Introduction of chain-linked volume measures in the Quarterly Spanish National Accounts

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1 Introduction

Modern market economies are characterised by the performance, over a specific period of time, of a high number of transactions that involve the production and sale of goods and services (mainly products). The value in current terms of each of said transactions is obtained by multiplying the amount produced or exchanged of the product in question by its corresponding unitary price. Thus, for a specific time interval (e.g., a year or a quarter) the total value of the transactions that take place in a given economy results from adding up the individual values of all the transactions performed over said period.

The comparison of said values in time, generally, results from combining variations in the exchanged amounts and modifications regarding the prices at which the transactions have been performed. Consequently, from a statistic and economic point of view, it is interesting to note the extent to which said nominal variations are due to one or another factor, breaking down the nominal variation as regards volume and price.

This double statistic and analytical need has given way to two types of measurements that isolate the effect of variations in amount from variations in prices: estimates at constant prices and chain-linked volume measures. The latter provide a more accurate estimate of the economic phenomenon linked to the production and exchange of amounts of products. Thus the INE, following recommendations issued by Eurostat and other international statistics institutions, has applied this measurement system when compiling National Accounts, both yearly and quarterly.

In the first place, the different assessment systems are set out: at current prices (section 2), at constant prices of a base year (section 3), at prices of the previous year alongside the corresponding chain-linked volume measure (section 4). Hereunder is a chain-linked indices methodology applied to the data published for the 2000-2004 accounting series at constant prices for 1995. Finally, the European Union legal framework that sustains the introduction of this new assessment system is also analysed.

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2 Valuation at current prices

As aforementioned, valuation at current prices is obtained aggregating current exchanges values for all products of the economy. The following table presents an example including hypothetical data on two products (A and B) for three years (0, 1 and 2).

Table 1: Exchange value at current prices

					Year				
		0			1			9	
Product	Price	Quantity	P0Q0	Price	Quantity	P1Q1	Price	Quantity	P2Q2
A B	3 4	5 7	15 28	5 7	9 7	18 35	1 6	9 11	9 66
Total			43			53			75

3 Valuation at constant prices for a year (fixed base)

Interannual variations in the previous table result both from modifications in the amounts exchanged of A and B, and variations in their respective prices. In order to isolate the former from the latter, the valuation at constant prices assesses exchanges in terms of the valid prices for a certain period, called the "base period." The following results are obtained by taking year 0 as the base year, for example:

Table 2: Exchange values at constant prices for year 0

					Year				
		0			1			2	
Product	Price	Quantity	P0Q0	Price	Quantity	P0Q1	Price	Quantity	P0Q2
A B	4	5 7	15 28	2 5	9 7	27 28	1 6	9 11	27 44
Total			43			55			71

Adopting a set year for the valuation implies that, to the extent that the exchange structure for said year is modified over time[1], the corresponding assessment loses relevance and significance, from both economic and statistic viewpoints. Consequently, in order to update quantification structures, base year changes are performed periodically.

Valuations at prices for the previous year (mobile base) and chain-linked volume measures.

If the loss of relevance of the base can be solved by modifying the base year periodically, the ideal solution is to update said base with the same frequency that the estimate is calculated. This operation obtains valuations at prices of the previous year, called "links," which appear in the following table:

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[1] Given the changes in relative prices; modifications in the exchange patterns brought about by changes in technology or preferences; modifications in products exchanged, etc.

