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Comparing current and constant price multipliers for Belgium

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Abstract - This paper first describes the methodology that has been followed to deflate a consistent time series of Belgian SUT and IOT for the period 1995-2007. Based on this series, the evolution 1995-2005 of final demand multipliers derived from current and constant price IOT is then compared. This analysis is made at a very detailed industry level.

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1. Introduction

As part of the system of national accounts, Supply and Use Tables (SUT) and Input-Output Tables (IOT) provide detailed information about economic flows in monetary terms: they describe production processes, the supply and use of goods and services, and income generated through production. Input-output analysis is essentially concerned with quantifying the mutual interrelationships among various industries. One of the most common applications of input-output analysis is the computation of multipliers. In this paper, we compare the evolution of current and constant price multipliers for Belgium between 1995 and 2005.

In Belgium, the principal macroeconomic statistics and forecasts are published under the responsibility of the National Accounts Institute (NAI), which is composed of three member institutions: Statistics Belgium, the National Bank of Belgium (NBB) and the Federal Planning Bureau (FPB). The compilation of the Belgian SUT (and national accounts) has been delegated by the NAI to the NBB; the construction of the IOT to the FPB.

According to the ESA 1995 transmission programme[1], SUT_{cup} (in current prices) and SUT_{pyp} (in prices of the previous year) have to be compiled and delivered to Eurostat annually, and IOT_{cup} every five years (for the benchmark years ending in 0 and 5). As compiling SUT and IOT is a very demanding task and as national accounts should be sufficiently stable for the reference year, Eurostat allows a maximum transmission delay of 36 months and does not ask for revisions of SUT and IOT.

In practice, however, national accounts can still be subject to major revisions even after 36 months (due to so-called *benchmark* or *occasional* revisions, contrary to continuous *regular* revisions), which gives rise to a problem of consistency when using time series of SUT and IOT. Moreover, for Belgium only current price SUT and IOT have so far been published officially by the NAI. A first task necessary to allow an appropriate comparison of multipliers over time, was thus to construct a consistent time series of current price SUT and IOT, compiled in one vintage of national accounts. A second task was to deflate these SUT and IOT.

Both tasks have been carried out by the FPB in 2012.[2] In this non-official 'analytical' database, Belgian annual SUT 1995-2007 and 5-yearly IOT (1995-2005) have been brought in line with the national accounts vintage of November 2010[3], which was the last full version of the national accounts in NACE Rev. 1.1. In particular, this updated series of tables takes into account the benchmark revision of the GDP expenditure approach introduced in the Belgian national accounts in 2009. The whole updating exercise was implemented at the working format disaggregation level of about 130 industries (NACE Rev. 1.1) and some 320 products (CPA 2002). The constant price tables have been calculated with base year 2005.

1 REGULATION (EC) No 1392/2007 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 November 2007 amending Council Regulation (EC) No 2223/96 with respect to the transmission of national accounts data.
2 For a description of the methodology followed, see: Avonds et al. (2012).
3 For this national accounts vintage, see: NAI (2010).

The resulting consistent time series of updated SUT and IOT at both current and constant prices allows us, for the first time for Belgium, to realise a series of traditional input-output analyses without methodological break and to isolate the impact of price effects.

The core of this paper consists of two chapters. The method followed to deflate the SUT and IOT is described in Chapter 2. In Chapter 3 the evolution 1995-2005 of three types of multipliers (output, income and employment multipliers) computed at current and constant prices will be compared.

2. Deflating SUT and IOT

In this chapter, the method followed to deflate SUT and IOT will be described. As explained in the introduction, the starting point for this deflation exercise is a consistent series of current price SUT 1995-2007, that has been adapted to the 2010 vintage of national accounts, computed both at purchasers' prices and at basic prices. Moreover use tables have been broken down according to the origin of goods and services (domestic production or imports).

