On The Intertemporal Stability of Bridge Matrix Coefficients

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Abstract

An increasing number of input-output analysts use micro data from household surveys in order to model the consumption patterns of households as a function of other variables like prices, income, and socio-demographic factors. These surveys usually adopt a different classification (COICOP) than the input-output tables (CPA/NACE). A bridge matrix is required to convert the data from COICOP to CPA/NACE (and vice versa).

This procedure is unproblematic when a bridge matrix is available for the year(s) to which the model refers. If a model is used to construct forecasts or scenarios of the future a problem arises, because the coefficients relating consumption purposes and commodity groups may change over time. This problem has not been adequately addressed in the literature.

The present paper examines a time series of annual bridge matrices from 1991 to 2006 for Germany. It uses descriptive statistics, visualisations, and econometric techniques to identify trends and patterns in the development of coefficients over time. It concludes that modellers may treat many coefficients as (approximately) constant over time, but certain key coefficients are not constant and should receive more attention.

Keywords: Input-output model, consumption expenditure, household sector, bridge matrix.

Topic: 2. Methodological aspects in the input-output analysis.

1. Introduction

Input-output tables tend to focus heavily on the intermediate consumption of products by firms or industries and give little attention to the final consumption of products by households or government. This slightly lopsided perspective has become embodied in the open input-output model, where final demand is fully exogenous and the household sector is only a passive absorber of value added. Adjusting supply to demand, the statistical offices of most countries now produce input-output tables which describe in great detail the transactions between industries while offering very little detail on the transactions of the household sector. Usually there is only one column describing the final consumption expenditure by households and two rows that show the amount of wages and profits earned in each industry. Given this information it is possible to build models with a partly endogenous household sector, but only under the assumption of a 'representative' household.

Lately, however, a number of studies have highlighted the importance of differentiating the household sector, as notable differences between household groups have been observed. As the common input-output tables do not provide much information on the household sector, these studies have to find the required data elsewhere. The most important source of household information is, of course, a *household survey*.

Household surveys are performed routinely by public agencies in many countries. Using questionnaires and interviews, they collect information on the economic background (income, wealth, employment status etc.), various socio-demographic characteristics (age, gender, nationality of household members) and the consumption expenditure of households. This information makes it possible, for example, to estimate the saving rate and consumption patterns of households from different economic and socio-demographic backgrounds.

Using the information from household surveys in input-output models, however, can be more difficult than it seems, because the survey data are usually compiled according to the COICOP classification, which is different from the

CPA/NACE classification underlying most input-output tables. Therefore, a *bridge matrix* is required to convert data from COICOP into CPA or NACE. Such bridge matrices have been used in a number of recent papers, including Kronenberg (2009; 2010), Washizu and Nakano (2010), Druckman and Jackson (2010), and Mongelli et al. (2010).

In all these papers, a common assumption is implicitly taken for granted: The coefficients of the bridge matrix are assumed to be constant. This may not be entirely realistic if, for example, the relative prices of some goods change drastically or the analysis is conducted over a period of many years. It is possible that substitution effects and technological change (which may in reality be impossible to disentangle) lead to changes in these coefficients. For example, a bridge matrix that allocated expenditure on energy (COICOP code 045) over commodity categories such as gas (CPA code 11) and heating oil (CPA code 23), may be subject to change when the relative prices of gas and oil change, or when technological change (e.g. the installation of gas distribution grids) opens up new consumption possibilities. Therefore, one may wonder whether it is appropriate to assume constancy of the bridge matrix coefficients over time.

This question is related to the intertemporal stability of input-output coefficients, which has been studied by a number of authors (Dietzenbacher and Hoen, 2006; Gaiha, 1980; Sevaldson, 1969). The intertemporal stability of bridge matrix coefficients, by contrast, has not been studied extensively. Alcalá et al. (1999) have shown that such matrices can be subject to change over time, but they did not discuss the question whether these changes are statistically significant. The aim of the present paper is to determine whether the bridge matrix coefficients can be considered – from a practical viewpoint – as stable over time, and whether the failure to control for changes in bridge matrix coefficients in input-output models is likely to cause biased results. To this end the paper uses a time series of consumption allocation tables for Germany provided by the Federal Statistical Office (Destatis). The paper contributes to the literature on input-output modelling in general, and to that on forecasting and future scenario construction in particular.

In the following section, the series of consumption allocation tables for Germany is described, and the corresponding bridge matrix coefficients are defined and interpreted. In section 3, the bridge matrix for 2006 is described in some detail. Section 4 reports on the evolution of certain bridge matrix coefficients by plotting them graphically over the time period from 1991 to 2006. Section 5 presents the results of a time series regression analysis and shows the some trends are indeed statistically significant. Finally, Section 6 concludes.

