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Contribution to cross cutting topic "Maintaining Representative Turnover and SPPI: Re-stratification, Resampling, Rebasing, and Updating Weights"

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Introduction

The Federal Statistical Office of Germany is producing SPPIs according to the European regulation on short term statistics. Currently the collection, calculation and transmission of SPPIs for 17 industry sectors (NACE-2-digit, -3-digit or -4-digit industries or aggregations of 3-digit industries) out of NACE sections H, J, M and N is obligatory. For the first base period (2006) 14,500 prices were collected quarterly from 2,800 respondents. Additional price observations were derived from scales of fees, free accessible prices in the internet, prices collected by price statistics for other purposes and from purchased data sets. In the end of 2013 results for the new base year 2010 were published. This included not only a rescaling into 2010 = 100 but also a revision of weighting schemes and the revision of indices for the timespan between the new base year and the 3rd quarter of 2013. At the same time as updated weighting schemes for elementary indices and aggregates were calculated, we checked

- the relevance of service products
- the relative importance of elementary indices
- the adequacy of the number of price observations collected for each elementary index

The measures taken to re-allocate price observations, to re-define the scope of elementary indices and to calculate the required sample size will be described for industry 70.2 "management consultancy activities" in the following chapters.

Principles for the index revision and rotation in Germany

Reweighting and rebasing of German SPPIs take place every five years, with years which finish by "0" or "5" according to the European regulation on short term statistics. The results of reweighting and rebasing have to be transmitted to Eurostat three years after the end of the new base year at the latest. With the publishing of rebased SPPI indices the figures for the time span between beginning of the new base year and publication date are revised.

For the service sector only little statistical data on revenue by product type is available. Thus, the new weighting schemes are derived from various sources:

- supplementary survey to the structural statistics on business services "Turnover by product type and residence of client" (if available for the industry)
- data from business associations or public authorities, e.g. the Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway or the Federal Office of Goods Transport
- additional inquiries among the respondents of the SPPI surveys
- results of different statistical surveys, e.g. transport statistics
- purchased data, e.g. from International Air Transport Association (IATA)

The lack of information on products also applies for the population in business register. Therefore, it is impossible to draw new samples for specific products. Samples are drawn on the lowest possible industry-level. The preparatory work starts after the revision process. This includes, inter alia, the checking of the classification of the most important entities e.g. by internet researches, the exclusion of middle sized enterprises already reporting for more than two surveys, the exclusion of entities that are intended to be dismissed from the survey, plausibility

checks on the relation of turnover and number of employees and many comparisons with the expert knowledge in the organizational unit.

Cut-off limit – i.e. the boundary for the exclusion of small enterprises – and the boundary of the "census stratum" (the enterprises that are drawn with probability = 1) are chosen according to the particular structure of the industry. For this purpose the results of the structural business statistics in the services sector are used. Due to lack of information on the services offered, it is expected that the randomly drawn entities are not necessarily suitable to replace the companies that are to be dismissed. Therefore, in the strata foreseen for random sampling a multiple of the sample size actually required is drawn – depending on the complexity of the products, 2 or 3 times the actual sample size. Over the two years following the index revision, the units below the census stratum are successively replaced. The surplus enterprises serve as a kind of stock for replacing "out of business units".

The so-called census stratum is reviewed every year. In case of "new born" entities or entities which appeared in the industry because of re-classification or appeared in the most important stratum because of increasing turnover, we ask them about their most representative service products and for regular price reporting for these products.

First results on appropriateness of sample size, number of elementary indices and number of price observations

In the 2012 Voorburg presentation on efficiency the Federal Statistical Office of Germany described how SPPIs were developed successively from 2007 onwards and only limited experience could be transferred from CPI index calculation. Thus, the sample sizes for each ISIC group were assigned according to the individual market characteristics with an upper limit derived from national regulation on price statistics[1] for services. In the light of 5 years of experience in production of SPPIs the revision to base year 2010 was the opportunity to review the configuration of these surveys.

It was agreed that the starting point for determining the sample size should be the significance of the ISIC group in relation to the covered markets. The larger the size of the industry – measured by share of turnover – the more establishments should be included in the survey.