This series of SUT has been first deflated to obtain constant price tables (with base year 2005) (see section 2.1). In a second step constant price IOT for 1995, 2000 and 2005 have been derived from the constant price SUT for these years (see section 2.2).[4]

2.1. Constant price SUT

According to Eurostat[5], the process of the compilation of SUT at current and constant prices can be organised in two ways. The first can be referred to as the *sequential approach*, meaning that the compilation of balanced current price SUT is first completed and these tables are deflated and balanced in constant prices afterwards. The alternative is the *simultaneous approach*, which means that the tables at current and constant prices are compiled and balanced 'at the same time' (by an iterative process). The simultaneous approach is more complicated, but generally leads to an outcome of higher quality, because it creates the possibility to analyse values, prices and volumes in relation to each other during the balancing process.

In this deflation exercise however the sequential approach has been used. The main reason is the timing of the deflation exercise and the particular Belgian institutional context: it was carried out by the FPB, ex post to the finalisation of national accounts. As we chose to comply with the given national accounts aggregates at constant prices, a simultaneous approach was simply not feasible.

The deflation method followed here is based on two main principles: (i) the deflation is done at basic prices and (ii) separate price indices (with base year 2005) by product for domestic production and imports – unofficially provided by the NBB – are used.

The different steps of the deflation process of the SUT are described below.

a. First estimate of SUT at constant basic prices

A *first estimate* of the SUT[6] at constant basic prices is obtained by:

- deflating the make tables and the use tables for domestic production by the price indices for domestic production, and
- deflating the use tables for imports by the price indices for imports.

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4 Remark that the official IOT for 2005 was already consistent with the national accounts vintage of 2010. Moreover, with base year 2005, the IOT of 2005 is the same at current and at constant prices.

5 Eurostat (2008), pp. 247-252.

6 In this stage, margins have been deleted from the supply and use tables. Margins will be treated separately (see step b and d.3).

The total use tables at constant prices are then obtained as the sum of the constant price use tables of domestic production and imports.

In this first stage for each product[7] the assumption of an identical price in all uses (taking into account its domestic or foreign origin) is made. It also follows that after this first stage, supply and use at constant basic prices of all products is automatically balanced.

b. First estimate of trade margins

Trade margins (both on the supply and the use side) were not considered in the previous step.[8] To build a complete SUT at constant prices (up to the computation of value added), a deflation of margins is however necessary. A first estimate of the use table of trade margins at constant prices has been obtained by multiplying the margin rates (by type and product) of the year 2005[9] by the first estimate of the constant price use totals by product (from step a), and then distributing these margin totals over industries according to the structure of the use table of margins at current prices.

c. Treatment of taxes and subsidies on products

Taxes and subsidies on products figure in the use table at basic prices as separate rows (totals by industry) and thus have also to be deflated to obtain a complete use table. Taxes and subsidies at constant prices have been obtained for each year by multiplying the first estimates of the constant price use tables (from step a) by the tax and subsidy rates of the year 2005 [10] (cell by cell multiplication).

As this calculation is based on a first estimate of the use table, a plausibility check on the final version of the use table has been performed at the end of the procedure. Based on this plausibility check, no adjustment seemed necessary. Accordingly, this outcome for taxes and subsidies at constant prices can be considered as a final result.

d. Imposing national accounts totals at constant prices

As mentioned before, we chose to comply with the available national accounts aggregates at constant prices. The final SUT at constant prices were constrained to respect the following constant price (with base year 2005) national accounts totals (provided by the NBB): output (P1) at basic prices by industry, intermediate consumption (P2) at purchasers' prices by industry[11], total imports of goods and services (P7), total final consumption expenditure of households (P31S14), total final consumption expenditure of NPISH (P31S15), total final (individual and collective) consumption expenditure of general gov-

[7] As a reminder, computation has been carried out at the working level of some 320 products.

[8] To ensure consistency with the official SUT 2005-2007, transport margins have been set to zero for the years 1995-2004 in the current price tables. They have been allocated to the corresponding transport services or to wholesale margins.

[9] Four types of trade margins have been distinguished: wholesale and retail trade margins on motor vehicles and motorcycles; wholesale and retail trade margins on fuels; other wholesale trade margins; other retail trade margins. Margin rates have been computed by dividing margins at current prices by uses at current basic prices for the year 2005.

[10] Tax and subsidy rates have been computed by dividing taxes and subsidies at current prices by uses at current basic prices for the year 2005. Five types of taxes were distinguished (VAT, excises, import duties, EU taxes and other taxes on products).