2. Computing the Bridge Matrices

The bridge matrices that form the foundation of the present study were computed from data provided by Destatis in the framework of the German National Accounts. Destatis publishes input-output tables for Germany on an annual basis. The earliest of these tables refers to 1991, the year after German reunification. Older tables were published before that, but since 1990/1 marks a significant turning point in the economic history of Germany, it seems appropriate to use only tables from 1991 on. The most recent table refers to 2007. The national input-output tables always come with a set of additional information, including supply and use tables and a sectoral breakdown of employment. Most importantly for the context of the present paper, each input-output table is accompanied by a consumption allocation table (*Konsumverflechtungstabelle*, henceforth CAT) for the same year. However, since the CAT is published somewhat later than the corresponding input-output table, a CAT for 2007 is presently not (yet) available. This means that we have access to a series of 16 CAT's for the period from 1991 to 2006.

Using these CAT's, a corresponding series of bridge matrices can be computed, which offers the opportunity to study the evolution of the bridge matrix coefficients over a period of 16 years. During this period the German economy experienced a number of "shocks" caused by major political events, such as the consequences of reunification (which was completed formally on 3rd October 1990 but led to a restructuring of the East German economy that would take many years), the introduction of the Euro, and the successive enlargement from EU-12 to EU-27. In the meantime, substantial changes could be observed in the household sector: the population grew from 80 millions to 82 millions, the number of households grew from 35 millions to 39 millions, and the mean age increased from 39.4 years to 42.6 years.

The cumulative effect of these political and social developments could have had a significant effect on the coefficients of the CAT. In the following, the structure of the CAT's and the bridge matrices is discussed in some detail.

Table 1: The consumption allocation table for 2006

		Consumption purpose (COICOP Code)			
		Food	Non-alcoholic beverages	Others	Total
CPA Code	Commodity group	011	012		
01	Products of agriculture and hunting	13,234	22	10,976	24,232
02	Products of forestry and logging	0	0	919	919
05	Fish and other fishing products	437	0	0	437
10	Coal and lignite; peat	0	0	538	538
11	Crude petroleum and natural gas	0	0	16,810	16,810
12	Uranium and thorium ores	0	0	0	0
13	Metal ores	0	0	0	0
14	Other mining and quarrying products	89	0	42	131
15.1 - 15.8	Food products	110,255	6,729	9,126	126,110
15.9	Beverages	7	11,069	19,802	30,878
24	Chemical products	8	0	16,995	17,003
	Others	0	0	1,071,822	1,071,822
	Total	124,030	17,820	1,147,030	1,288,880

Source: Destatis, author's calculations. All numbers in millions of Euros

Since the CAT's published by Destatis distinguish 41 consumption purposes and 71 commodity groups, it is not sensible to reproduce the entire table in this article. Table 1 instead presents an aggregated version of the 2006 table which is sufficient for the purpose of illustrating the layout and some interesting features of a CAT.

The aggregated CAT shown in Table 1 reproduces the upper-left part of the full-scale CAT, including the first two COICOP categories (food and non-alcoholic beverages) and a number of CPA commodity groups. Like the familiar IOT, a CAT can be read column-wise or row-wise. Each column refers to a COICOP consumption purpose; each row refers to a CPA commodity group. The first column, for example, shows how the expenditure on the COICOP category 'food' is allocated to the various CPA commodity groups. The bottom row states that consumers spent 124,030 MEUR on this purpose. Naturally, the major part of this (110,255 MEUR) was allocated to the CPA commodity group 'food products'. However, a significant amount (13,234 MEUR) was allocated to 'products of agriculture and hunting'. The difference is that 'products of agriculture and hunting' refer to raw products such as potatoes and tomatoes, whereas 'food products' are processed products such as potato chips and tomato ketchup. Further significant amounts were allocated to 'fish and fishing products' (439 MEUR) and 'other mining and quarrying products'[1] (89 MEUR), and some smaller amounts were allocated to 'beverages' (7 MEUR) and chemical products (8 MEUR). The entire expenditure on 'food' is allocated to these six commodity groups, which means that the other 65 cells in the CAT's column for 'food' are equal to zero. In this respect, food is no exception – most of the entries in the CAT are equal to zero. Out of the 2,911 cells in the full-scale CAT, only 220 contain nonzero entries. Thus, 92.4% of the CAT's cells contain a value of zero[2].

