New evidence on elementary index bias

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The issue

- large theoretical literature on the choice of index formula for inflation measurement
- cost of living index: superlative price index (Fisher Ideal index)
- in practice : aggregate index is a *weighted sum* of lower (product) level aggregates
- in practice: lowest level of aggregation usually no weights available: say Kellog's cereal vs Nestle cereal. But now potentially available with scanner data
- Elementary index bias: difference between price change measured using any elementary index and Fisher Ideal index
- ISSUE : How large is elementary index bias?

What do we know about the issue

- Know relatively little about the importance of elementary index bias in practice for official price statistics
- REASON: You need expenditure information at the lowest product level to check whether not having it at the lowest level is important.
- Earlier studies: Silver(1995),Feenstra and Shapiro (2001) , Dalén (1997), Hawkes (1999), Reinsdorff (1999), Jain and Abello (2001), Rotaru et al. (2011),...
- How generalisable are results? How wide is variation across product categories? Does elementary index bias show in aggregate index numbers?

Our data

- 15844 items (unique stock keeping unit in particular country-store type)
- example: 1 liter plastic bottle regular Coca Cola in Germany-Gas stations
- 42 product categories: rice ; cereal ; tinned tuna ; margarine ; frozen peas ; still water ; ...
- 10 euro area countries
- unit price and quantity: monthly-store type level
- item selection: most sold brands and most sold package sizes

Data

Country	product cat.	SKU	store types	items
AT	41	371	9	1925
BE	38	338	4	925
DE	40	383	14	2350
ES	16	153	15	816
FR	32	333	8	2002
GR	34	347	5	1680
IE	33	306	4	891
IT	34	346	20	2952
NL	33	242	12	779
PT	37	347	9	1524

Diewert (1995)
Thus the lowest level aggregates would normally be shop specific unit values. However if individual outlet data on transactions were not available or were considered to be too detailed, then unit values for a homogeneous commodity over all outlets in a market area might form the lowest level of aggregation.

What we do :

- construct elementary indexes as the direct comparison index at December 2010, base December 2009
- construct aggregate indexes
- calculate difference with Fisher Ideal index

Elementary indices (no weighting)

- Dutot Index

$$DUTOT_{it} = \frac{\sum_b^B p_{ibt}}{\sum_b^B p_{ibt_0}} \tag{1}$$

- Jevons Index:

$$JEVONS_{it} = \prod_b^B \sqrt{\frac{p_{ibt}}{p_{ibt_0}}} \tag{2}$$

- Carli index:

$$CARLI_{it} = (1/B) \sum_b^B \frac{p_{ibt}}{p_{ibt_0}} \tag{3}$$

Elementary indices (with weighting)

- Laspeyres Index (Base month weights)
- Paashe Index (Base month weights)
- Lowe index (modified Laspeyres)
- Expenditure weighted Jevons index
- Geometric Lowe index
- Fisher Ideal index

Aggregate indexes

- Laspeyres Index (Base month weights) (aggregate of elementary indexes)
- Lowe index (modified Laspeyres) (aggregate of elementary indexes)
- Fisher Ideal index (directly from the item data)

Elementary index bias (percentage points)

	CARLI	DUTOT	JEVONS
mean	0.49	-0.05	0.00
sd	3.12	3.58	3.01
min	-19.74	-27.53	-21.59
p50	0.42	0.14	0.08
max	24.03	9.98	13.54

Elementary index bias (percentage point)

	LASP	LOWE	PAAS	JEVEW	GLOWE
mean	0.55	0.23	-0.53	0.27	-0.05
sd	1.29	1.08	1.22	1.03	1.07
min	-5.09	-4.54	-10.47	-5.57	-6.87
p50	0.20	0.10	-0.20	0.09	-0.01
max	11.69	7.69	5.36	10.39	5.99

Biases of Aggregate indexes

- Laspeyres Index (Base month weights) (aggregate of elementary indexes)
- Two sources of bias:
- 1) elementary index is different from Fisher Ideal
- 2) aggregation of product categories to national index uses fixed weight Laspeyres
- We define *"aggregate elementary index bias"* as difference between Laspeyres aggregation of elementary index and Laspeyres aggregation of Fisher Ideal elementary indexes
- We define *"upper level substitution bias"* as difference between Laspeyres aggregation of Fisher Ideal elementary indexes and Fisher Ideal.

Upper level substitution and aggregate elementary index bias (percentage point)

Elementary Index	mean	sd	min	p50	max
Upper level substitution bias					
	0.20	0.25	0.01	0.10	0.66
Aggregate elementary index bias					
CARLI	0.34	1.19	-1.84	0.48	2.31
DUTOT	-0.13	1.49	-3.00	-0.01	2.55
JEVONS	-0.06	1.22	-2.42	0.15	1.78
LASP	0.45	0.30	0.15	0.34	0.98
LOWE	0.22	0.22	-0.03	0.11	0.59
PAAS	-0.44	0.29	-0.96	-0.34	-0.15
JEVEW	0.26	0.24	-0.00	0.16	0.65
GLOWE	0.03	0.17	-0.16	-0.01	0.40

Euro area : Upper level substitution and aggregate elementary index bias (percentage point)

Elementary Index	mean	sd	min	p50	max
Upper level substitution bias					
	0.11				
Aggregate elementary index bias					
CARLI	0.31				
DUTOT	-0.13				
JEVONS	0.01				
LASP	0.34				
LOWE	0.12				
PAAS	-0.33				
JEVEW	0.20				
GLOWE	-0.02				

Conclusion

- elementary index bias varies a lot (across product categories, countries)
- using weights reduces the variability of the bias considerably
- aggregate elementary index bias looks more important than upper substitution bias