Table 3: Exchange values at prices of the previous year

					Year						
		0			1				2		
Product	Price	Quantity	P0Q0	Price	Quantity	P1Q1	P0Q1	Price	Quantity	P2Q2	P1Q2
A B	3 4	5	15 28	5	9 7	18 35	28	1 6	9 11	9 66	18 55
Total			43			53	55			75	73
Link			100				127.9				137.7

As valuations have always been performed considering consecutive pairs of years, creating a homogeneous series that represents the whole sequence of years requires the chain-linking of all yearly links. Said chain-linking is obtained by multiplying each annual link as an index by the chain accumulated up until the previous year. The chain obtained using this method is obviously an index number. Therefore, its conversion to monetary terms is performed by multiplying it by the value at current prices for a specific year, called "reference year". The following table considers year 0 as the reference period:

Table 4: Chain-linked index: basic and monetary expressions

					Year						
		0							2		
Product	Price	Quantity	P0Q0	Price	Quantity	P1Q1	P0Q1	Price	Quantity	P_2Q_2	P1Q2
A 4	3 B	5 7	15 28	2 5	9 7	18 35	27 28	1 6	9 11	9 66	18 55
Total			43			53	55			75	73
Link			100				127.9				137.7
Chain-linked index			100				127.9				176.2
Monetary valuation			43				55				75.8

where: (55/43) x 100= 127.9
(73/53) x 100= 137.7   43x127.9 = 55   43x176.2 = 75.8
127.9x137.7= 176.2

Conversely to what occurs with the valuation at constant prices in which the reference year and the base coincide, it must be noted that they are not equivalent in the system for valuation at prices of the previous year. Thus, the reference year defines the scale for the chain-linked index (setting it at 100), whilst the temporal base is mobile, with as many bases as consecutive pairs of years. Therefore, as a whole, the chain-linked valuation lacks a fixed base (mobile base).

Applying the methodology generates a loss of additivity in the chain-linked volume measures (except in data corresponding to the years considered as the *mobile base* and the immediately subsequent year). Losing additivity implies that, for example, the addition of the components of the Gross Domestic Product (GDP) does not coincide with the latter (except in the data corresponding to the years considered as the *mobile base and the immediately* subsequent year). In general, a variable assessed considering chain-linked volume measures does not add up to the elements that compose it which have been equally assessed via chain-linked volume measures. Losing additivity is a direct consequence of the

mathematical properties of the valuation system. Therefore, discrepancies do not reflect any deterioration whatsoever regarding quality in the measuring process.

The following table considers four products (A, B, C and D) and two ways of aggregating them: Z=X+Y, where X=A+B and Y=C+D and V=A+B+C+D. All years, except for the reference year (0) and the following year (1), show a discrepancy between both forms of composing totals Z and V.

Table 5: Chain-linked index: loss of additivity

Product	Year 0			Year 1				Year 2			
	Price	Quantity	P0Q0	Price	Quantity	P1Q1	P0Q$_1$	Price	Quantity	p_2Q_2	p_1Q_2
A	3	5	15	2	9	18	27	1	9	9	18
B	4	7	28	5	7	35	28	6	11	66	55
X=A+B			43			53	55			75	73
Link			100			127.9					137.7
Chain-linked index			100			127.9					176.2
Monetary valuation (X)			43			55					75.8
C	5	11	55	6	14	84	70	9	16	144	96
D	6	14	84	7	11	77	66	5	14	70	98
Y=C+D			139			161	136			214	194
Link			100			97.8					120.5
Chain-linked index			100			97.8					117.9
Monetary valuation (Y)			139			136					163.9
Z=X+Y			182			191					239.6
V=A+B+C+D			182			214	191				267
Link			100			104.95					124.77
Chain-linked index			100			104.95					130.94
Monetary valuation (V)			182			191					238.3
Z=X+Y Monetary			182			191					239.6
valuation (V)			182			191					238.3
difference			0			0					1.3

In order to facilitate analysis and estimates, the reference is modified each time a new datum is published, always ensuring that the last year is additive. Modifying the reference changes the levels of the whole series, but preserves growth, as appears in the following table, referring exclusively to products A and B and their aggregate (X) that are included in table 5:

Table 6: Chain-linked index with reference modification

Year Reference		Year		
		0	1	2
0	Chain-linked index	100.0	127.9	176.2
	Monetary valuation	43.0	55.0	75.8
	Δ	-	27.9	37.7
1	Chain-linked index	78.2	100.0	137.7
	Monetary valuation	41.4	53.0	73.0
	Δ	-	27.9	37.7
2	Chain-linked index	56.8	72.6	100.0
	Monetary valuation	42.6	54.5	75.0
	Δ	-	27.9	37.7

5 Counterfactual assessment of the National Accounts

The table hereunder is a numerical example comparing the data published at constant prices for 1995 for the main demand aggregates (SNA 1995 Base), with those that would have been obtained if the chain-linked methodology had been applied to said figures.