Table 1 also shows that a CAT may contain some important information which may not be known to all input-output modellers. For example, in the absence of a CAT one might be tempted to allocate the entire expenditure on COICOP category 'non-alcoholic beverages' to the CPA group 'beverages'. According to Table 1, however, this would be a mistake. Only 62.1% of the entire expenditure is allocated this way; the remainder is allocated to 'food products'. The reason for this is that certain products like fruit juice and milk are not assigned to CPA category 15.9 (which is titled 'beverages') – they are assigned to categories 15.3 (processed and preserved fruit and vegetables) and 15.5 (dairy products and ice cream). Even if the analyst is aware of these peculiar rules, she cannot know for certain the share of these products in total expenditure. Therefore, a CAT is absolutely indispensable for models which combine household survey data and input-output data.

While the CAT itself is simply a collection of data, input-output modellers will mostly be interested in the bridge matrix that can be derived from it. Let each element $b_{i,j}$ of the bridge matrix $\mathbf{B}$ be defined as

$$b_{i,j} = \frac{K_{i,j}}{K_j^{COICOP}} \qquad \textbf{(1)}$$

[1] This would be mostly salt.
[2] It should be noted, however, that the entries in the CAT's are rounded to full millions, so some cells may contain values which appear as zero because they were smaller than 0.5 million EUR.

where $K_{i,j}$ represents element i, j of the CAT $\mathbf{K}$ and K_j^{COICOP} represents the total expenditure on COICOP consumption purpose j. Then, $b_{i,j}$ is the share of K_j^{COICOP} that is allocated to CPA commodity group i. If we know $b_{i,j}$ for all i and j, we can translate the information from the household survey into the CPA classification for use in an input-output model. For example, the data from Table 1 yields a value of 0.107 for $c_{01,011}$. When translating COICOP into CPA, we would allocate 10.7% of ‘food’ expenditure to ‘products of agriculture and hunting’.

However, the coefficients computed from Table 1 are valid only for the year 2006, the date of the corresponding CAT. In other years, the coefficients may take different values. The aim of this paper is to find out whether the coefficients are stable over time and how many of them are characterised by significant time trends. We begin, however, with a detailed analysis of the bridge matrix for 2006, because this will provide us with the detailed knowledge that is required to understand the intertemporal aspects later on.

3. The Bridge Matrix for 2006

As it would be impractical to reproduce the entire bridge matrix, which contains 71 rows and 41 columns, this section reports some descriptive statistics and summary measures of the bridge matrix for 2006.

Table 2: Concentration of bridge matrix coefficients

Consumption purpose		Number of nonzero entries	Cumulative coefficents				
COICOP	Heading		1st	2nd	3rd	4th	5th
011	Food	6	0.89	1.00	1.00	1.00	1.00
012	Non-alcoholic beverages	3	0.62	1.00	1.00	1.00	1.00
021	Alcoholic beverages	2	0.95	1.00	1.00	1.00	1.00
022	Tobacco	2	1.00	1.00	1.00	1.00	1.00
031	Clothing	7	0.81	0.97	0.99	1.00	1.00
032	Footwear	4	0.96	1.00	1.00	1.00	1.00
041	Actual rentals for housing	1	1.00	1.00	1.00	1.00	1.00
042	Imputed rentals for housing	1	1.00	1.00	1.00	1.00	1.00
043	Maintenance and repair of the dwelling	8	0.38	0.62	0.73	0.82	0.89
044	Water supply and miscellaneous services relating to the dwelling	6	0.47	0.65	0.82	0.95	0.98
045	Electricity, gas and other fuels	6	0.47	0.75	0.98	0.99	1.00
051	Furniture and furnishings, carpets and other floor coverings	10	0.80	0.88	0.92	0.96	0.98
052	Household textiles	3	0.99	0.99	1.00	1.00	1.00
053	Household appliances	5	0.89	0.95	0.98	1.00	1.00
054	Glassware, tableware and household utensils	8	0.25	0.49	0.72	0.93	0.96
055	Tools and equipment for house and garden	10	0.44	0.77	0.88	0.92	0.95
056	Goods and services for routine household maintenance	12	0.36	0.59	0.68	0.76	0.84
061	Medical products, appliances and equipment	7	0.67	0.96	0.97	0.99	1.00
062	Out-patient services	2	0.99	1.00	1.00	1.00	1.00
063	Hospital services	1	1.00	1.00	1.00	1.00	1.00
071	Purchase of vehicles	2	0.94	1.00	1.00	1.00	1.00
072	Operation of personal transport equipment	16	0.54	0.80	0.85	0.89	0.92
073	Transport services	5	0.36	0.68	0.88	0.95	1.00
081	Postal services	1	1.00	1.00	1.00	1.00	1.00
082	Telephone and telefax equipment	1	1.00	1.00	1.00	1.00	1.00
083	Telephone and telefax services	1	1.00	1.00	1.00	1.00	1.00
091	Audio-visual, photographic and information processing equipment	10	0.39	0.66	0.80	0.88	0.94
092	Other major durables for recreation and culture	7	0.45	0.73	0.87	0.95	0.98
093	Other recreational items and equipment, gardens and pets	15	0.40	0.70	0.83	0.88	0.91
094	Recreational and cultural services	7	0.69	0.81	0.88	0.94	0.98
095	Newspapers, books and stationery	11	0.80	0.90	0.93	0.95	0.97
096	Package holidays	1	1.00	1.00	1.00	1.00	1.00
10	Education	2	0.97	1.00	1.00	1.00	1.00
111	Catering services	4	0.88	0.99	1.00	1.00	1.00
112	Accommodation services	1	1.00	1.00	1.00	1.00	1.00
121	Personal care	8	0.43	0.81	0.94	0.96	0.98
123	Personal effects n.e.c.	9	0.47	0.74	0.92	0.95	0.97
124	Social protection	3	0.97	1.00	1.00	1.00	1.00
125	Insurance	1	1.00	1.00	1.00	1.00	1.00
126	Financial services n.e.c.	3	0.90	0.98	1.00	1.00	1.00
122, 127	Other services n.e.c.	8	0.38	0.58	0.73	0.86	0.96

