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Structural development of Germany and Japan 1980 – 1995

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Abstract

By application of the so-called Minimal Flow Analysis and other quantitative tools of structural analysis to a set of 54-sector Input Output-tables for Germany and Japan, made comparable by one of the authors, a comparison of the development of both countries is done. The analysis uncovers mainly common structural features for the time-span of 1980 to 1995 .

There are commonalities as well as differences which, however, could be tracked down to certain national peculiarities.

1. Introduction[3]

One of the most interesting questions of input-output analysis (IOA) is whether there are common patterns of development of economies along the time axis. This question is backed by the idea of "evolution". This implies that if starting points and environments of development are similar to a certain extent the plot of economic evolution should also show similarities.

To make commonalities of developmental pattern visible – if they exist – we need an instrument, a kind of looking glass, which allows for it. There is e.g. the approach of Qualitative Input-Output-Analysis (QIOA), especially MFA (Schnabl 1994) as well as Quantitative Analyses such as Rasmussen's coefficients (Rasmussen 1956) which could be used for this task.

We analyze a time series of four IO tables for both countries encompassing a time span of 15 years by qualitative as well as quantitative methods. While qualitative methods like the MFA deliver *graphs* of sectoral relationships, the additional quantitative methods like Rasmussen's coefficients produce more detailed information on certain se-

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lected properties of the sectoral relationship. Thus the integration of both approaches is a good basis to reflect the whole picture.

2. The Database: Harmonization of IO Table for Both Countries

For the comparison of the IO structures, we have recompiled the IO tables for the years 1980, 1985, 1990 and 1995 of the UN classification type A (including domestic production and imports) for both countries in current prices. The fundamental characteristics of the original IO tables for both countries had first to be harmonized in order to make the comparison meaningful. This was basically done by adjusting Japanese IO tables to the German classification scheme. This could easily be achieved, because the number of sectors in the Japanese original tables is over 400 and it was easy to aggregate them according to the scheme of the German Federal Statistical Office (FSO). Thus the comparison was possible on the basis of 54 sectors. Besides the classification of the sectors, additionally the following critical elements had to be adjusted.

2.1. Treatment of by-products

By-products of the Japanese tables are transferred by the Stone-method. This is the reason why we could find some negative values even in the intermediate input/demand section. But since the tables for Germany are compiled by the SNA method (so-called "Ueberleitungsmodell"), for the comparability of the tables, the ESA method was adopted for the recompilation of Japanese tables which transfers by-products outside of the intermediate input/demand section.

2.2. Imputed interest

The original Japanese tables deal with the service of imputed interest (the difference between receipts in consideration for loan and payments for interest on deposits) as intermediately demanded by each of other sectors. On the other hand, the FSO shows imputed interest as input within the financial sector, while the same amount is also deducted from value added (operating surplus) of the sector. Thus the adjustment of Japanese tables was also necessary for imputed interest.

2.3. Classification of fixed capital formation

In Japan, fixed capital formation is normally divided into two categories, i.e. public fixed capital formation by government and private fixed capital formation by private sectors. In the FSO tables, on the other hand, fixed capital formation is classified according to its function, i.e. fixed capital formation in plant and equipment and fixed capital formation in construction. By referring to the investment matrix, the fixed capital formation of Japanese tables was reclassified according to the definition of FSO.

2.4. Consumption outside of households

The original Japanese tables have an item called "consumption outside of households" in the final uses and primary inputs quadrants. The term basically means consumption by business enterprises such as social expenses and welfare benefit expenditures. To achieve consistency with the FSO tables, these row and column values were added to the sector for "other market services" since consumption is essential for market services.

2.5. A Sector for the n.e.c.(not elsewhere classified)–case

There exist "unclassifiable" rows and columns in the intermediate input/demand quadrant in the original Japanese tables. These are in fact used for adjustments of errors and omissions without any distinction between goods and services. Since the FSO table does not have this kind of "sector", we have opted for proportional distribution of unclassifiables to the two residual sectors of "Other Manufactures" and "Other Services" according to the amount of total supply of goods and services.

3. Methodologies applied

3.1 The MFA–Method

Contrary to *conventional Qualitative* Input–Output Analysis (QIOA) developed in 1979 by one of the authors and H.W. Holub (Schnabl&Holub 1979, Holub & Schnabl 1985) where the IO–table entries t_{ij} are directly taken from the intermediary transaction matrix T, the MFA does not use the transaction matrix T, but rather intermediary "layers" derived from it as *intermediary stages* (see Appendix 2 and Schnabl 1994) as given by Eq. (4) to (6). They are developed according to the following steps: Rewriting the Transaction matrix T

$$T = A < x > \tag{1}$$

where A represents the matrix of input coefficients and $\langle x \rangle$ the diagonal matrix of the output vector x, we can further replace x by

$$x = By \tag{2}$$

The Leontief inverse B is again substituted with the usual conditions valid by:

$$B = I + A + A^2 + A^3 + \ldots \tag{3}$$

Thus, the transaction matrix T can be divided into *layers* according to the Eulerian power series, where the first three layers are given here as an example:

$$T_0 = A < y > \tag{4}$$

$$T_1 = A < Ay > \tag{5}$$

$$T_2 = A < A^2 y >, \ etc. \tag{6}$$

These layer-matrices reflect the intermediary flows in monetary units (e.g., Mio. DEM) and are thus comparable to each other. If we then apply a filter F, equally defined, the effect of filtering entries smaller than F, can be interpreted with respect to the "economic significance" of that entry surpassing the Filter F according to Eq. (7)

$$t_{ij}^k \geq F \tag{7}$$

for any i,j with i,j = 1... n and k < n − 1, where F is a given filter level.

Thus, *adjacency* matrices W_k can be set up, corresponding to the matrices T_k by the process of *binarisation* (i.e., setting w_{ij}^k to 1, if the entry surpasses the Filter; 0 otherwise) which are the basis for the graph–theoretical analysis producing structural graphs (for more details see Schnabl (1994) or Appendix 2).

A process of scanning through the range of possible filter levels gives important hints to choose a kind of "endogenous" filter level f_{end} in order to determine the "correct" filtering level as sketched below. This results from two *divergent* structural features of the MFA procedure:

- *High filter levels* provide for a good structure, but reduce scope i.e. additional intermediary stages or *indirect* flows are depicted incompletely. This would result in a "flat" structure.
- *Low filter levels* however give sufficient scope in order to include intermediary stages but at the same time result in a reduced structural *differentiation* tending to include too many flows into the analysis

The *optimum* filter level obviously exists somewhere in the middle of the scanning range and is found by application of the "entropy"– information measure developed by Shannon. (Shannon & Weaver, 1949, for more details see Schnabl 1994). Thus with the endogenization of the filter a structural picture is achieved.

3.2. Quantitative Methods

As a representative quantitative Method two coefficients are adopted here, which Rasmussen(1956) developed originally to clarify the role of each sector in the process of development. One is the *power coefficient* of dispersion, which is defined as the column sum of Leontief's inverse matrix $(I-A)^{-1}$ for each sector divided by the average of column sums, where b_{ij} is the ij–th element of the Leontief inverse matrix.

It expresses how much production is induced in the total of all sectors against the average (being supposed to be 100) when *one* unit of final demand has been caused to a certain sector. When the power coefficient of sector j (U_j) is greater than 100 , sector j is assumed to have a stronger power of dispersion than the average, and vice versa.

$$U_j = \sum_i b_{ij} / \left[\left(\sum_{ij} b_{ij} \right) / n \right] \times 100\,(\%) \tag{8}$$

Another measure is the *sensitivity coefficient* of dispersion, which is defined as row sum of Leontief's inverse matrix for each sector divided by the average of row sums. This is the coefficient expressing how much the production is induced in each sector against the average of all sectors (being supposed to be 100) when one unit of final demand has been caused to *every* sector,

$$V_i = \sum_j b_{ij} / \left[\left(\sum_{ij} b_{ij} \right) / n \right] \times 100\,(\%) \tag{9}$$

When the sensitivity coefficient of sector i (V_i) is greater than 100, sector i is assumed to be more *sensitive* to other sector's production.

Though each of both coefficients expresses a kind of *efficiency* with regard to the inducement of production stimulated by *one* unit of final demand, we can also estimate the actual effects on outputs when we multiply *actual* final demand from right hand side of b_{ij}. Instead of considering power and sensitivity coefficient of dispersion by Rasmussen, here we define and analyze the next two coefficients called *actual power coefficient* (U'_i) and *actual sensitivity coefficient* (V'_j) reflecting the differences of final demand.

$$U'_j = \sum_i b_{ij} y_j / \left[\left(\sum_{ij} b_{ij} y_j \right) / n \right] \times 100\,(\%) \tag{10}$$

$$V'_i = \sum_j b_{ij} y_j / \left[\left(\sum_{ij} b_{ij} y_j \right) / n \right] \times 100\,(\%) \tag{11}$$

where y_j is the j'th component of the final demand vector. Thus the *actual* power and sensitivity coefficient do not only contain information of input relations but also *integrate* information contained in the final demand vector y.