[11] As a reminder, both P1 and P2 are at the working level of about 130 industries. Remark that by respecting output at basic prices and intermediate consumption at purchasers' prices by industry, value added by industry has also been respected.

ernment (P31S13 and P32S13), total gross fixed capital formation (P51), total change in inventories (P52), and total exports of goods and services (P6).

Since the first estimates of the SUT at constant prices (from step a and b) are not consistent with these constant price national accounts totals, a number of sequential adjustments were implemented:

1. Supply tables (composed of products from step a and margins from step b) were adjusted column-wise, proportionally to the national accounts totals for constant price output by industry and total imports of goods and services.
2. Use tables (excluding trade margins) (from step a) were adjusted column and row-wise by means of a RAS procedure. Constant price intermediate consumption totals by industry and final demand totals by category (for the above mentioned final demand categories)[12] from the national accounts were used as column totals, and total supply by product coming from the previously adjusted supply tables (step d.1) were used as row totals. The resulting total use tables have been broken down into use of domestic production and imports according to the structure of the use tables obtained in step a.
3. Finally, the use tables of trade margins (from step b, 4 types of margins) have been adapted proportionally to the trade margin totals obtained in step d.1.

All this finally results in a full set of constant price (with base year 2005) SUT at both basic and purchasers' prices for the years 1995 to 2007, compatible with constant price totals of the 2010 vintage of the national accounts.

Imposing to respect constant price national accounts aggregates leads to final deflators (results taken from step d) which are different from the deflators based on the initial price indices (step a). Looking at the 1995-2005 growth rates of the initial and final deflators of output (P1) by product (some 320 products), Spearman's rank correlation coefficient between both series amounts to 91%. In the light of the computation of multipliers, it is important to notice that imposing the national accounts constraints does not affect substantially the relative prices between products.

2.2. Constant price IOT

Finally, and this is a novelty for Belgium, constant price IOT (at prices of 2005) have been calculated for the years 1995 and 2000, both for the total tables and the tables differentiating between domestically produced and imported products.[13] The constant price IOT were derived from the constant basic price SUT. This is the so-called *indirect* method, which is generally preferred to the *direct* method consisting in deriving constant price IOT from current price IOT.

The IOT are of the product-by-product type, as preferred by Eurostat. In product-by-product IOT, the heterogeneous industries of the SUT are transformed into so-called homogenous industries. This

[12] More particularly, for six final demand categories (P31S14, P31S15, P31S13, P32S13, P51 and P6). P52 (change in inventories, which can be either positive or negative) has been treated separately outside the RAS procedure.

[13] Needless to say that for the year 2005 constant and current price IOT are identical.

means that the secondary output[14] of each industry, together with the associated intermediate and primary inputs, have to be transferred to the industries of which they are the characteristic products.

The method used to calculate constant price IOT is analogous to the one used to construct current price IOT. The main elements of this method are briefly commented on below.

The transformation of SUT into product-by-product IOT was carried out using a 'mixed technology model' with a clear predominance of the product technology assumption[15]. In general, product technology has been preferred because it is considered as more plausible and better in line with the principles of input-output analysis. Some of the negatives originating from the application of the product technology assumption have been eliminated by applying analytical disaggregations[16] at constant prices. In a limited number of cases[17], the industry technology assumption was applied. The remaining (small) negatives[18] were eliminated by purely mechanical procedures (Almon-RAS).

The updated constant price IOT for the years 1995 and 2000 were then split into IOT for domestic output and for imports, by means of a method proposed in Eurostat (2008, p. 332). This method consists in deriving IOT for imports from the use table of imports, by making the assumption that the import/domestic production ratio (in this case taken from the use tables at constant prices) of a particular input of an industry applies to all products for which this input is used by that industry. The total of imported products used to produce a product is then calculated by aggregating all industries producing that product. The IOT for domestic output is calculated as the difference between the total IOT and the IOT for imports.

14 Secondary production is output that, according to the underlying product and activity classifications, is not characteristic for the industry that actually produces it.

15 According to the product technology assumption, each product is produced in its own specific way, irrespective of the industry where it is produced.