Source: author's calculations

Table 2 shows for each of the 41 consumption purposes the number of nonzero coefficients as well as the cumulative size of the fifth largest coefficients. For example, it states that five of the bridge matrix coefficients for 'transport services' (COICOP code 073) are not equal to zero. Furthermore, it states that the largest coefficient is equal to 0.36, the sum of the two largest coefficients is equal to 0.68, the sum of the three largest coefficients is equal to 0.88, the sum of the four largest coefficients is equal to 0.95, and the sum of the five largest coefficients, naturally, is equal to 1.00.

According to Table 2, there are eight consumption purposes which have exactly one nonzero coefficient in the bridge matrix[3]. In other words, these consumption purposes can be allocated to precisely one CPA category. If this were the case for all consumption purposes, the life of an input-output modeller would be a lot easier (but this paper would be a lot shorter). For these consumption purposes, one can safely assume intertemporal stability of the bridge matrix coefficients, because the structure of the CPA and COICOP classifications allows a uniquely determined allocation.

Some consumption purposes can be nearly, but not quite, uniquely allocated. For example, a share of 0.95 of expenditure on alcoholic beverages is allocated to one CPA category (beverages), and the remaining share of 0.05 is allocated to another CPA category (products of agriculture and hunting). The example of tobacco is even more striking: Almost all of this expenditure is allocated to 'tobacco products' (CPA code 16), but a very small share (0.4 percent, to be precise) is allocated to 'articles of paper and paperboard' (CPA code 21.2).

Other consumption purposes, by contrast, are much more heterogeneous. The category labelled 'furniture and furnishings, carpets and other floor coverings' (COICOP code 051) includes a variety of different products, which means that the associated column of the bridge matrix contains 10 nonzero entries. However, the five largest coefficients taken together account for 98% of total expenditure in this category. This is more or less true for virtually all consumption purposes. The sum of the five largest coefficients is almost always close to one. This means that only a small number of the bridge matrix coefficients is truly relevant from a practical point of view.

4. Evolution of the Bridge Matrix Coefficients

In order to study the changes in the bridge matrix between 1991 and 2006, a two-step procedure is most enlightening. The first step consists of comparing results for 1991 and 2006; the second step traces some important developments over the entire period of observation.

The number of nonzero entries has changed. In 2006 there were 220 whereas in 1991 there were only 218. A closer inspection reveals that all the nonzero entries of 1991 where still larger than zero in 2006 and that two cells had, in addition, received nonzero values in the meantime. In quantitative terms, however, these two cells are negligible, and the difference may be due to rounding errors[4]. This means that when we consider the evolution of the bridge matrix over the years, we are practically concerned with the evolution of 220 coefficients, because the other elements of the bridge matrix have always been equal to zero (allowing for rounding errors).