4. Results

4.1. Results of the MFA-Analysis

The MFA develops a graph showing the most *relevant* sectoral connections within an economy. In these figures the relevant sectors are given as circles labeled with a 3-letter symbol which are ordered according to a *centrality* coefficient, calculated as a ratio of input- and output relations from the graph-theoretical matrices (cf Appendix 2)[4]. Arrows denote a *unilateral* delivery, fat lines a *bilateral* link between two sectors.

Dotted lines (whether arrows or fat lines) signal that there is that type of connection just *one* filter level *below* the endogenous filter level f_{end} which we can read from the signature on the lower right side of each graph: e.g., in Fig.2a this signature reads "G 8054.A/d13" the last figure, which is "13" tells us that the endogenous filter level (f_{end}= 13, i.e. the 13th scan level of overall 50 scanlevels) and the marginal filter level therefore 13 − 1 = 12 which applies, here to the connection WTR=Cst (Wholetrade→Construction). Within the signature the "G" here stands for Germany (as the "J" for Japan in all graphs of Fig. 1). The next two digits tell the year (80=> 1980) the following two the aggregation level (54 sectors for all tables). The "A" says that we deal with the actual final demand y in absolute amounts, as given in the IO table of that year, in order to derive the structure. An alternative, which however is *not* used here, would be to apply a *synthetic* y–vector 1 (y = [1,1,....1]) instead of the *actual* y–vector. This delivers a so–called *standard–structure*, determined only by the input coefficient matrix A which then reflects "technical" relationships (as analog of the Rasmussen coefficient of eq. (8) and (9), while the *actual structure* used here rather reflects "economic" relationships, which better fit our goal of analysis, i.e. to elucidate possible pattern of *economic evolution*. This goal seems also to better supported by using the Power–coefficients of Rasmussen according to eq. (10) and (11). Since the integration of actual final demand into the analysis is in absolute currency units it seems also more apt to use IO–tables in *current* prices instead of tables in "constant" prices.[5]

4.1.1. STRUCTURAL DEVELOPMENT OF JAPAN 1980 – 1995

The graphs for Japan are given in Figs. 1 *a* to *d* for the years 1980 to 1995 in steps of 5 years. For a systematic approach to the question whether there are common patterns of structural development this should already be a time–span long enough for first conclusions since longer time spans also tend to bring up problems in the consistency of the database.

It is quite useful to arrange the results according to the typical location of sectors (source, centre or sink position[6], cf. Appendix 2) and with respect to the type of linkage (unilateral/bilateral). The *bilateral* links deserve special attention because they form a kind of "*growth– dipole*": Due to the fact that there must exist relatively large input–coefficients a_{ij} and a_{ji} in order to make a certain *bilateral* connection *ij* show up as relevant (e.g., a rise in the final demand of sector *i* would cause a rise in the output of sector *j* which would reflect back to the first, because of its larger than average connection), this *feedback* defines an eminent local *non–linearity* and thus also potential growth dynamic of these sectors within the IO–system which reflects high sensitivity to exogenous as well as "internal" growth impulses (Cf. also the above arguments for

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[4] The reader not familiar with MFA and iths method of derivation of a structural graph is recommended to switch to Appendix 2 before continuing.

[5] Moreover for Germany the FSO did not publish IO–tables based upon 70ESA(68SNA) in constant prices so that the statistical basis is lacking.

[6] Due to the so–called sectoral centrality coefficients c_j, $c_j \in [0,..,2]$, which are a well suited transform of the ratio of overall outflows to inflows of each sector, giving a sector a higher c_j if it has more outflow than inflow connections and vice versa, (see also Appendix 2). This projection interval was roughly divided into 3 ranges, 0 to 0.7("source"), 0.7 to 1.3 ("centre") and 1.3 to 2 ("sink"), where the centre–sectors are characterized in the graphs by *fat* circles.

Tablel: Locations of relevant sector for Japan 1980-1995

YEAR	Souce sectors	Centre sectors	Sink sectors
J1980	Agr, Edu, Msv Tsp, Cfl	WTr, Rnt, Rst RTr	ElM, Mch, Fod, Cst Gov
J1985	Agr, Edu Rst	WTr, Rnt MSv ElM	Mch, Fod, Cst, RTr, Gov
J1990	Agr, Edu, MSv	WTr Rst ElM	Mch, Fod, Cst, RTr, Rnt
J1995	Agr MSv	WTr Rst Edu Fod	ElM Cst, RTr Rnt

both *actual* Rasmussen coefficients of eq. (10) and (11)).

In order to ease the task to follow the developmental *changes* between the graphs we concentrate the information in a synoptic table (Table 1).

The grouping of columns is defined as follows: Sectors are displayed in *columns* if they occur in the same category over several years. If a sector appears or totally vanishes like Tsp (Transport) in the group of source sectors for 1980, it is given in *italics* in a second line. If a sector consistently belongs to the relevant sectors, but changes the category, like *Edu* (Education) which is missing 1995 in the sourcing sector's group, it is shown in a second line at the appropriate side (*Edu*, left position in the last line of the category "Centre" for 1995).

As we can see from table 1, the group of *source* sectors is quite consistent over the timespan of 15 years with respect to the sectors Agr (Agriculture), *Edu* (Education and Research) and *MSv* (Market Services). The sector *Cfl* (Casting/Forging Iron) vanishes after 1980 like *Tsp* does. A change between *categories* is given with the sectors *Rst* (Restaurants), most frequent position in "Centre" and *Edu* (changes to Centre in 1995)

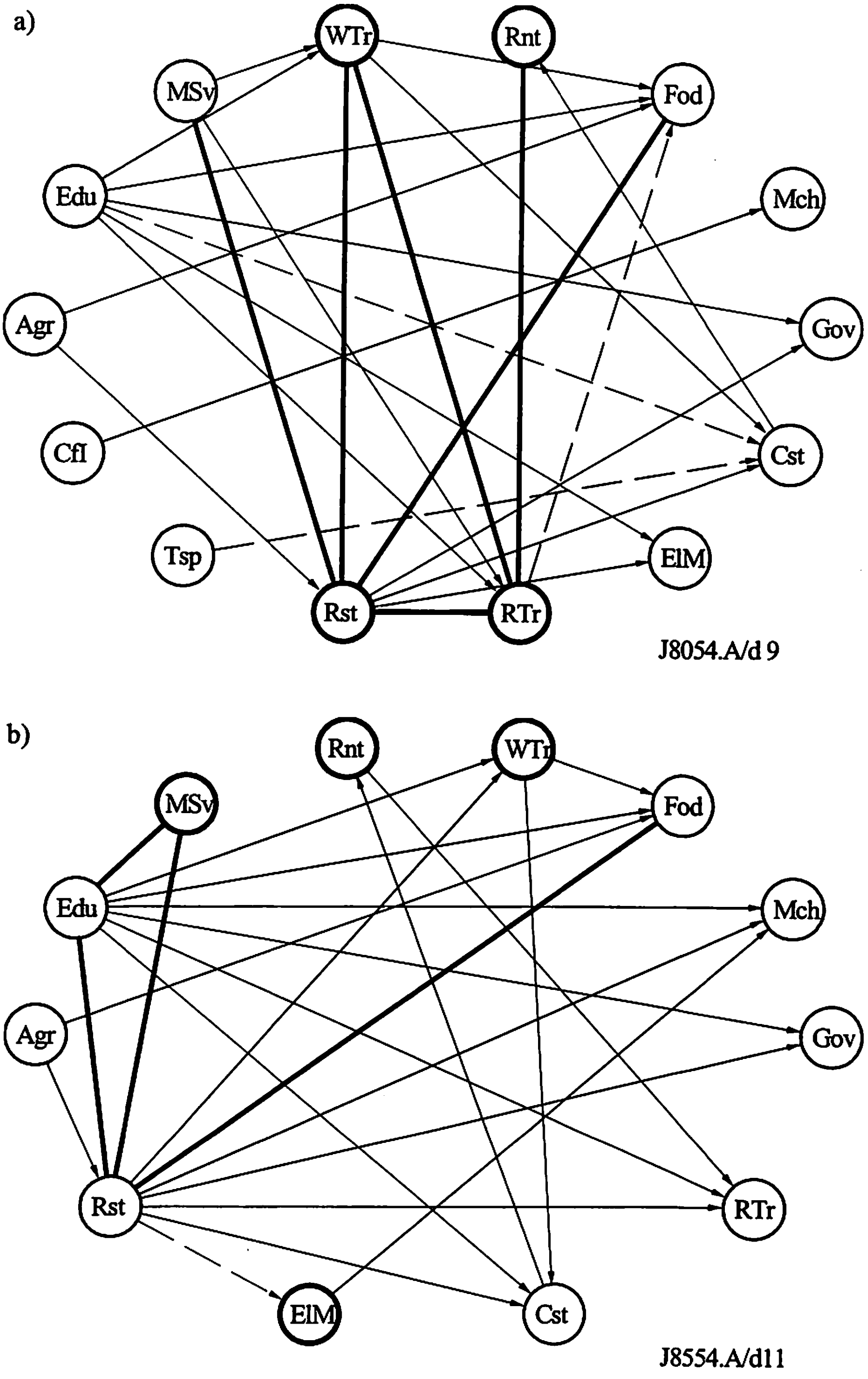
The stable *Centre-group* consists of the sectors *WTr* (Whole Trade), RSt (Restaurants, only 3 tables/years) while *Rnt* (Renting) and *ElM* (Electrical Machinery) both only show up for two years. Both sectors reside in the other years in the category "Sink sectors". In 1985 *MSv* (Market Services) changed once from source to centre and in 1980 *RTr* (Retail Trade) seems to be "falsely" allocated to centre while its normal position is "sink".