As the sole criterion for determining the sample size, this seemed inadequate. E.g. the reason for the relatively low number of reporting units in the SPPI for telecommunications is the high concentration of the market.

In markets dominated by a few market leaders, small and medium-sized enterprises are supposed to have little influence on price developments. Under this assumption, in addition to the importance of the individual markets for the value creation of the service sector, the concentration of the markets was an important determining factor for the required number of reporting units. If a small number of enterprises make up the major share of turnover, the number

[1] Gesetz über die Preisstatistik vom 9. August 1958 in der im Bundesgesetzblatt Teil III, Gliederungsnummer 720-9, veröffentlichten bereinigten Fassung (685).

of enterprises questioned can also be small as long as the market players are included in the survey[2].

Under the condition that the sample size after rebasing should remain less than 2800 enterprises, an allocation of (maximum) sample size to the industries was developed as a mixture of census and random samples depending on the concentration of the industries:

ISIC	Title	Sample Size in 2006	Sample size by share of Turnover (2010)	Mixture of random sample and census	Sample size after reallocation of surplus companies
4912	Freight rail transport	62	46	5	5
4923	Freight transport by road	350	255	255	358
5011 5012	Sea and coastal water transport	30	93	93	130
51	Air transport	8	41	8	8
5210	Storage and warehousing	125	57	57	80
5224	Cargo handling	80	22	22	30
53	Post and courier services	350	209	14	14
61	Telecommunications	30	549	29	29
62	Computer programming, consultancy and related activities	298	615	615	863
631	Data processing, hosting and related activities; web portals	26	29	29	41
639	Other information service activities	25	2	2	3
6910	Legal activities	360	38	38	54
6920	Accounting, bookkeeping, auditing activities; Tax consultancy	150	54	54	76
7020	Management consultancy activities	150	149	149	209
7110	Architectural and engineering activities	143	231	231	324
7120	Technical testing and analysis	65	43	43	61
7310	Advertising	110	41	41	58
7320	Market research, opinion polling	60	17	17	23
78	Employment activities	170	179	179	252
80	Security and investigation activities	90	32	32	45
812	Cleaning activities	156	98	98	137
	Total	2833	2800	2011	2800

The industry of management consultancy activities is not so concentrated that it would be suitable for a restriction on the census stratum. However, in comparison with the rest of the service industries the sample size that was chosen during the conception phase for the construction of the SPPI (150) has shown to be appropriate. If further researches on

[2] Similar considerations are treated in section 5.E paragraph 5.64 of the PPI Manual published by the IMF in 2004.

appropriateness of number of first aggregates and number of price observations would result in the conclusion that more entities would be required the sample could be extended up to 209.

The first researches on the volatility of elementary aggregates and price observations lead to the results presented in table 2. Columns 4 and 5 should be interpreted as indicators for the suitability of the number of first aggregates and number of price observations. A figure of 1.0 for "inter-aggregate heterogeneity" means that the volatility of the first aggregates compared to the other industries is similar to the average of all industries. 1.0 for "intra-aggregate heterogeneity" means that the volatility of the prices within the first aggregates of an industry is average compared to the rest of the service industries.

ISIC	Title	# of prices in 2006	Inter aggregate heterogeneity	Intra aggregate heterogeneity	Inter- and IntraAH adjusted # of prices
4912	Freight rail transport	834	1.3	1.3	1,279
4923	Freight transport by road	1,470	1.7	1.3	1,783
5011 5012	Sea and coastal water transport	883	1.7	0.3	422
51	Air transport	231	1.9	0.4	551
5210	Storage and warehousing	390	1.6	0.7	867
5224	Cargo handling	351	1.0	0.5	384
53	Post and courier services	1,768	1.2	0.5	449
61	Telecommunications	286	NA	NA	NA
6910	Legal activities	662	0.6	1.6	705
6920	Accounting, bookkeeping and auditing activities; tax consultancy	1,352	0.6	1.2	520
7020	Management consultancy activities	1,008	0.5	1.0	401
7110	Architectural and engineering activities	586	1.0	1.2	948
7120	Technical testing and analysis	239	0.7	0.9	486
7310	Advertising	782	1.2	1.6	1,441
7320	Market research and opinion polling	468	0.8	1.2	712
78	Employment activities	870	0.6	1.7	719
80	Security and investigation activities	518	0.4	1.1	357
812	Cleaning activities	721	0.2	0.7	113
	Total or *average*	**13,419**	***1***	***1***	**12,138**

Thus, the volatility of first aggregates in the SPPI of "management consultancy activities" is considerably lower than the average of the other service industries, the volatility of price observations within the first aggregates is average. This could have been because the breakdown of the index into products, into functions of the executive staff and into company size classes was more detailed than in average. From experiences during the first base period we learnt that a too detailed index structure may conflict attempts to maintain the representativeness of the index. If the specification of an elementary index is too narrow price observations may only be replaced with great difficulty.