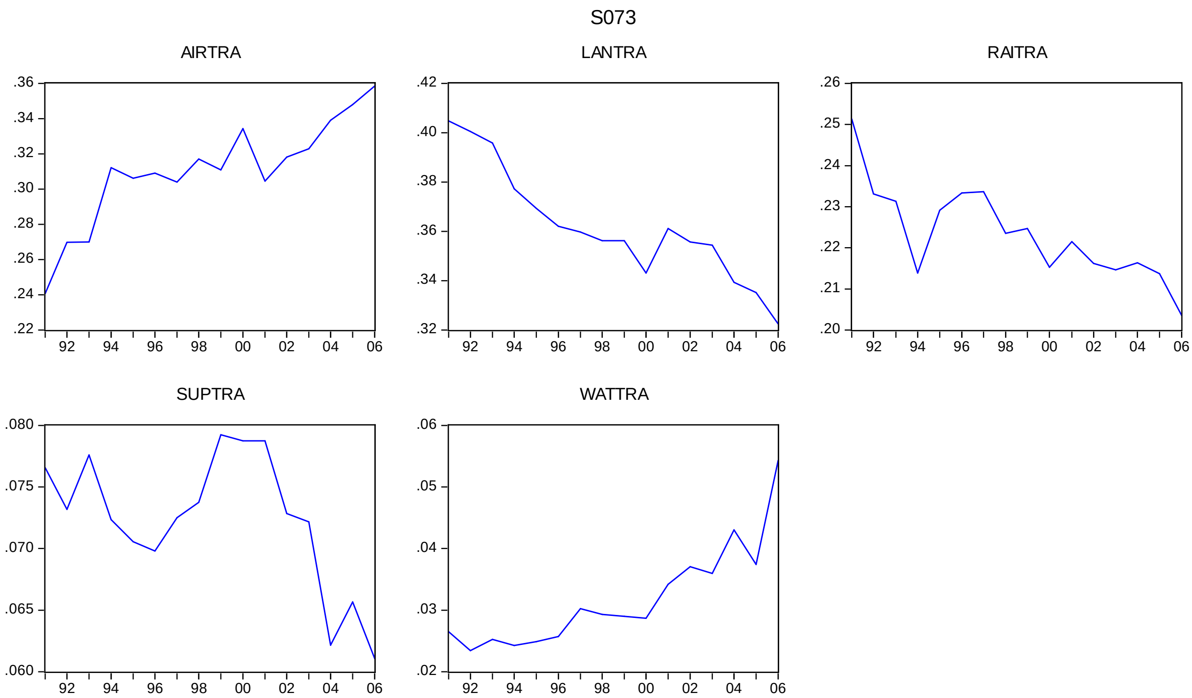
Figure 1: Evolution of coefficients for 'food' (COICOP 011)

Source: author's calculations

[3] Actual and imputed rentals for housing, hospital services, postal services, telephone and telefax equipment, telephone and telefax services, package holidays, accommodation services, and insurance.
[4] These two cells contain values of 1 and 2 million EUR, respectively. It is possible that their values for 1991 were smaller than 0.5 million EUR. In this case they would have been rounded to zero.

In order to get a first glimpse at the evolution of bridge matrix coefficients, it is useful to look at some graphs. Figure 1 shows the evolution of the coefficients for ‘food’ (COICOP 011). The largest coefficient, as evidenced by Table 1, is the one for ‘food products’ (CPA 15.1-15.8). However, a glance at Figure 1 makes it clear that this coefficient was not constant over time. It started at a value of 0.900 in the table for 1991, then moved up to a peak value of 0.904 in 1993, and subsequently declined to a value of 0.888 in 2005, although in 2006 it had again increased to 0.889. In general, the figure suggests a downward trend in this coefficient. The opposite is true for the coefficient on ‘products of agriculture and hunting (CPA 01), which grew from a value of 0.096 in 1991 to 0.107 in 2006. The coefficients on ‘products of fishing’ (CPA 05) and ‘other products of mining and quarrying’ (CPA 14) have also increased between 1991 and 2006. The coefficients of ‘beverages’ (CPA 15.9) and ‘chemical products’ (CPA 24 excl. 24.4) have moved up and down without any obvious trend.

Figure 2: Evolution of coefficients for ‘transport services’ (COICOP 073)



Source: author’s calculations

Figure 2 shows the evolution of the coefficients for ‘transport services’ (COICOP 073). The visual representation suggests that there could be significant time trends. Most notably, the coefficient of ‘air transport services’ (CPA 62) has increased from 0.24 to 0.36, whereas the coefficient of ‘rail transport services (CPA 60.1) has decreased from 0.25 to 0.20 and that of ‘other land transport services’ (CPA 60.2-60.3) has decreased from 0.40 to 0.32. This suggests that consumers’ preferences may have shifted from land transport to air transport or that relative prices have shifted in a way which increased the share of air transport in total transport service expenditure.

The visual representations in Figure 1 and Figure 2 make it possible to identify possible trends, but they do not permit statements on the statistical significance of those trends. Therefore, the next section will discuss the identification of significant trends by econometric means.