FIXED BASE 1995

	1000 CONSTANT	1000 CURRENT	IQ	TP	IV	2001 CONSTANT	2001 CURRENT	IQ	IP	IV	2001 CONSTANT	2001 CURRENT	IQ	n>	TV	3003 CONSTANT	3003 CURRENT	IQ	IP	IV	2004 CONSTANT CURRENT
Domestic FCE on food, beverage and tobacco	63,407	70,755	102.64	105.05	107.82	65,084	76,291	102.0	104.89	107.07	66,437	81,684	101.83	103.96	105.86	67,651	86,468	101.3	103.45	104.85	68,566	90661
Domestic FCE on items other than foodstuffs	270,009	312,606	102.79	103.09	105.97	277548	331,257	101.9	103.17	105.14	282,834	348.279	102.75	103.04	105.88	290,611	368,744	103.1	102.94	106.18	299,771	391,549
FCE NPISH	3,760	4,300	101.73	103.72	105.51	3,825	4,537	104.2	103.69	108.13	3989	4,906	104.64	104.31	109.15	4,174	5,355	101.8	103.35	105.23	4,250	5,635
FCE PAs	**93,927**	107,780	103.55	103.17	106.83	97,261	115,145	104.1	103.35	107.58	101,244	123875	103.89	103.38	107.41	105,185	133,050	104.8	104.66	109.77	110,325	146,049
GFFC in capital goods	41,299	45,566	98.82	101.01	99.82	40,812	45.4S3	94.55	101.62	96.08	38,588	43,700	101.00	101.91	102.93	38,974	44,980	105.8	102.09	108.01	41,236	48584
GFFC in construction	68,955	83,660	105.30	105.46	111.05	72,610	92,904	105.2	105.27	110.80	76,422	102.938	104.30	106.03	110.59	79,708	113,838	104.4	107.86	112.66	83,255	128,253
GFFC in other products	20,252	25,115	103.66	103.69	107.49	20,993	26,995	103.01	104.70	107.85	21,625	29,114	103.00	105.44	108.60	22,274	31,619	103.2	107.15	110.60	22,993	34.972
Variation in stocks	1987	2,272	83.09	102.55	85.21	1,651	1,936	110.4	102.16	112.86	1824	2,185	124.18	104.19	129.38	2,265	2,827	156.3	254.23	397.56	3,542	11239
Export of goods	113,026	126,559	102.36	102.06	104.47	115695	132,221	102.9	99.98	102.96	119,135	136131	103.93	99.60	103.51	123,814	140,912	106.9	98.87	105.71	132,383	148,958
Export of non-tourist services	20,195	23,216	111.13	102.87	114.32	22,443	26,540	103.5	103.16	106.80	23,235	28,344	99.42	102.55	101.96	23,101	28,900	98.85	102.50	101.31	22,835	29280
Import of goods	-144,002	-164,255	103.26	99.83	103.08	-148,697	-169,316	103.3	98.07	101.39	-153,731	-171,670	105.16	99.68	104.83	-161,670	-179,958	109.8	102.88	113.03	-177.608	-203,402
Import of non-tourist services	-23,124	-27,033	106.94	104.00	111.22	-24,729	-30,066	100.90	101.85	102.76	-24,951	-30,897	102.32	101.16	103.51	-25,531	-31,981	100.55	102.95	103.52	-25,671	-33,106
GDP	529,691	610,541	102.80	104.19	107.11	544496	653,927	102.23	104.50	106.83	556,651	698589	102.50	104.01	106.61	570,556	744,754	102.69	104.44	107.24	585,877	798,672
GROUPING																						
	431,103	495,441	102.93	103.39	106.42	443718	527,230	102.43	103.46	105.98	454,504	558744	102.89	103.26	106.24	467,621	593,617	103.27	103.40	106.79	482,912	633,894
FCE GFC																						
Exports	132,493	156,613	102.70	104.03	106.84	136.066	167,318	101.7	104.51	106.35	138,459	177.937	103.44	105.00	108.61	143,221	193,264	105.4	109.45	115.41	151,026	223,048
Imports	133,221	149,775	103.69	102.23	106.00	138.138	158,761	103.0	100.52	103.60	142,370	164.475	103.19	100.05	103.24	146,915	169,812	105.6	99.35	104.96	155,218	178,238
	-167,126	-191,288	103.77	100.44	104.23	-173,426	-199,382	103.03	98.61	101.60	-178,682	-202,567	104.77	99.87	104.63	-187,201	-211,939	108.59	102.77	111.59	-203279	-236,508
GDP	529,691	610,541	102.80	104.19	107.11	544496	653,927	102.23	104.50	106.83	556,651	698589	102.50	104.01	106.61	570,556	744,754	102.69	104.44	107.24	585,877	798,672