Thus, for industries differing largely from the average further researches were performed.

Analysis of the explanatory contributions of elementary aggregates and bootstrap analysis

The detailed structure of the SPPI on "management consultancy activities" during the first base period was as follows:

base period 2006			
aggregates		weights	number of price observations
Product 1: corporate management, operational and organizational structure		**51,10**	***411***
50,000 € ‹ turnover ‹ 5 Mill. €	*proprietor*	30,90	*50*
	project manager		*35*
	senior advisor		*35*
	junior advisor		*32*
turnover ›= 5 Mill. €	*proprietor*	20,20	*65*
	project manager		*65*
	senior advisor		*67*
	junior advisor		*62*
Product 2: strategy		**27,10**	***349***
50,000 € ‹ turnover ‹ 5 Mill. €	*proprietor*	11,80	*31*
	project manager		*26*
	senior advisor		*24*
	junior advisor		*19*
turnover ›= 5 Mill. €	*proprietor*	15,30	*63*
	project manager		*62*
	senior advisor		*64*
	junior advisor		*60*
Product 3: IT-consultancy		**7,20**	***209***
50,000 € ‹ turnover ‹ 5 Mill. €	*proprietor*	3,50	*19*
	project manager		*16*
	senior advisor		*17*
	junior advisor		*15*
turnover ›= 5 Mill. €	*proprietor*	3,70	*27*
	project manager		*38*
	senior advisor		*39*
	junior advisor		*38*
Product 4: Human Resources		**6,90**	***39***
50,000 € ‹ turnover ‹ 5 Mill. €	*proprietor*	6,50	*9*
	project manager		*8*
	senior advisor		*7*
	junior advisor		*6*
turnover ›= 5 Mill. €	*proprietor*	0,40	*2*
	project manager		*3*
	senior advisor		*2*
	junior advisor		*2*
Product 5: travel expenses		**7,70**	**1**
Sum of weights / total number of price observations		**100,00**	**1009**

Following the first analysis on sample size and number of observations in 2012, the calculation of the new weighting scheme for base year 2010 and the difficulties recognized when searching for substitutes of price observations, four questions needed to be answered by further studies on aggregates of the index.

1. It was known, that the weight of product „human resources consultancy" was going to decrease to less than 5% in the 2010 weighting scheme. At the same time the elementary indices were under-stuffed with price observations. Normally about 20 price observations are required to ensure a kind of robustness against outliers. Does the price development of this product deviate significantly from the overall index? How does the overall index look like without the explanatory contribution of the product "human resources consultancy"?
2. Normally, in German SPPIs no respondents with turnover below 250,000 € are incorporated. Furthermore price observations of enterprises in these size classes are difficult to replace. How does the overall index look like without the explanatory contribution of these size classes?
3. In the size class of enterprises with less than 5 Mill € of turnover the replacing of price observations for the function of project manager and junior advisor had been difficult. Furthermore the heterogeneity of elementary aggregates had been proved to be below average. How would an abandonment of above-named elementary aggregates influence the overall index?
4. Would it be possible to reduce the number of price observations in the well stuffed elementary aggregates without abandoning robustness against outliers and without influence on the overall index?

In order to answer the first two questions alternative index calculations were simulated. The comparison of price development of the index results in its previous structure (but weighting scheme of base year 2010) with the alternative calculations was performed for the time span between 2009 and 2012. Absolute deviations of the simulated index from the index in its previous structure and absolute deviations of the quarterly percentage change of the simulated index from the index in its previous structure were calculated and cumulated. This resulted in a ranking of alternative index structures.