The stable *sink*-sector group consists of *Cst* (Construction), for all 4 years, *Mch* (Machinery), *Fod* (Food), *RTr* (Retail Trade) for 3 years and the sectors *ElM* (Electrical Machinery), *Rnt* (Renting) and *Gov* (Government Services) for only 2 years.

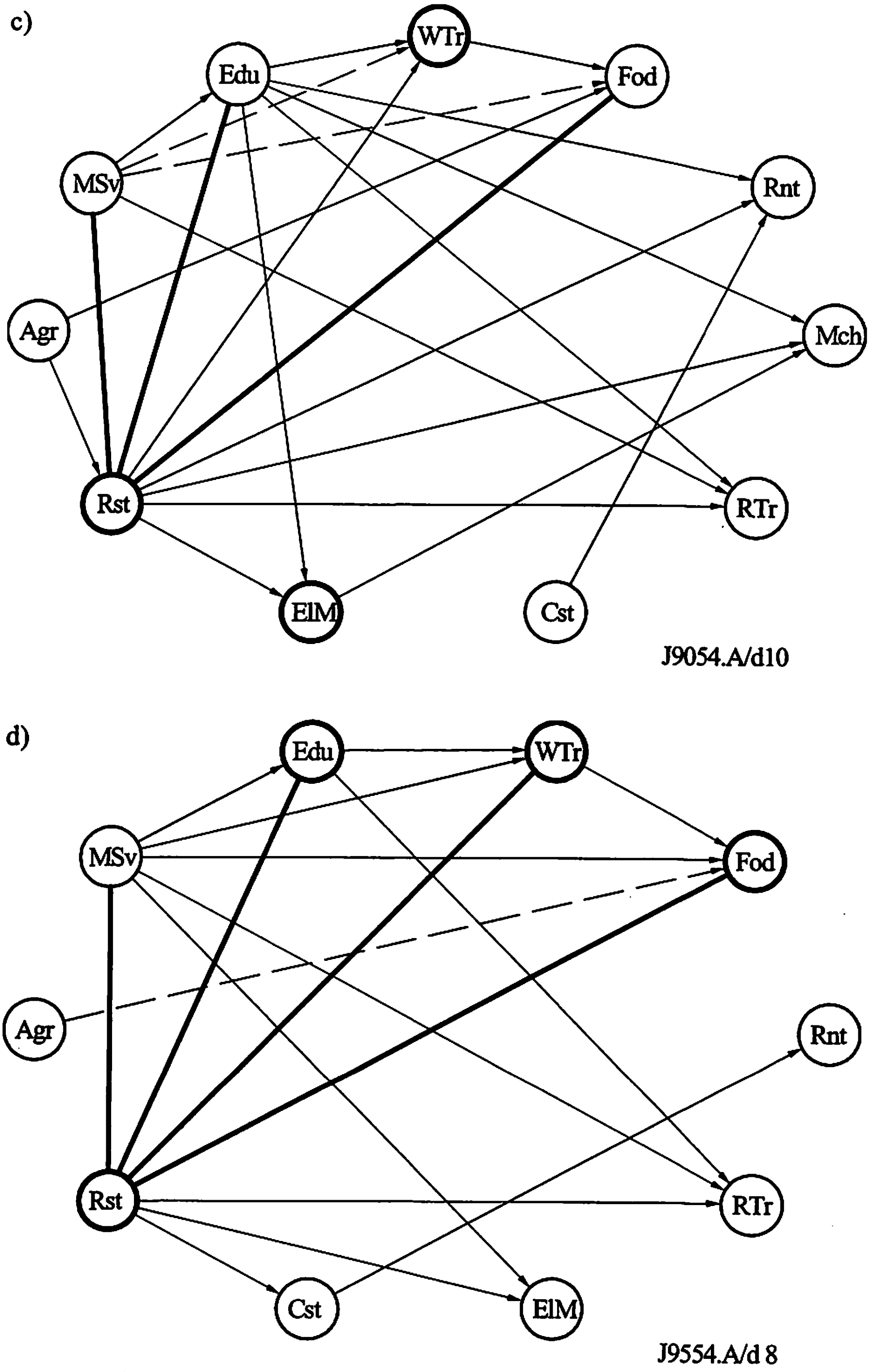
Besides the fact whether a sector belongs to a certain category within the structure or not – which means that it is interpreted "not relevant" with respect to the endogenous filter level f_{end} – there is a differentiation of *links*, with respect to their existence as well as their strength.

A thorough analysis of all links would transgress the given limited space. Most of them are very plausible like *Edu–ElM* (Education/Research – Electrical Machinery), some are less expected, like *Edu–WTr* (Education/Research – Whole Trade). Most interesting, however, are the so-called *bilateral* links, depicted as *fat* lines, which reflect

Figurel a,b: Characteristic Stracture of Japan 1980 (a) and 1985(b)



Figurel c, d: Characteristic Stracture of Japan 1990 (c) and 1995(d)



an underlying growth-dipole. These can form a *bilateral chain*, like *MSV=Rst=RTr=Rnt* in 1980 (Market Services=Restaurants=Retail Trade=Renting), where bilaterality is signaled here by "=". Even more interesting, however, is the formation of a *feedback loop* of bilateral links into a *bilateral triangle*, like *WTR=Rst=RTr* in 1980 or *RST=Edu=MSV* in 1985. Another type of superstructure of bilateral links is the "spider". It can be seen in Fig. 1c and d, with *Rst=(MSv,Edu,Fod)* for 1990, enhanced to *Rst=(MSv, Edu, WTr, Fod)* in 1995, because of the simple unilateral link *Rst*→*WTr* of 1990 turning into a bilateral one in 1995. This, by the way, shows, how the evolution into new types of structure could be expected: There seems to exist some inherent dynamic that *strong links* tend to grow. If they don't, as with the degeneration of a bilateral link *Edu=MSv* into a *simple* arrow *MSv*→*Edu* in 1990, this might have technological reasons. In either case it is a hint for the structurally oriented economist to look closer into the history (see also Schnabl 2000).

In summary we can state, that the bilateral superstructure of Japan for the whole 15 years is given by a *bilateral spider* around the sector *Rst* (Restaurants) which changes sometimes into a structure of ephemeral bilateral triangles connected to it.

4.1.2. STRUCTURAL DEVELOPMENT OF GERMANY 1980 - 1995

The graphs for Germany are given in Figs. 2 a - d for the years 1980 to 1995 like for Japan. The German reunification of 1990 is questioning full comparability of the German 1995 table with respect to its predecessors, because it is the first table which was established for the whole economic area of Germany, which already implies a change in the statistical basis. Thus we have to bear in mind that this table may probably include a structural break. On the other hand it puts the interesting question whether this break in the economic system shows up in the *structure* of the 1995-table if compared to the former tables of the pure "western" German economy as well as to the development of Japan at the same time. By this comparison we should get interesting hints whether the western German economy was simply "swallowing" the much smaller economy of the former GDR(roughly 1/4 of the western German size) or whether distinct changes in the "new" overall structure are emerging.

We again summarize the positions of sectors according to the categories source, centre and sink in Table 2 and discuss changes and structural cores.

The stable group of *source* sectors consists of the sectors *MSv* (Market Services, all 4 years) and *WMn* (Wood Manufacture, for 3 years). The sectors *Moi* (Mineral Oil) as well as *NfM* (Non ferrous Metals) and *Bev* (Beverages) are a group member only in the 1980 and 1985 table. *Edu* (Education/Research) shows up only in 1985. Sectors changing in-between categories are *Pls* (Plastic), *Cfl* (Casting /Forging Iron), *WTr* (Whole Trade), *Tsp* (Transport) and *Agr* (Agriculture) - which is a main source sector in Japan - was located in the centre group until 1985.