16 By *analytical disaggregations,* we mean exogenous estimations of inputs to be transferred together with secondary outputs. The introduction of these disaggregations relaxes to some extent the assumption of product technology.

17 For the computation of the constant price IOT for 1995 for instance, industry technology has been applied in 9 out of 127 industries.

18 The remaining negatives in the constant price IOT for 1995 represent 3.55% of P2, which is less than the corresponding share in the current price IOT of the same year (3.92%).

3. Current and constant price multipliers

As explained above, the updating exercise resulted in a consistent time series of annual current and constant price SUT (1995-2007) and 5-yearly current and constant price IOT (1995, 2000, 2005) for Belgium. All tables are broken down according to the origin of goods and services (domestic production or imports).

Based on the current and constant price IOT for domestic production, three types of final demand multipliers have been calculated: output (OM), income (IM)[19] and employment multipliers (EM). For the latter two, both absolute (simple) multipliers (IM-S, EM-S) and relative (type I) multipliers (IM-I, EM-I) have been computed.[20] In this section, the evolutions of current and constant price multipliers over the period 1995-2005 will be compared.

In the three types of multipliers considered here, the Leontief inverse matrix $L = (I\text{-}A^d)^{-1}$ plays a central role, A^d representing the matrix of technical domestic intermediate input coefficients. For the calculation of income and employment multipliers, the Leontief inverse is pre-multiplied by respectively technical primary input coefficients and technical employment coefficients. When calculating multipliers at current prices over time, the evolution of these technical coefficients is not only determined by 'real' changes in production technologies, but also by relative price changes.[21] By computing constant price multipliers, the relative price change effect is excluded and a more appropriate measure of technological change (reflecting changes in the input structure) is obtained.[22]

Some figures can illustrate the extent of relative price changes in Belgium over the period considered here. Between 1995 and 2005, overall prices (all goods and services) rose by 1.8% on average per year.[23] For almost 40% of all product groups a close to average inflation (between 1.3 and 2.3% per year) was observed. For 22 product groups (out of 133) however, a price decrease was observed (up to -1.8% on average per year). This was for instance the case for office machinery, computers and communication equipment, but also for prepared animal feeds and paper products. Price increases of over 3% per year on the other hand were observed for 14 product groups (e.g. for cement and a number of services, such as hotel services and distribution of water). The price of petroleum products has even increased by 11% per year over the period considered.

Have those observed relative price changes led to significant different evolutions of current and constant price multipliers?

First of all, at the level of the total economy, the evolution of current and constant price multipliers is identical. This can intuitively be understood by considering a multiplier as the ratio between the initial effect of the exogenous final demand shock and the cumulated (direct and indirect) effect. As explained

19 *Income* stands for *primary inputs*, which is value added augmented by non-deductible taxes less subsidies on intermediate consumption.

20 This is the terminology used in Miller and Blair (2009). For more details, see: Hambÿe (2012) and Hambÿe (2013).

21 If prices of all goods and services have the same growth rates (and relative prices thus do not change over time), the evolution of current and constant multipliers is identical.

22 Remark that the original input-output model developed by Leontief was even expressed in physical units (e.g. bushels of wheat, yards of cloth…). Accordingly, direct input coefficients were based on physical quantities of inputs divided by physical quantities of output. See Miller and Blair (2009, p. 41).

23 Measured here by domestic production prices at basic prices, at the aggregation level of 133 product groups.

before, the evolution of this ratio over time is determined by changes in production technology (volume effect) and by relative price changes. The latter factor plays only because the price change of the product group (in the denominator of the ratio) is different from the (weighted) price change of the cumulated effect (in the numerator of the ratio, which is a mix of different goods and services that are directly and indirectly impacted). As for total economy multipliers, both the denominator and the numerator consist of the same (complete) mix of goods and services of the economy, the relative price effect disappears and the evolution over time of the current and constant price multipliers becomes the same. This is obviously not true for the simple employment multiplier.[24] The evolution of the current price simple employment multiplier is affected downward by the fact that the value of a million euro decreases over time, which is not the case for the constant price simple employment multiplier. Indeed, the difference between the two (14.9 persons per million € of 1995 and 12.5 persons per million € of 2005) reflects perfectly overall inflation, which was 19% over 1995-2005). A column EM-S* was added in the table below (part 1995 CUP), correcting the simple employment multipliers of 1995 for overall inflation.

