1}\ B_{\bullet 2} \dots B_{\bullet 42}\right),$$

where V is the global intensity of the Leontief inverse. Following Hewings et. al. (1997) the coefficients can be illustrated in graphical form in order to reveal the economic landscape of a region at a certain point in time. In the diagrams below, the landscapes of Upper Austria and Styria for the year 1990 are depicted.

Diagram 1: Economic landscape 1990 in Upper Austria

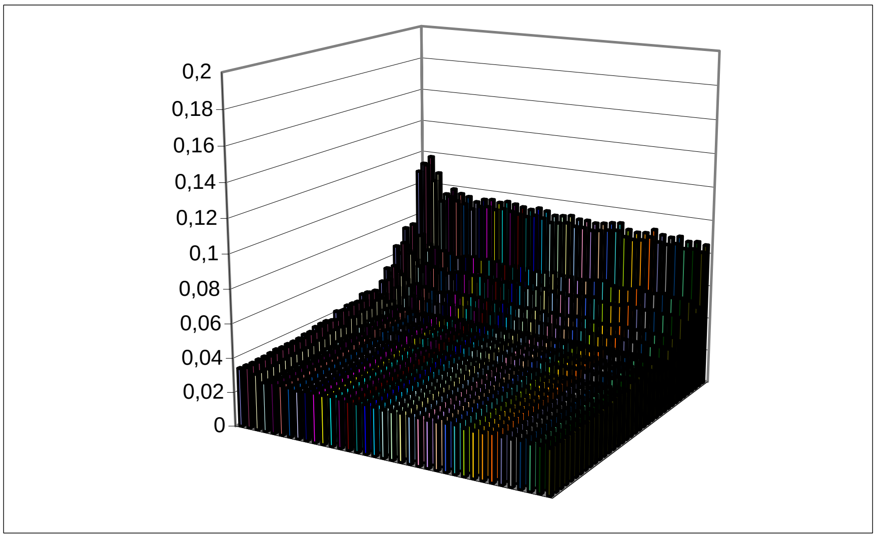
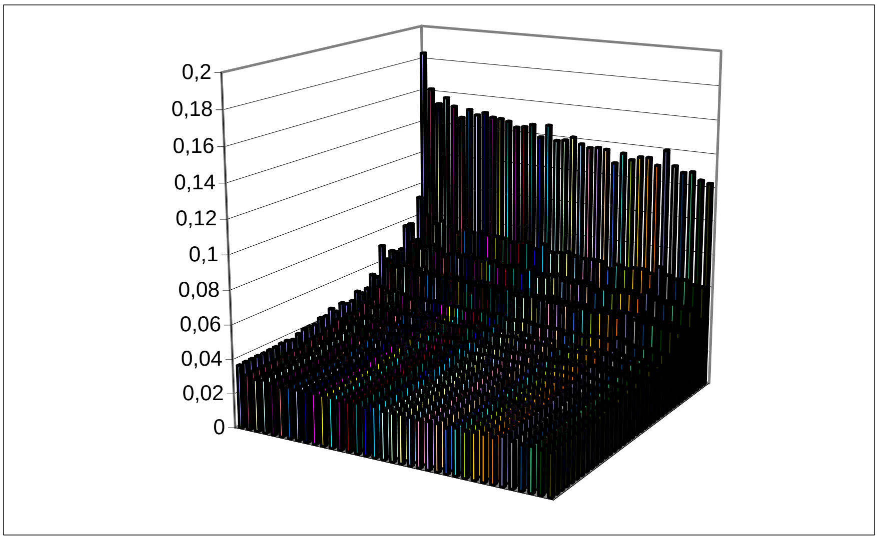


Diagram 2: Economic landscape 1990 in Styria



The diagrams provide another way of looking at the differences in the economics structure of the two regions. However, given the illustrative nature of the preliminary results presented here, no further economic interpretation is offered at this point.

5 Final Remarks

The purpose of this paper was to describe the structure of a regional econometric input-output model implemented in Austria and to illustrate the potential use of this type of model in analysing regional structural changes. Its specific features make the model, in principle, very suitable for this kind of economic analysis: The model contains information on the behaviour of key sectoral variables over a long time period and, through statistical estimations, on their determinants. By integrating an input-output table into the model and a procedure to update the table's coefficients changes in sectoral flows between regional industries can be modelled as well. Thus a time series of I-O tables can be derived and provides a rich source for analysing structural changes over time. However, needless to say, before further interpretation of the results from the model's application it is crucial to carefully evaluate the model's reliability and empirical robustness in order to avoid any false economic conclusions.

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Appendix

Table A1: The 36 industries represented in the regional models

No.	NACE 2	Description
01	01, 02, 05	Agriculture, forestry and fishing
02	10, 11, 13, 14, 26	Mining and Other non-metallic mineral products
03	15, 16	Food and beverages, tobacco
04	17, 18	Textiles
05	19	Leather
06	20	Wood and products of wood
07	21	Paper and paper products
08	22	Printing and Publishing
09	23, 24	Chemicals and allied products
10	25	Rubber and plastic products
11	27	Manufacture of basic metals
12	28	Manufacture of fabricated metal products
13	29	Machinery and equipment
14	30, 31, 32	Office, accounting and computing machinery; Electrical machinery and apparatus n.e.c; radio, television and
15	33	Medical, precision and optical instruments
16	34, 35	Motor vehicles, trailers and other transport equipment
17	36, 37	Furniture, manufacturing n.e.c., Recycling
18	40, 41	Electricity, gas, steam and hot water supply; Collection, purification and distribution of water
19	45	Construction
20	50	Sale, maintenance and repair of motor vehicles and motorcycles
21	51	Wholesale Trade
22	52	Retail Trade
23	55	Hotels and restaurants
24	60, 61, 62	Land, water and air transport
25	63	Supporting and auxiliary transport activities
26	64	Post and telecommunications
27	65, 66, 67	Financial intermediation and auxiliary activities; Insurance, pension funding and auxiliary activities
28	70, 71	Real estate and renting of machinery and equipment
29	72	Computer and related activities
30	73, 74	Research and development; other business activities
31	75	Public administration and defence
32	80	Education
33	85	Health and social work
34	90, 93, 95	Sewage, refuse disposal and sanitation; other service activities; private households with employed persons
35	91	Activities of membership organizations n.e.c.
36	92	Recreational, cultural and sporting activities

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