5. Identification of Trends

In order to estimate the extent and statistical significance of time trends, one would have to estimate the following equation for each bridge matrix coefficient:

$$b_{i,j,t} = \beta_{i,j} + \tau_{i,j} t + \varepsilon_{i,j,t} \qquad \textbf{(2)}$$

where $b_{i,j,t}$ are the 71 bridge matrix coefficients for consumption purpose j observed in year t and $\varepsilon_{i,j,t}$ is the error term, while $\beta_{i,j}$ and $\tau_{i,j}$ are the coefficients to be estimated. The interpretation would be that $\beta_{i,j}$ is the intercept, i.e. the value of $b_{i,j}$ that we would expect to have observed in year 0 if $\varepsilon_{i,j,0}$ had been equal to zero. That is, $\beta_{i,j}$ will generally not be equal to $b_{i,j,0}$ because $\varepsilon_{i,j,0}$ was probably not equal to zero.

The more interesting coefficient, however, is $\tau_{i,j}$. This is the estimated effect of t on $b_{i,j,t}$, in other words the time trend in which we are interested. If it is different from zero, we have a time trend. This will be the case quite frequently (basically, as soon as there is any change in $b_{i,j,t}$ over time). However, the interesting question is whether the time trend is statistically significant, i.e. significantly different from zero. The results of the econometric estimation can tell us whether this is the case.

However, it would have been quite bothersome to actually estimate an equation for each of the 2911 bridge matrix coefficients. Therefore, a slightly different specification was adopted:

$$b_{i,j,t} = \beta_{1,j} d_{1,j} + ... + \beta_{71,j} d_{71,j} + \tau_{0,j} d_{0,j} t + ... + \tau_{71,j} d_{71,j} t + \varepsilon_{i,j,t} \quad \textbf{(3)}$$

where $d_{i,j}$ is a set of 71 dummy variables for each commodity group. For $i = 1$, all dummies except $d_{1,j}$ are equal to zero, so (3) collapses to $b_{1,j,t} = \beta_{1,j} + \tau_{1,j} t + \varepsilon_{1,j,t}$, which is of course exactly the same as equation (2). The adoption of (3) just made it easier to implement the estimations using the EViews software; it does not affect the interpretation of the results.

Table 3: Estimation of time trends in the coefficients for 'food'

Dependent Variable: S011
Method: Panel Least Squares
Date: 07/02/10 Time: 11:34
Sample: 1991 2006
Periods included: 16
Cross-sections included: 71
Total panel (balanced) observations: 1136

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AGRIC	0.095525	0.000198	482.4748	0.0000
BEVERA	5.28E-05	0.000198	0.266580	0.7898
CHEMIC	6.40E-05	0.000198	0.323363	0.7465
FISH	0.003008	0.000198	15.19102	0.0000
FOOD	0.900762	0.000198	4549.530	0.0000
MINQUA	0.000588	0.000198	2.968580	0.0031
AGRIC_TREND	0.000874	2.25E-05	38.84182	0.0000
BEVERA_TREND	4.10E-07	2.25E-05	0.018235	0.9855
CHEMIC_TREND	1.24E-06	2.25E-05	0.055082	0.9561
FISH_TREND	3.20E-05	2.25E-05	1.423357	0.1549
FOOD_TREND	-0.000917	2.25E-05	-40.79067	0.0000
MINQUA_TREND	1.02E-05	2.25E-05	0.452178	0.6512

R-squared	0.999987	Mean dependent var	0.014085
Adjusted R-squared	0.999985	S.D. dependent var	0.105891
S.E. of regression	0.000415	Akaike info criterion	-12.62157
Sum squared resid	0.000171	Schwarz criterion	-11.99216
Log likelihood	7311.053	Hannan-Quinn criter.	-12.38384
Durbin-Watson stat	1.005740		

Source: authors' calculations

Table 3 shows the results of this estimation for the consumption purpose 'food' (COICOP 011). As shown in Table 1 and Table 2, there are six nonzero coefficients. The largest is of course the coefficient on food products (FOOD, CPA 15.1-15.8). The estimated intercept (β) is 0.90, which means that the share of food products in total consumption expenditure for food would have been exactly 90 percent in 1991 if the error term ε had been equal to zero. The second largest coefficient is that on products of agriculture and hunting (AGRIC, CPA 01), which amounts to 9.6 percent. The other coefficients are relatively small.

Concerning the time trends, Table 3 allows for some interesting observations. With regard to AGRIC and FOOD, we can observe highly significant time trends with very low p-values. The time trend of AGRIC is positive, while that of FOOD is negative. In other words, consumers seem to have substituted products of agriculture and hunting for (processed) food products. This might reflect changed attitudes toward healthy diets, for example buying fresh vegetables on the market to prepare a "real" meal rather than buying convenience food and simply putting it into the microwave oven. However, it should be noted that the trend, though significant, is very small. All else being equal, the share of AGRIC in food expenditure rises by a mere 0.09 percentage points per year, while that of FOOD falls by a similar magnitude. Thus, we have here an example of a significant time trend, but since its magnitude is so small, its inclusion in a model may not be strictly necessary. The other time trends are statistically not significant. Thus, with respect to food expenditure, it may be permissible to assume constant bridge matrix coefficients.