The stable *centre-group* consists of the sectors *Rnt* (Renting, 4 years) and - for only 3 years - *Chm* (Chemistry). The sectors *Pls* (Plastic products), *Tsp* (Transport), *Cfl* (Casting/Forging Iron) and *WTr* (Whole Trade) reside only in the first two tables in the centre position while *ElM* (Electrical Machinery) and *Gov* (Government services) belong to the centre for the last two years. It is, however, clear that - due to the "hard" thresholds (0.7 and 1.3 for centrality coefficients, cf. Appendix 2) - there will occur some change between the categories if a sectors resides close to one of the

Figure2 a,b: Characteristic Structures of Germany 1980 (a) 1985 (b)

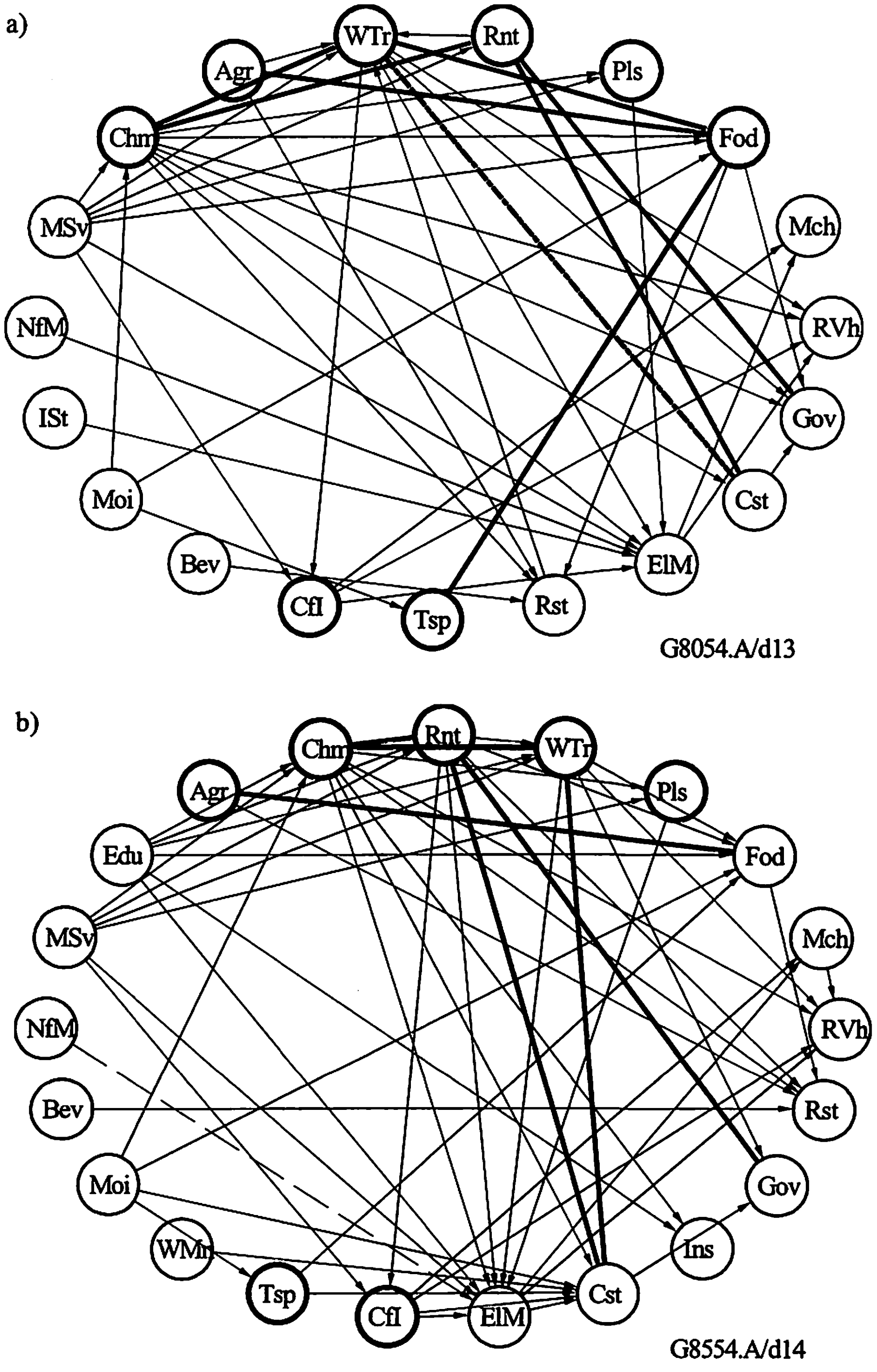


Figure2 c,d: Characteristic Structures of Germany 1990 (c) 1995 (d)

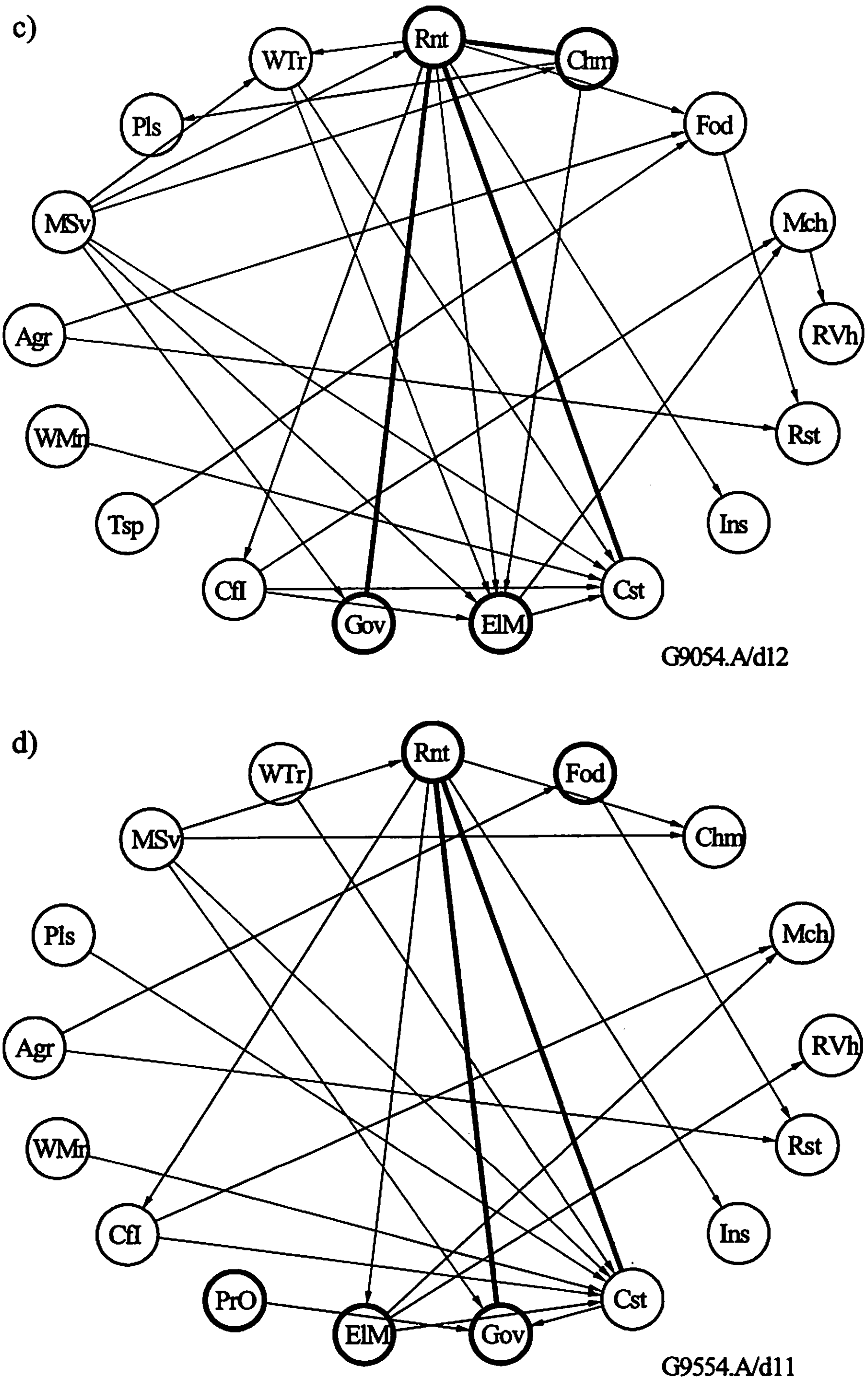


Table 2: Locations of relevant sectors for Germany 1980-1995

YEAR	Source sectors	Centre sectors	Sink sectors
G1980	Moi,NfM Bev,MSv ISt	Chm, Pls, Cfl, WTr, Rnt, Tsp Agr, Fod	Mch,RVh,ElM Cst,Rst Gov
G1985	Moi,NfM,WMn,Bev,MSv Edu	Chm, Pls, Cfl, WTr, Rnt, Tsp Agr	Mch,RVh,ElM,Fod,Cst,Rst,Ins,Gov
G1990	Agr WMn MSv Pls, Tsp, Cfl,WTr	Chm Rnt ElM Gov	Mch,RVh Fod,Cst,Rst,Ins
G1995	Agr WMn MSv Pls Cfl,WTr	Rnt ElM, Fod, Gov, PrO	Mch,RVh Cst,Rst,Ins Chm

thresholds, while the whole pattern of *relevant* sectors remains quite stable over the whole time.