The abandoning of small enterprises with turnover between 50,000 € and 250,000 € had the least influence on the overall index. It also turned out that the explanatory contribution of human resources consultancy was relatively small regarding the new weight of less than 5%. On the other hand the 5% of turnover represented 1 bill €. As products representing turnover above 1 bill € are regarded as important, it was decided to continue the price survey for human resources consultancy. Nevertheless, in order to lessen the problem of replacing price observations for this product it was decided to abandon the distinction between medium sized enterprises (250,000 € up to 5 mill €) and large enterprises (more than 5 mill €). In this way it would be possible to increase the number of price observations for the functions of consultants in this area without increasing the total number of price observations.

By taking a closer look at the inter-aggregate heterogeneity it became clear that it wasn't required to collect prices for four different functions of consultants. Within one product and one size class the elementary indices developed very similar. Thus, the total number of price observations

could be decreased significantly by abandoning the price survey for two out of four functions of consultants.

In order to answer the last question Bootstrap analysis was performed. This meant the elementary aggregates were reproduced with a random sub-sample of the price observations. It turned out that between 30 and 40 prices are sufficient reproduce the price development of these aggregates and to guarantee robustness against outliers.

As a result, the structure of the SPPI for management consultancy has changed as follows:

aggregates		weights in %	number of price observations	weights in %	number of price observations	aggregates	
		base year 2006		base year 2010			
Product 1: corporate management, operational and organizational structure		**51,10**	***411***	***44,06***	***213***		
50,000 € ‹ turnover ‹ 5 Mill. €	*proprietor*	30,90	*50*	*6,74*	*37*	*proprietor*	250,000 € ‹ turnover ‹ 5 Mill. €
	project manager		*35*			*project manager*	
	senior advisor		*35*	*10,92*	*45*	*senior advisor*	
	junior advisor		*32*			*junior advisor*	
turnover ›= 5 Mill. €	*proprietor*	20,20	*65*	*4,04*	*33*	*proprietor*	turnover ›= 5 Mill. €
	project manager		*65*	*7,58*	*33*	*project manager*	
	senior advisor		*67*	*9,76*	*34*	*senior advisor*	
	junior advisor		*62*	*5,02*	*31*	*junior advisor*	
Product 2: strategy		**27,10**	***349***	***24,63***	***182***		
50,000 € ‹ turnover ‹ 5 Mill. €	*proprietor*	11,80	*31*	*3,77*	*22*	*proprietor*	250,000 € ‹ turnover ‹ 5 Mill. €
	project manager		*26*			*project manager*	
	senior advisor		*24*	*6,10*	*35*	*senior advisor*	
	junior advisor		*19*			*junior advisor*	
turnover ›= 5 Mill. €	*proprietor*	15,30	*63*	*2,26*	*32*	*proprietor*	turnover ›= 5 Mill. €
	project manager		*62*	*4,23*	*31*	*project manager*	
	senior advisor		*64*	*5,46*	*32*	*senior advisor*	
	junior advisor		*60*	*2,80*	*30*	*junior advisor*	
Product 3: IT-consultancy		**7,20**	***209***	***17,64***	***187***		
50,000 € ‹ turnover ‹ 5 Mill. €	*proprietor*	3,50	*19*	*2,70*	*20*	*proprietor*	250,000 € ‹ turnover ‹ 5 Mill. €
	project manager		*16*			*project manager*	
	senior advisor		*17*	*4,37*	*25*	*senior advisor*	
	junior advisor		*15*			*junior advisor*	
turnover ›= 5 Mill. €	*proprietor*	3,70	*27*	*1,62*	*27*	*proprietor*	turnover ›= 5 Mill. €
	project manager		*38*	*3,03*	*38*	*project manager*	
	senior advisor		*39*	*3,91*	*39*	*senior advisor*	
	junior advisor		*38*	*2,01*	*38*	*junior advisor*	