Table 4: Estimation of time trends in the coefficients for 'transport services'

Dependent Variable: S073
Method: Panel Least Squares
Date: 07/02/10 Time: 14:20
Sample: 1991 2006
Periods included: 16
Cross-sections included: 71
Total panel (balanced) observations: 1136

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AIRTRA	0.268585	0.001130	237.7383	0.0000
LANTRA	0.395851	0.001130	350.3878	0.0000
RAITRA	0.238121	0.001130	210.7732	0.0000
SUPTRA	0.076900	0.001130	68.06812	0.0000
WATTRA	0.020542	0.001130	18.18284	0.0000
AIRTRA_TREND	0.005567	0.000128	43.37842	0.0000
LANTRA_TREND	-0.004502	0.000128	-35.08425	0.0000
RAITRA_TREND	-0.001957	0.000128	-15.24650	0.0000
SUPTRA_TREND	-0.000612	0.000128	-4.770955	0.0000
WATTRA_TREND	0.001504	0.000128	11.72329	0.0000

R-squared	0.998717	Mean dependent var	0.014085
Adjusted R-squared	0.998535	S.D. dependent var	0.061817
S.E. of regression	0.002366	Akaike info criterion	-9.138502
Sum squared resid	0.005566	Schwarz criterion	-8.509093
Log likelihood	5332.669	Hannan-Quinn criter.	-8.900768
Durbin-Watson stat	1.337091		

Source: authors' calculations

Table 4, by contrast, shows a case where time trends are not only statistically significant but also of considerable magnitude. It refers to the consumption purpose 'transport services', which is characterised by five nonzero coefficients in the bridge matrix: for air transport (AIRTRA), transport by rail (RAITRA), land transport other than rail (LANTRA), water transport (WATTRA), and supporting services (SUPTRA, e.g. travel agencies). Interestingly, all of these coefficients exhibit statistically significant time trends. The time trend of air transport is estimated to be 0.005567, which means that the share of air transport in total expenditure on transport services rises by 0.56 percentage points per year. Conversely, the time trends for land transport are negative. The share of rail transport falls by 0.20 percentage points per year, while that of land transport other than rail falls by 0.45 percentage points per year. These time trends can have a significant influence on model results over a period of, say, ten or twenty years. If we were to construct a model that does not take them into account, we might seriously underestimate the future demand for air travel and overestimate the future demand for land travel. The other time trends (on SUPTRA and WATTRA), are also statistically significant.

6. Conclusion

The results presented above clearly indicate that the conversion coefficients between CPA and COICOP may be subject to statistically significant trends. A very interesting example is the case of transport services, where the share of air transport has significantly increased at the expense of land transport over the time period between 1991 and 2006. The presence of such trends means that models which use a bridge matrix to convert data from COICOP into CPA (and vice versa) might produce misleading results if the trends in the conversion coefficients are not taken into account.

The present study, still being at an early working paper stage, has not dealt with the question how trends in the conversion coefficients can be captured in a model. As a first step, it might be a good idea to identify time trends econometrically (as in section 5) and extrapolate the trends into the future. However, a simple extrapolation ignores the fact that changes in conversion coefficients can be driven by various factors which may persist in the future or not. As a next step, it would be good idea to look at the influence of price changes on conversion coefficients and to model them explicitly.