The stable *sink*–group consists of the sectors *Mch* (Machinery), *RVh* (Road Vehicles), *Cst* (Construction) and *Rst*(Restaurants) for *all* of the tables while *ElM* (Electrical Machinery), *Fod* (Food) and *Gov* (Government Services) reside there only for 2 years.

The analysis of *links* shows again, that most of them are quite plausible like *Agr* →*Rst* (AgricultureRRestaurants) or *NfM*→*ElM* (Nonferrous Metals→Electrical Machinery). It would however take too much space to analyze them all systematically. Much more interesting, are, as we already know, the so–called bilateral links, given by fat lines, which reflect underlying growth–dipoles. These can form a bilateral chain, like *Agr=Fod=Tsp* (Agriculture=Food=Transport), where bilaterality is signaled by "=". An even more interesting *superstructure* like the *bilateral spider*, is given by *Rnt=* (*Chm,Gov,Cst*) in 1980 and 1985 which is weakened a bit in 1990 and degenerates to a chain in 1995. The German structure does not contain any bilateral *triangles*. Besides the above mentioned spider there exists only one other spider around Fod (Food) in 1980 – which again degenerates in the following years – and some bilateral *chains*. This again shows, how the evolution into new types of structure can happen: Against the expectation that some inherent dynamics of strong links stimulates them to grow and to extend, the spider around *Fod* (Food) *degenerates* into the bilateral chain *Agr= Fod*. If this happens, as with the degeneration of the link *Tsp=Fod* into a *simple* arrow *Tsp*→*Fod,* this might be due to the effect of *income elasticities* below unity which weaken the growth of certain sectors like Agriculture or Food (*Agr* or *Fod*) (Schnabl 2000). In either case it is a hint for the structurally oriented economist to look closer into the data.

In summary we can state, that the *bilateral* structures of Germany mostly consist of *bilateral chains* in addition of two "*spiders*", one around *Fod* (Food) which vanishes after 1980 and one around *Rnt* (Renting) which is stable until 1985 and degenerates into a bilateral chain afterwards. In contrast to that, Japan's prominent spider was around the sector *Rst* (Restaurants) which was accompanied by ephemeral bilateral triangles. Besides the PrO–sector (Private Organisations) coming into the picture in 1995 and *Tsp* vanishing from the scenery, there seems be no fundamental change in the structure of "whole" Germany compared to the western structure before the 90s.Thus we interpret that there was rather an assimilation of the former GDR economy into the larger western German economy than the expected structural break which could well be expected due to fundamental historical change which the reunification of at the end of 1990 meant.

4.1.3. Summary of MFA-Analysis

We could achieve more generalization if we try to integrate the previous Tables 1 and 2 into a synopsis. Table 3 summarizes the above findings sorted by the *corresponding* years. The table uses the following conventions: Sector symbols (e.g. *Agr*) are located in the same *column* if a sector is found more than once in the same group, however if changing position *between* categories it is written in a second line on the side where one could expect the standard category. If we only display the sectors which *both* countries *share* at least in one year, we get Table 3. This however, can imply to lose even an important sector like Chm (Chemistry) for Germany.

It turns out, that certain sectors share the same category within years and countries, like *Agr* (Agriculture), *MSv* (Market Services) and to a certain extent, *Edu* (Education/Research) in the source-sector category. If such a sector shows up 5 times or even more it is printed in bold letters. In the case of centre-sectors these are the sectors *WTr* (Whole trade) and *Rnt* (Renting). For the sink-sectors it is the sectors *Mch* (Machinery), *RVh* (Road Vehicles), *Fod* (Food) and *Cst* (Construction). Thus the typical common *source* sectors in both countries are *Agriculture* and *Market Services*. The sectors *Wholesale trade* and *Renting* represent the *centre* group and *Machinery*, *Road Vehicles*, *Food* and *Construction* the typical *sink* sectors.

Moreover, for Germany, we saw that he axis *Agr=Fod=Rst* ("food-backbone") was weakening during the 15 years of observation and finally changing into a unilat-

Table 3: Japan/Germany Synopsis of 1980-1995

YEAR	Source sectors	Centre sectors	Sink sectors
J1980	**Agr,Edu,Msv** Tsp	**WTr,Rnt** Rst	**ElM,Mch,RVh,Fod,Cst** Gov
G1980	**MSv**	**WTr,Rnt** Agr, Tsp Fod	**ElM Mch,RVh** Cst,Rst,Ins,Gov
J1985	**Agr,Edu** Rst	**WTr,Rnt** MSv ElM	**Mch** **Fod,Cst** Gov
G1985	**Edu,MSv**	**WTr,Rnt** Agr, Tsp	**ElM,Mch,RVh,Fod,Cst**,Rst,Ins,Gov
J1990	**Agr,Edu,MSv**	**WTr** ElM Rst	**Mch** **Fod,Cst** Rnt
G1990	**Agr** **MSv** Tsp WTr	**Rnt** ElM Gov	**Mch,RVh,Fod,Cst**,Rst,Ins
J1995	**Agr** **MSv**	**WTr** Edu Fod,Rst	ElM **Cst** Rnt
G1995	**Agr** **MSv** WTr	**Rnt** ElM,Fod Gov	**Mch,RVh** **Cst**,Rst,Ins

eral connection, whereas a strong bilateral spider–position was built up and kept stable until 1995 around the sector *Rnt* (Renting). In Japan the "food–backbone" was represented by the *Fod=Rst* link which turned into a spider position around the sector *Rst* (Restaurants/Hotels).

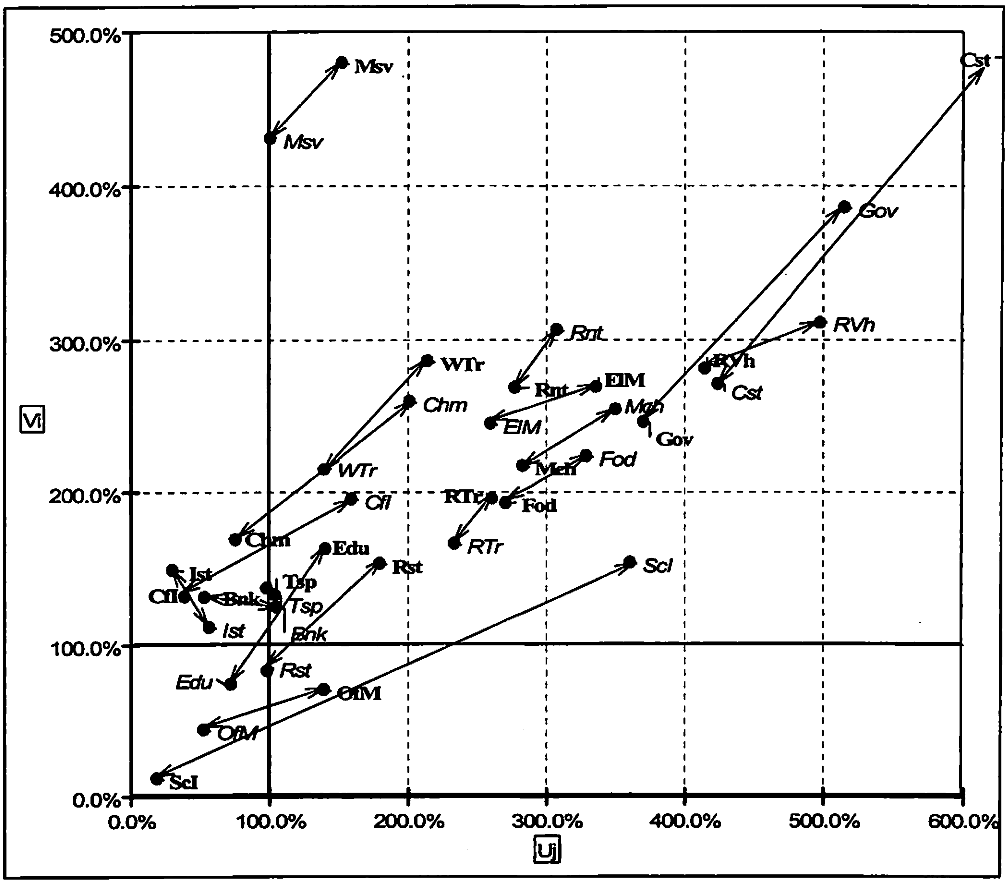
Table 3 hints to certain structures (like the food–backbone) that favor the existence of common pattern of development on the one hand and certain peculiarities of the countries on the other hand which can only be interpreted against the background of the economic or technological history of that country (cf. also Schnabl 2000). Examples for the latter are the *Mac* (Machinery) and *RVh* (Road vehicles) sectors for Germany and Japan that are known as prominent export industries of both countries.