where:

IQ = volume index IP = price index IV = value index

The indices with the highest level of break down are taken as the interannual indices:

CHAIN-LINKED INDICES

	2000 CORRIENTES	IQ	IP	IV	2001 CONSTANTES período anterior	2001 CORRIENTES	IQ	IP	IV	2002 CONSTANTES período anterior	2002 CORRIENTES	IQ	IP	IV	2003 CONSTANTES período anterior	2003 CORRIENTES	IQ	IP	IV
Domestic FCE on food, beverage and tobacco	70.755	102,64	105,05	107,82	72.626	76.291	102,08	104,89	107,07	77.877	81.684	101,83	103,96	105,86	83.177	86.468	101,35	103,45	104,85
Domestic FCE on items other than foodstuffs	312.606	102,79	103,09	105,97	321.334	331.257	101,90	103,17	105,14	337.566	348.279	102,75	103,04	105,88	357.856	368.744	103,15	102,94	106,18
FCE NPISH	4.300	101,73	103,72	105,51	4.374	4.537	104,29	103,69	108,13	4.732	4.906	104,64	104,31	109,15	5.134	5.355	101,82	103,35	105,23
FCE APs	107.780	103,55	103,17	106,83	111.606	115.145	104,10	103,35	107,58	119.860	123.875	103,89	103,38	107,41	128.697	133.050	104,89	104,66	109,77
GFFC in capital goods	45.566	98,82	101,01	99,82	45.029	45.483	94,55	101,62	96,08	43.004	43.700	101,00	101,91	102,93	44.137	44.980	105,80	102,09	108,01
GFFC in construction	83.660	105,30	105,46	111,05	88.094	92.904	105,25	105,27	110,80	97.781	102.938	104,30	106,03	110,59	107.364	113.838	104,45	107,86	112,66
GFFC in other products	25.115	103,66	103,69	107,49	26.034	26.995	103,01	104,70	107,85	27.808	29.114	103,00	105,44	108,60	29.988	31.619	103,23	107,15	110,60
Variation in stocks	2.272	83,09	102,55	85,21	1.888	1.936	110,48	102,16	112,86	2.139	2.185	124,18	104,19	129,38	2.713	2.827	156,38	254,23	397,56
Export of goods	126.559	102,36	102,06	104,47	129.548	132.221	102,97	99,98	102,96	136.152	136.131	103,93	99,60	103,51	141.478	140.912	106,92	98,87	105,71
Export of non-tourist services	23.216	111,13	102,87	114,32	25.800	26.540	103,53	103,16	106,80	27.477	28.344	99,42	102,55	101,96	28.181	28.900	98,85	102,50	101,31
Import of goods	-164.255	103,26	99,83	103,08	-169.610	-169.316	103,39	98,07	101,39	-175.048	-171.670	105,16	99,68	104,83	-180.535	-179.958	109,86	102,88	113,03
Import of non-tourist services	-27.033	106,94	104,00	111,22	-28.909	-30.066	100,90	101,85	102,76	-30.336	-30.897	102,32	101,16	103,51	-31.615	-31.981	100,55	102,95	103,52
	610.541	102,83	104,16	107,11	627.814	653.927	102,31	104,42	106,83	669.012	698.589	102,57	103,93	106,61	716.572	744.754	102,84	104,27	107,24
PIE GROUPING:																			
FCE	495.441	102,93	103,39	106,42	509.941	527.230	102,43	103,46	105,98	540.035	558.744	102,88	103,26	106,24	574.863	593.617	103,27	103,41	106,79
GFC	156.613	102,83	103,90	106,84	161.045	167.318	102,04	104,22	106,35	170.732	177.937	103,52	104,92	108,61	184.202	193.264	105,32	109,58	115,41
Exports	149.775	103,72	102,20	106,00	155.348	158.761	103,07	100,52	103,60	163.629	164.475	103,15	100,09	103,24	169.658	169.812	105,55	99,45	104,96
Imports	-191.288	103,78	100,43	104,23	-198.520	-199.382	103,01	98,63	101,60	-205.384	-202.567	104,73	99,90	104,63	-212.151	-211.939	108,45	102,89	111,59
GDP	610.541	102,83	104,16	107,11	627.814	653.927	102,31	104,42	106,83	669.012	698.589	102,57	103,93	106,61	716.572	744.754	102,84	104,27	107,24