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Appendix

Table 5: Commodity classification

No.	Code	Full name	CPA
1	AGRIC	Products of agriculture, hunting and related services	01
2	AIRTRA	Air transport services	62
3	ARTPAP	Articles of paper and paperboard	21.2
4	BASFER	Basic ferrous metals	27.1. - 27.3
5	BASPRE	Basic precious metals and other non-ferrous metals	27.4
6	BEVERA	Beverages	15.9
7	BUILDI	Building installation, completion and other construction services	45.3 - 45.5
8	CERAMI	Other non-metallic mineral products	26.2 - 26.8
9	CHEMIC	Chemical products excl. pharmaceutical products	24 (excl. 24.4)
10	CLOTHI	Wearing apparel; furs	18
11	COAL	Coal and lignite; peat	10
12	COMPUT	Computer and related services	72
13	COMSOC	Compulsory social security services	75.3
14	EDUCAT	Education services	80
15	ELECTR	Electricity, steam and hot water	40.1, 40.3
16	ELEMAC	Electrical machinery and apparatus n.e.c.	31
17	FABMET	Fabricated metal products, except machinery and equipment	28
18	FININT	Financial intermediation services, except insurance and pension funding services	65
19	FISH	Fish and other fishing products; services incidental of fishing	05
20	FOOD	Food products	15.1 - 15.8
21	FOREST	Products of forestry, logging and related services	02
22	FOUNDRY	Foundry work services	27.5
23	FURNIT	Furniture; other manufactured goods n.e.c.	36
24	GASES	Gas	40.2
25	GLASS	Glass and glass products	26.1
26	HEALSOC	Health and social work services	85
27	HOTRES	Hotel and restaurant services	55
28	HOUSER	Private households with employed persons	95
29	INSPEN	Insurance and pension funding services, except compulsory social security services	66
30	LANTRA	Other land transportation services	60.2 - 60.3
31	LEATHE	Leather and leather products	19
32	MACHIN	Machinery and equipment n.e.c.	29
33	MEDPRE	Medical, precision and optical instruments, watches and clocks	33
34	MEMORG	Membership organisation services n.e.c.	91
35	METORE	Metal ores	13
36	MINQUA	Other mining and quarrying products	14
37	MOTVEH	Motor vehicles, trailers and semi-trailers	34
38	OFFMAC	Office machinery and computers	30
39	OILGAS	Crude petroleum and natural gas; services incidental to oil and gas extraction excluding surveying	11
40	OTHBUS	Other business services	74
41	OTHSER	Other services	93
42	OTHTRA	Other transport equipment	35
43	PHARMA	Pharmaceutical products	24.4
44	PLASTI	Plastic products	25.2

45	POSTEL	Post and telecommunication services	64
46	PRIMED	Printed media	22.1
47	PRIREC	Printing services and recorded media	22.2 - 22.3
48	PUBADM	Public administration and defence	75.1 - 75.2
49	PULPAP	Pulp, paper and paperboard	21.1
50	RAITRA	Railway transportation services	60.1
51	RANDD	Research and development services	73
52	REALES	Real estate services	70
53	RECCUL	Recreational, cultural and sporting services	92
54	REFPET	Coke, refined petroleum products and nuclear fuels	23
55	RENTIN	Renting services of machinery and equipment without operator and of personal and household goods	71
56	RETTRA	Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods	52
57	RTVCOM	Radio, television and communication equipment and apparatus	32
58	RUBBER	Rubber products	25.1
59	SATFIN	Services auxiliary to financial intermediation	67
60	SECRAW	Secondary raw materials	37
61	SEWWAS	Sewage and refuse disposal services, sanitation and similar services	90
62	SITPRE	Site preparation, construction, civil engineering	45.1 - 45.2
63	SUPTRA	Supporting and auxiliary transport services; travel agency services	63
64	TEXTIL	Textiles	17
65	TOBACC	Tobacco products	16
66	TRAMOT	Trade, maintenance and repair services of motor vehicles and motorcycles; retail sale of automotive fuel	50
67	URAN	Uranium and thorium ores	12
68	WATER	Water	41
69	WATTRA	Water transport services	61
70	WHOTRA	Wholesale trade and commission trade services, except of motor vehicles and motorcycles	51
71	WOOD	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials	20

Source: CPA 2002, Destatis

Table 6: Consumption purpose classification

No.	COICOP	Description
1	011	Food
2	012	Non-alcoholic beverages
3	021	Alcoholic beverages
4	022	Tobacco
5	031	Clothing
6	032	Footwear
7	041	Actual rentals for housing
8	042	Imputed rentals for housing
9	043	Maintenance and repair of the dwelling
10	044	Water supply and miscellaneous services relating to the dwelling
11	045	Electricity, gas and other fuels
12	051	Furniture and furnishings, carpets and other floor coverings
13	052	Household textiles
14	053	Household appliances
15	054	Glassware, tableware and household utensils
16	055	Tools and equipment for house and garden
17	056	Goods and services for routine household maintenance
18	061	Medical products, appliances and equipment
19	062	Out-patient services
20	063	Hospital services
21	071	Purchase of vehicles
22	072	Operation of personal transport equipment
23	073	Transport services
24	081	Postal services
25	082	Telephone and telefax equipment
26	083	Telephone and telefax services
27	091	Audio-visual, photographic and information processing equipment
28	092	Other major durables for recreation and culture
29	093	Other recreational items and equipment, gardens and pets
30	094	Recreational and cultural services
31	095	Newspapers, books and stationery
32	096	Package holidays
33	10	Education
34	111	Catering services
35	112	Accommodation services
36	121	Personal care
37	123	Personal effects n.e.c.
38	124	Social protection
39	125	Insurance
40	126	Financial services n.e.c.
41	122, 127	Other services n.e.c.

Source: CPA 2002, Destatis