4.2. Results of the Quantitative Analysis

4.2.1. Comparison in 1990

We compare the *actual* power and sensitivity coefficients that reflect also the differences in final demand 1990 between two countries using U'_j and V'_i calculated from Eq.(10) and (11).The results are given in Fig. 3. The sectors can be classified into *four* quadrants according to the fact whether the two coefficients exceed 100 % or not. Actually, there are only few sectors in Quadrant 3 ("south–west") since we took only the most prominent 20 sectors for display, the other 34 would have smaller coefficients.

Fig. 3: Actual sensitivity vs. power coefficients for 20 sectors (bold letters: Japan)



These Q3–Sectors are Education/Research (*Edu*), Office machines (*OfM*) and Restaurants (*Rst*) for Germany and Social Insurance (*Sci*) for Japan (*bold letters* denote Japanese sectors). Most of the sectors are in the Quadrant 1 (Q1, "north–east"), which shows sectors more influential and sensitive than the *average*. Q1–sectors in principle follow a similar principle of selection like MFA, however while here the average (= 100% at the scales) is taken as *criterion*, MFA endogenizes the criterion (f_{end})which is thus determined by the *inherent* data structure, while it is set exogenously (100% = average !) for the Rasmussen coefficients.

As Fig. 3 shows, sectors located in Quadrant 1 for *both* economies such as *RVh* (Road vehicles), *Cst* (Construction), *ElM* (Electric machinery), *Fod* (Food), *WTr&RTr* (Wholesale and Retail Trade), *Rnt* (Renting of immovable goods) and *MSv* (Market services) are *already* well known from our MFA results (see also synopsis in Table 3).

There are only a few sectors, which are "with the feet" in one quadrant and "with the head" in another, like *Chm* (Chemical products), *Cfl* (Casting/Forging Iron), *Edu* (Education/Research). If we interpret a more "north-easterly" position as "more dynamical" in its power (or sensitivity), we see that sometimes Japan is "dominant" (*Cst*, *ElM*, *RTr*, *WTr*, *Edu*, *MSv* and *Rst*) while in the other cases of Q1–sectors Germany seems to be "first" (*Gov*, *Mch*, *Rnt*, *Chm* and *ScI*). For each of both countries some of the sectors are well known as "power sectors" (like *ElM* or *Edu* in Japan or *Gov*, *ScI*, *Chm* and *Mch* in Germany), so that – if the interpretation is correct – the pictures of Fig. 3 possibly could tell us something about development differentials also between both countries. A tentative interpretation would be that in 1990 Japan had transformed itself into a service oriented economy to a higher extent than Germany. We leave this argument to interested researchers.

4.2.2. Structural Change from 1980 to 1995

Let us also consider the *intertemporal* changes of these actual coefficients since 1980 by Table 4 and 5, in which 20 sectors with highest coefficients (in 1995) are arranged. It is apparent from the tables that most of the sectors listed here are common in both countries.

There are also some exceptions such as *ScI* (Social insurance), *OfM* (Office machines), *Cfl* (Casting/Forging Iron) etc. As to Table 4, *the actual power* coefficients are intertemporarily rising in *Rnt* (Renting of immovable goods), *MSv* (Market services), *PrO* (Private non–profit Organizations), *Tsp* (Transport services), *Bnk* (Financial services) in both countries, though there are some differences in the levels of the coefficients such as in the case of *PrO* (Private non-profit Orgs). On the other hand, *Fod* (Food) and *Chm* (Chemical products) are sectors whose actual power coefficients are usually decreasing. The reverse tendency can be found in the case of *WTr* (Wholesale Trade) and *Ins* (Insurance).

Table 5 shows that most of the 20 highest *actual sensitivity* coefficients are quite common between both countries, though there are again some exceptions such as *ScI* (Social insurance), *Moi* (Mineral oil products), *ElP* (Electric power) and *ISt* (Iron & Steel). The coefficients of *MSv* (Market services), *Rnt* (Renting of immovable goods) and *Tsp* (Transport services) are rising more and more. On the other hand, *Fod* (Food) and *Chm* (Chemical products) show decreasing coefficients as it was the case with actual power coefficients. Also the actual sensitivity coefficients of *Ist* (Iron & steel) in

Japan and *Moi* (Mineral oil products) in Germany are decreasing gradually. As to the *Rst* (Restaurants/Hotels), the reverse tendency can be found between the two countries, i.e. the coefficient is increasing in Japan whereas it is decreasing in Germany.

Table 4: Highest 20 Sectors of Actual Power Coefficients in %

	Japan						F.R.G.				
	Sectors	1980	1985	1990	1995		Sector	1980	1985	1990	1995
38	Construction	1059,9	870,4	1037,1	924,3	38	Construction	526,2	400,4	424,6	551,4
52	Government serv.	373,4	388,6	370,7	441,4	52	Government serv.	547,2	534,6	515,1	546,8
21	Road vehicles	376,6	388,7	415,1	344,8	53	Social insurance	360,2	367,9	360,9	446,5
47	Real estate/renting	242,2	257,1	277,7	338,8	21	Road vehicles	358,1	429,1	498,2	444,3
24	Electric machinery	290,8	368,4	336,3	319,2	47	Real estate/renting	262,9	301,2	308,0	399,4
40	Retail trade	268,0	294,7	261,4	280,7	35	Food	406,2	365,8	329,4	271,9
39	Wholesale	168,1	183,0	214,7	262,9	19	General machinery	316,7	313,1	350,4	256,4
35	Food	340,8	323,9	271,2	241,3	40	Retail trade	245,3	228,2	234,0	236,0
19	General machinery	243,5	271,5	283,4	241,2	24	Electric machinery	221,1	225,3	260,2	231,6
51	Other market serv.	149,7	156,1	152,7	224,6	9	Chemical products	199,5	232,2	201,7	188,4
48	Hotel and restaurant	187,4	182,0	180,1	218,9	18	Metal products	169,6	158,1	159,7	145,2
54	Private non–pr. Serv.	119,2	125,8	135,6	174,1	51	Other market serv.	103,6	104,3	101,2	117,5
50	Health/Medical serv.	167,1	177,0	151,2	172,8	39	Wholesale	139,6	149,7	139,9	114,9
20	Office machines	52,4	108,4	139,7	118,2	44	Other tranport serv.	78,5	87,9	104,4	109,2
44	Other tranport serv.	86,8	83,8	98,4	114,3	45	Financial services	76,0	99,3	105,2	108,6
49	Research/Education	67,1	90,3	140,6	112,2	48	Hotels/Restaurants	114,2	108,8	98,7	98,2
34	Wearing apparel	83,6	88,6	81,0	75,4	46	Insurance	53,3	65,4	71,5	88,8
9	Chemical products	90,8	87,2	76,0	75,1	28	Wooden products	92,5	68,8	79,1	83,6
45	Financial services	45,5	52,9	54,0	64,1	49	Research/Education	69,9	76,7	72,8	80,1
46	Insurance	50,4	62,8	62,4	56,8	54	Private non–pr. Serv.	40,7	42,7	61,4	76,9

Table 5 : Highest 20 Sectors of Actual Sensitivity Coefficients in %

	Japan						F.R.G.				
	Sectors	1980	1985	1990	1995		Sectors	1980	1985	1990	1995
51	Other market serv.	368,8	434,3	479,3	520,2	51	Other market serv.	286,3	335,7	430,3	562,0
38	Construction	480,5	414,3	518,3	479,7	52	Government serv.	410,3	400,0	385,3	417,7
39	Wholesale	266,0	245,8	285,7	344,7	47	Real estate/renting	225,2	262,9	306,1	380,7
47	Real estate/renting	231,4	253,1	268,3	328,5	38	Construction	323,1	253,8	270,6	365,6
52	Government serv.	241,7	253,7	245,7	288,8	21	Road vehicles	230,0	266,0	310,5	287,5
24	Electric machinery	194,8	263,2	268,9	259,1	9	Chemical products	260,7	295,0	259,2	216,6
21	Road vehicles	228,3	255,5	280,7	251,4	24	Electric machinery	195,9	207,8	244,6	207,2
40	Retail trade	207,7	212,4	195,1	212,9	39	Wholesale	215,3	214,7	214,7	207,0
19	General machinery	179,8	198,4	217,3	183,1	19	General machinery	225,2	227,2	254,1	194,0
48	Hotel/Restaurants	141,3	150,5	152,8	176,8	53	Social insurance	151,1	154,5	153,2	190,1
35	Food	212,9	213,0	192,2	169,2	35	Food	273,7	247,9	223,6	184,8
44	Other tranport serv.	109,9	125,9	136,8	159,9	40	Retail trade	174,6	164,0	165,6	170,5
45	Financial services	106,4	128,9	130,9	155,8	18	Metal products	194,0	175,8	194,9	168,2
9	Chemical products	196,7	185,7	168,4	154,3	44	Other tranport serv.	115,9	125,8	131,9	135,7
49	Research/Education	90,3	129,3	162,3	150,2	45	Financial services	105,1	129,5	124,6	129,4
18	Metal products	136,3	121,1	131,2	135,2	54	Private non–pr. serv.	63,1	67,6	83,9	100,4
54	Private non–pr. serv.	63,3	71,1	77,6	103,8	50	Health/Medical serv.	77,1	76,4	77,8	94,0
50	Health/Medical serv.	81,6	92,5	78,5	98,9	10	Mineral oil products	170,7	155,7	92,1	85,4
3	Electric power	92,5	100,8	79,2	91,7	49	Research/Education	58,6	68,1	73,6	84,4
16	Iron and steel	256,6	194,7	148,7	76,7	48	Hotels/Restaurants	87,6	84,2	82,4	82,2