The following differences appear when comparing volume indices obtained for the grouping of four components, using both systems:

INDEXES	2000	2001	2002	2003	2004
FCE*	100.00	102.93	102.43	102.88	103.27
GFC	100.00	102.83	102.04	103.52	105.32
Exports	100.00	103.72	103.07	105.55	105.55
Imports	100.00	103.78	103.01	104.73	108.45
GDP	100.00	102.83	102.831	102.57	102.84

FIXED BASE 1995	2000	2001	2002	2003	2004
FCE*	100.00	102.93	102.43	102.89	103.27
GFC	100.00	102.70	101.76	103.44	105.45
Exports	100.00	103.69	103.06	103.19	105.65
Imports	100.00	103.77	103.03	104.77	108.59
GDP	100.00	102.80	102.23	102.50	102.69

DIFFERENCES	2000	2001	2002	2003	2004
FCE*	0.00	0.00	0.00	0.00	0.00
GFC	0.00	0.13	0.28	0.08	-0.12
Exports	0.00	0.03	0.030	-0.04	-0.10
Imports	0.00	0.01	-0.02	-0.04	-0.14
GDP	0.00	0.03	0.07	0.08	0.16

* differences appear as of the fourth

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6   Legal framework

Chain-linked volume measurements in Spanish National Accounts are envisaged in European Commission Decision number 98/715, establishing their compulsory nature in the transmission of data from National Statistics Institutes to the Statistical Office of the European Union, EUROSTAT.

Throughout 2005, the following EU countries will include chain-linked volume measures in their National Accounts: Germany, Austria, Cyprus, Denmark, Slovakia, Spain, Finland, France, Greece, Holland, Italy, Lithuania, Luxembourg, Malta, Poland, Portugal, Czech Republic, United Kingdom and Sweden. These measures are also applied in Australia, Canada, United States, Japan and New Zealand, among others.

There is no equivalent legal framework for Quarterly National Accounts. Nevertheless, to maintain consistency, Eurostat and other international statistical institutions such as the International Monetary Fund (IMF) and the Organisation for Economic Cooperation and Development (OECD), among others, have recommended their implementation. The methodology applied for the quarterly accounts requires a series of special technical considerations that are detailed in a specific document.