Product 4: Human Resources		**6,90**	*39*	*4,99*	*40*		
50,000 € ‹ turnover ‹ 5 Mill. €	*proprietor*	6,50	*9*	*0,92*	*20*	*proprietor*	turnover ›= 250,000 €
	project manager		*8*				
	senior advisor		*7*			*project manager*	
	junior advisor		*6*				
turnover ›= 5 Mill. €	*proprietor*	0,40	*2*	*1,58*	*20*	*senior advisor*	
	project manager		*3*				
	senior advisor		*2*			*junior advisor*	
	junior advisor		*2*				
				2,49	*1*	*commissions derived from ISIC 781*	
Product 5: travel expenses		**7,70**	*1*	**8,69**	*1*		
Sum of weights / total number of price observations		**100,00**	**1009**	**100,00**	**623**		

Altogether,

- 6 elementary aggregates for medium sized enterprises were abandoned.
- For the product with the smallest weight the distinction of medium sized and large enterprises was abandoned. For the resulting "size class" of enterprises with more than 250,000 € of turnover the prices for only two functions of employees will be collected in future. Thus, the number of elementary aggregates is reduced from 8 to 2.
- For all products the enterprises below 250,000 € of turnover were abandoned.
- The number of observations for every elementary aggregate was restocked to at least 20. In the same time – as a consequence of bootstrap analysis – the number of price observations in the formerly well stuffed aggregates was reduced to between 30 and 40.
- The sub-index of human resources consultancy was supplemented by the price development of commissions collected for the SPPI on ISIC 781 "Activities of employment placement agencies".

This decreased the elementary aggregates from 33 to 24 and the number of price observations from 1009 to 623. As we have seen by the researches on explanatory contributions, bootstrap analysis and inter-aggregate heterogeneity it can be expected that these gains in efficiency won't influence the overall index. On the contrary, the number of aggregates which might have been sensible to outliers was reduced to zero, the replacement of price observations within the aggregates is supposed to be simplified and the product of human resources consultancy is supplemented by the billing method of commission fees for employment placement services.

Sample design for rotation

The samples for SPPIs are drawn separately for each NACE industry from the business register. For the calculation of entities per size class Neyman allocation is used. The size classes are defined by turnover according to structural business statistics. These are much more detailed than the size classes defining the elementary aggregates of the index. As input the application for random sampling requires the definition of the cut-off-limit, the limit of the "census stratum" and the overall number of entities that should be sampled. As already mentioned, beyond the

classification of the entities according to their primary activity, the business register provides no further information on the services offered. Thus, in the strata destined for random sampling a multiple of the sample size actually required is necessary. For the industry of management consultancy activities this resulted in the following sample design:

management consultancy activities	entities (SBS)	share of turnover (SBS)		sample size		allocation of entities	
			above cut-off limit	intended	incl. surplus enterprises	prop. to turnover	according to Neyman
total	**51 445**	**100%**					
less than 250 000 €	42 053	17,2%					
above cut-off limit	**9 392**	**82,8%**	**100%**	**145**	**258**	**258**	**258**
250000€-500000€	4 449	6,9%	8%	113	226	27	30
500 000 € - 1 Mill €	2 286	7,3%	9%			28	31
1 Mill € - 2 Mill €	1 338	8,4%	10%			32	33
2 Mill € - 5 Mill €	825	11,4%	14%			44	56
5 Mill € - 10 Mill €	272	8,4%	10%			32	27
10 Mill € - 25 Mill €	153	10,5%	13%			41	39
25 Mill € - 50 Mill €	35	5,5%	7%			21	8
50 Mill € - 75 Mill €	12	3,3%	4%	32[3]	32	32	15
75 Mill € - 100 Mill €	8	3,1%	4%				5
100 Mill € and more	13	18,1%	22%				12

[3] number of entities in business register differs from the figures of structural business statistics

The limit of the census stratum depends on the structure of the industry's population. As shown in the table above, the entities with more than 50 Mill € of turnover have a share of 30% of the industry's turnover. They represent about one quarter of the overall number of entities foreseen for the sample. Decreasing the limit to 25 Mill € of turnover would have doubled the number of entities in the census stratum but it would only increase the represented turnover to 37%. In order to achieve a better representation of medium sized enterprises it was decided to allocate the rest of the intended sample size to the strata above 250 000 € and below 50 mill € of turnover. In these strata - destined for random sampling - a double of the intended 113 entities was selected by the application which uses Neyman allocation. Since Neyman allocation takes into consideration the standard deviation of turnover in the stratum, this leads to a slightly different assignation of entities than the allocation by share of turnover would have done.

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