4.2.3. Summary of Quantitative Analysis

As to the results of quantitative analysis carried out here, many similarities between the two countries could be found. The actual power and sensitivity coefficients of sectors that characterized both economies as export giants, such as Road vehicles, Electrical machinery, General machinery and so on, are higher than average. Besides, the influential power or sensitivity of services, such as Market services, Transport services, Financial services or Renting of immovable goods are increasing, reflecting the general trend versus a service-oriented economy.

The differences between Japan and Germany can be found in sectors such as Social insurance, Coal mining, Office machines and Research & Education that reflect the differences of economic tradition and circumstances, or in sectors such as Construction and Renting of immovable goods that reflect especially new circumstances after Reunification of Germany. In the latter case, though the actual power and sensitivity coefficients of these two sectors are always high in both countries, they rose drastically in Germany in the 90s.

5. Concluding Remarks

So far we have analyzed and compared the both economies of Japan and Germany qualitatively and quantitatively. Both analyses are mutually consistent to a high degree, as we have seen (integrating "actual" final demand information in *both* analyses which better reflect the overall effects of economic development than a purely technical oriented type of analysis) despite fundamental differences in both methodologies.

By the quantitative method, the effects on outputs by final demand are measured and expressed in a "portfolio"-figure which uses an "exogenous" threshold (100% = average) as criterion of differentiation between relevant and non relevant sectors. However the *linkages* between particular sectors are omitted here because of the complexity of implicit connections which are reflected in the coefficients of the Leontief Inverse B. To this type of problem, the *qualitative* approach of MFA is more effective and helps to reduce and elucidate the complicated relations in deriving not only a list of relevant sectors, quite similar to that of the quantitative analysis, but also plotting the connections between them and even specifying the type of connection (unilateral, bilateral). Another similarity between both methods is given by the Q1-sectors of the portfolio (Fig. 3).

In terms of the Rasmussen coefficients the sectors shown there have to be classified as relevant, and the more the more distant from the origin. Such a location implies a strong reaction to demand and fostering demand in the system at the same time. This puts a good comparability to the concept of a growth-dipole in MFA, as given in section 4.1.1. However, while the big actual Rasmussen coefficients refer to the *whole* IO-system, in MFA a growth-dipole always encompasses two sectors alone, as long as there does not exist a *superstructure* of the type of a bilateral *triangle or spider*, formed by several bilateral links. In this case however, the results of Rasmussen analysis and MFA will eventually tend to reflect the same, since several "big" sectors linked together will usually represent a great part of the whole IO-System.

While the above arguments show some similarities between both methods, it has to be pointed out also, that in the sense of qualitative/quantitative analyses they are quite different, albeit both are based on information given by the Leontief Inverse B. Here each method plays its own advantages given by its specialization. Thus MFA looks with a high degree of differentiation into the network of "connections" between single sectors and thereby – despite its quantitative "control" during the process of structurization–looses the quantitative overall picture, while the quantiative analysis better catches the overall relationships but cannot grasp "connections" between single sectors. Thus both methods are complementary in there results and therefore also should be used in this sense, which we have done here.

Since both results are well in line, the total result obviously reflects some basic property of *growth* in both countries which tentatively could be interpreted as both countries following a similar development route with respect to sectors which reflect overall "functional" economic activities like *Transport, Wholesale or Market Services* and general human needs like *Food, Restaurants or Renting* while options of technological specialization (as *Chemistry and Electrical Machinery*) show up as more differentiated between both countries. This is the more interesting as Japan and Germany have quite different histories and a different development of public institutions and of their economic system in political or societal terms.

References

Czayka, L. (1972) *Qualitative Input–Output–Analyse* (Meisenheim am Glan, Athenaum)

Eurostat (1979) *European System of Integrated Economic Accounts ESA*, Second Edition.

Harary, F. & Norman, R.Z. & Cartwright, D. (1965) *Structural Models: An Introduction to the Theory of Directed Graphs* (New York,London,Sidney, Macmillan)

Holub, H.W. & Schnabl, H. (1985) Qualitative Input–Output–Analysis and Structural Information. *Economic Modelling*, 2, pp. 67–73

Holub, H.W. & Schnabl, H. & Tappeiner, G. (1985) Qualitative Input–Output–Analysis with Variable Filter, *Zeitschrift für die gesamte Staatswissenschaft, 141*, pp. 282–300

OECD (1995) *The OECD Input–Output Database*, Paris

Rasmussen, P. N. (1956) *Studies in Intersectoral Relations*, Amsterdam.

Shannon, C.E & Weaver, W. (1949) *The Mathematical Theory of Communication* (Urbana, (Ill.), University of Illinois Press)

Schnabl, H. (1992) Analysis of Economic Structures Based on Connection Layers – a New Technique for Qualitative Input–Output–Analysis. *Jahrbücher für Nationalökonomie und Statistik, 209/5–6*, pp. 385–406

Schnabl, H. (1994) The Evolution of Production Structures – Analysed by a Multilayer Procedure, in *Economic System Research 6/1*: 51–68

Schnabl H. (2000) Evolutionary patterns of multisectoral growth dynamics. in: Commerce, complexity and evolution. Eds. W. Barnett et.al. Cambridge University Press, Cambridge, 2000, pp. 215–232

Schnabl, H. & Holub, H.W. (1979) Qualitative und quantitative Aspekte der Input–Output Analyse. *Zeitschrift für die gesamte Staatswissenschaft, 135*, pp. 657–678

Yoshinaga, K. (1996) Introducing, Recompiling and Analysing Input–Output Tables for Japan, *Kansai University Review of Economics and Business*, 25–1, pp. 1–60.

Appendix 1:Table of Sector–abbreviations

Agr	Agricultural Products	WMn	Wooden Manufacture
For	Forestry and Fishery	PPP	Pulp & Paper Products
ElP	Electric Power, Steam	PPr	Paper Products
Gas	Gas supply	Prn	Printing
Wat	Water	Lea	Leather Products
Coa	Coal Mining	Txt	Textiles
Mng	Mining Products	WAp	Wearing Apparel
Pet	Crude Petroleum	Fod	Food
Chm	Chemical Products	Bev	Beverages
Moi	Mineral Oil	Tob	Tobacco
Pls	Plastic Products	Cst	Construction
Rub	Rubber Products	WTr	Wholesale Trade
Stn	Stones, Clay	RTr	Retail Trade
Cer	Ceramics	RWy	Railway Services
Gls	Glass Products	ShT	Ship Transport
ISt	Iron and Steel	PTT	Post, Telecom
NfM	Non ferrous Metals	Tsp	Transport
CfI	Cast/forged Iron and Metals	Bnk	Bank Services
Mch	Machinery	Ins	Insurance
OfM	Office Machines	Rnt	Renting
RVh	Road Vehicles	Rst	Restaurants
Shp	Ships	Edu	Education and Research
ASC	Air– and Space Craft	Hea	Health Services
ElM	Electrical Machinery	MSv	Market Services
FMc	Fine Mechanics	Gov	Governments
MuS	Music and Sport Products	ScI	Social Insurance
Tmb	Timber	PrO	Private Organisations

Appendix 2: The MFA–method

In addition to the very short statements of designing principles of MFA, already given in section 3.1, we will give some more information on this method. Still more details can be found in (Schnabl 1994).

Starting with the development of layer matrices T_k derived from the IO–transaction matrix T (see section 3.1)

$$T_0 = A < y > \tag{a.1}$$

$$T_1 = A < Ay > \tag{a.2}$$

$$T_2 = A < A^2 y > etc. \tag{a.3}$$

Where k = $1,2,3,\ldots,n-1$ for a table of dimension n. This upper limit is on the one hand given by the graph-theoretical implication that in any graph of connected sectors, the longest *path* (=cycle–free connection between any two "sectors") can at maximum be of length n–1, given n sectors), on the other hand, we seldom end up at high k's because the basic filtering procedure of MFA, explained next paragraph, mostly stops at a lower k, because the A^k rather fast vanish and thus also T_k and their entries t_{ij}^k fall below a given filter F. Thus the filter level finally is limiting this extension because the creation of layers has to be continued only until no more entry suffices the minimal flow condition

$$t_{ij}^k \geq F \tag{a.4}$$

for any i,j with $i,j = 1 \cdots n$ and $k < n$. where F is a given filter (in currency units). It should be pointed out here, that due to the way of deriving the layer matrices, the T_k are in currency units, as used for the underlying IO–table (e.g Millions of DEM) and thus also filter F has the same dimension. This shows also that the design of MFA has a basic *economic rationale* since it compares "economic" flows in terms of *value* of deliveries between sectors which by the MFA–procedure are afterwards ordered *hierarchically* with respect to there size as well as depending on their *type* of "connectivity".

After calculating layers T_k, $k = 1, 2, 3, \cdots$, each entry t_{ij}^k in the k^{th} layer T_k is checked, whether condition (a.4) is valid, i.e., whether there is any information *relevant* for structure. Thus, the corresponding binary adjacency matrices W_k are obtained from the matrices T_k by the process of *binarisation* (i.e.,setting w_{ij}^k to 1, if the entry $t_{ij}^k > F$, else to zero). These adjacency matrices W_k are then used in a standard graph–theoretical design (Harary, Norman, Cartwright, 1965), in order to determine the *links* within the structure according to equation (a.5) and (a.6), where the matrix multiplication is done in a boolean (#) manner (i.e., 1+#1 = 1 for the step of addition during the matrix multiplication).

$$W^k = W_k W^{k-1}. \tag{a.5}$$

W_k is reflecting the connections of sectors of the length of k steps. Once the single power matrices W^k, $k = 1, 2, 3, \cdots$, have been determined, *condensation* of these power -matrices W^k to the so-called dependency-matrix D is done, again by boolean summation, according to eq. (a.6)

$$D = W^1 +\# W^2 +\# W^3 + \ldots\ldots +\# W^k \tag{a.6}$$

Where W^k is the *last* power matrix not already vanished, and k depending on the structure of the given IO table. In practical runs k mostly does not exceed k = 6, even for a table of dimension 54 as given here.

Thus an individual entry $d_{ij} = 1$ if and only if there exist direct *or* indirect links between sectors i and j (of any path–length < n) which *altogether* sum up to a value greater than (or equal to) the chosen filter level F. It has to be pointed out that a given filter F, is used in the filter condition according to equation (a.4) throughout *all* layer matrices. Therefore it is already clear at this point that the resulting structure, reflected in the matrix D depends on the filter F and thus raises the question *which* filter to use. We address this problem in the next paragraphs after finishing the description of the graph–theoretical procedure.

The next aim of this graph–theoretical derivation is to calculate the so–called *connexity –matrix* H, whose general term is :

$$h_{ij} = d_{ij} + d_{ji} \tag{a.7}$$

The connexity matrix H *qualifies* all connections by three indices, i.e., 0, 1, 2. This is an efficient standard graph-theoretical procedure in order to automatically label each sector with respect to his place within the total structural plot and degree of interconnectivity with others [cf. Harary et al. (1965)]. Individual values of h_{ij} denote the following:

h_{ij} = 0, sectors i and j are *isolated*;
1, a *unidirectional* link exists between sectors i and j; going from i to j
2, a *bilateral* (mutual) link exists between sectors i and j, i.e., the delivery flows between sectors i and j have at least the defined minimum F.

In order to find an appropriate filter F whose structure delivers a "characteristic" picture of the economy, the procedure described above is done *about* 50 times for 50 different equidistant scan levels of F, starting with $F_0 = 0$ (i.e. *no* filtering) to the *highest* possible filter F_h that would just let remain the last two *bilaterally* connected sector in the structure. This highest filter has to be found by some iterative process, but can usually be found directly by the smaller one of the two biggest entries in layer T_o (since all following layers $T_1,T_2,..$ usually – but not necessarily – will have smaller entries). The interval $[F_o..F_h]$ is then divided by 50 (this number could be changed but is a good compromise between having a scanning grid fine enough which however does not cost too much computer time). If we call the amount of equidistant filters *s* (for step) then we have

$$s = (F_h - F_0)/50 = F_h/50 \tag{a.8}$$

And for the *i*-th scan filter F_i :

$$F_i = i * s \qquad \text{with i = 0, 1, 2,.....50} \tag{a.9}$$

The question, *which* one of the 50 Filters F_i would be the "best", is tried to answer[7] by using the concept of *Entropy* or "information content" developed in information theory (Shannon/Weaver 1949) in applying the well known Entropy formula to the "alphabet" given by the three possible outcomes of h_{ij} (= 0,1,2) on each scan level F_i .

We then take the endogenized filter level f_{end}, as *that* scan level *i* of all F_i,. i = 1,....,50, where the Entropy E has its *maximum*, because this is the *most informative, richest* structure of isolated, unilaterally and bilaterally connected sectors. Therefore the expressions filter *level*, and filter *value* F_i designate the same cutting-off-threshold in a basic sense[8]). Sometimes the "Entropy-curve" (a plot of E against the scan level *i* , cf. Schnabl 1994) has a kind of *plateau* with no "distinct" maximum, then – in order to cut as few as possible sectors off – we take an *average* of the filter levels where

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[7] Each method has an inherent goal of research. Here it is to find *growth-centers* as local nonlinear feed backs within a rather linearly connected environment of sectors. This goal then is approached by a given method more or less effectively. Thus one can argue about this effectiveness, but one can hardly argue about the *goal* behind, because every researcher has the freedom to set his own goals. Qualitative methods like QIOA, Aroche's ICA etc. (like quantitative also) mostly have differences in their goals and consequently in their methodology.

(a) the ratio of unilaterally and bilaterally connected sectors is closest to 1 and
(b) the plateau of the Entropy–curve is "beginning"

This is a pragmatic approach to the practical problem of determining f_{end} .The resulting 50 single H–matrices of *each scan level* are then *cumulated* to the so–called H_{cum}–matrix, which is the starting point of extracting an "averaged" *overall structure* defined as the *characteristic* structure of the table under study [for more details, see Schnabl (1994)]. A transformation of the *ratio* of row sums and column sums of the H_{cum} matrix (eq. (a.10))

$$c_j = 1 + (rowsum_j - columnsum_j) / (rowsum_j + columnsum_j) \tag{a.10}$$

projects into the interval [0...2] and thus delivers the so–called *centrality coefficients* c_j for *each* sector (j = 1,2,..n) which are used to orient the resulting graph. Thus sectors are arranged according to the amount of their c_j and thus to the relationship of each sector between outgoing and incoming flows. E.g., sectors with only few or no "input–connections", function as a kind of *source* of the whole system and thus show a c_j=0 or close to it. They are ordered in the left part of the ellipse, those with a $c_j \sim 1$ in the *middle* (additionally characterized by a *fat* circle) and those with a $c_j > 1.3$ on the right side. Thus "source", "centre" and "sink" can be easily differentiated on the graph. The "flow direction" of deliveries is basically from left to right.

An additional differentiation in the setup of the graph is to fight the arbitrariness of a sharply set threshold. If – lets say – the process of finding the endogenous filter delivers an f_{end} = 9, the ninth Filter of 50, any flow in H_{cum} less than 9 would be ignored (i.e. set to zero). This is a hard cut for flows with an "8" in the H_{cum} matrix. In this case, in order to establish something like a gray–zone, we would also register flows with 8, i.e. *one* filter level below f_{end} and give it the same type of graphical connection (i.e. "arrow" if *unilaterally*, "fat line" without arrows if *bilaterally* connected, *but* in *dotted* lines. (in our results e.g. the connection WTr=Cst in Fig. 2a is of that type which means this bilateral connection would not be existent on the level f_{end} = 13 but only at filter level i = 12, *one* level *below* (last number in the signature "G8054.A/d13, which tells that this graph is for Germany (G), for the year 1980 (80) in a dimension of 54 sectors and based on "actual" final demand ("A") amounts as given in that IO table of 1980)

Sectors for which entries in H_{cum} do not reach f_{end} (or f_{end} –1) are "isolated" and are not shown at all in the elliptical plot, thus only *connected* sectors (of any type of connectedness) show up with their respective graphical representation (arrow or fat line, either solid or dotted).

Graphs give a good overview of structure but leave still some tasks of analysis of their content to the viewer. This is eased to some extent by setting up *tables* where the sectors are sorted in the 3 groups *source* (c_j<= 0.7), *centre* (0.7< c_j<= 1.3) and sink (1.3< c_j), a classification which divides the whole interval c_j ([0,...,2] into three almost equal ranges.

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[8] In order to differentiate the meaning of "filter" in a mathematically correct manner, we use throughout the paper the term f_{end} for the optimum, endogenized filter *level* (=a certain i of the 50 possible scan levels) which, however, corresponds to a certain filter value F_i (e.g. in Mio. DEM). Both, in pragmatic sense, denote the same thing.