Table 1 Total economy multipliers
1995-2005

	1995 CUP (= 95P95)						1995 COP (= 95P05)					2005 CUP = 2005 COP (= 05P05)				
	OM-S	IM-S	IM-I	EM-S	EM-S*	EM-I	OM-S	IM-S	IM-I	EM-S	EM-I	OM-S	IM-S	IM-I	EM-S	EM-I
Total economy	1.59	0.74	1.54	14.9	12.5	1.49	1.59	0.74	1.54	12.5	1.49	1.58	0.70	1.51	10.7	1.47

Source: FPB

The observed evolution of economy-wide multipliers over time originates only from changes in production technology; relative price movements have no impact. The equality of constant and current price changes in economy-wide multipliers does of course not hold at the industry level. We first analyse the evolution of current and constant price multipliers split into goods and services, and then look at the more detailed level of some 130 homogenous industries.

3.1. Goods and services breakdown

To understand the different evolution of constant and current price multipliers for goods and services, a number of underlying factors should be born in mind. First of all, over the period 1995-2005 price inflation for goods (1.4% per year) has on average been significantly lower than for services (2.0%). The resulting relative price change makes that the Leontief inverse matrix based on input coefficients calculated at current prices differs from the table computed at constant prices. As this Leontief inverse matrix is present in the formulas of all five multipliers considered here, this is an important factor to take into account. A second important factor to notice is the fact that the production directly and indirectly generated following a demand shock on goods is more heterogeneous[25] than in the case of a demand shock on services. Finally, the technical primary input and employment coefficients are rather different on average for goods and for services, and their evolution differs at current and at constant prices, as is shown in the table below.

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24 The simple employment multiplier has a unit, as it gives the cumulated employment effect per million euro. For the other four multipliers considered here, the numerator and denominator have the same unit and so these multipliers are unitless numbers.

25 More precisely, a demand shock on goods generates (in relative terms) more services than vice versa.

Table 2 Technical coefficients: goods and services breakdown
1995-2005

	1995 CUP (= 95P95)		1995 COP (= 95P05)		2005 CUP = 2005 COP (= 05P05)	
	Goods	Services	Goods	Services	Goods	Services
Primary input coefficient	29.9%	60.0%	27.1%	61.3%	26.5%	55.5%
Employment coefficient*	4.7	10.4	4.9	10.1	3.8	8.7

* For 1995 CUP: corrected for general inflation
Source: FPB

All technical coefficients decrease between 1995 and 2005. For goods, the primary input (employment) coefficient decreases less (more) at constant prices as compared to current prices. For services, the opposite is true.

Table 3 Multipliers: goods and services breakdown
1995-2005

	1995 CUP (= 95P95)						1995 COP (= 95P05)					2005 CUP = 2005 COP (= 05P05)				
	OM-S	IM-S	IM-I	EM-S	EM-S*	EM-I	OM-S	IM-S	IM-I	EM-S	EM-I	OM-S	IM-S	IM-I	EM-S	EM-I
Goods	1.69	0.58	2.01	10.8	9.1	1.99	1.73	0.56	2.16	9.5	2.02	1.67	0.51	1.97	7.3	2.04
Services	1.54	0.87	1.41	20.5	17.3	1.31	1.52	0.88	1.39	16.6	1.31	1.55	0.82	1.41	14.3	1.32

Source: FPB

Combining all these elements leads to a very mixed picture of multipliers. Without going into the details, a number of global conclusions and observations can be made. First of all, because of the degree of heterogeneity of the generated production, differences between current and constant price multipliers are generally more important for goods than for services. Secondly, relative price movements lead to an output multiplier at current prices in 1995 for goods which is lower than the corresponding constant price multiplier (1.69 compared to 1.73), and vice versa for services (1.54 compared to 1.52). As a consequence, both for goods and services, the change in the output multiplier between 1995 and 2005 is somewhat more marked at constant prices than at current prices (-0.06%-point compared to -0.02%-point for goods, and +0.03%-point compared to +0.01%-point for services). Furthermore, the evolution over time of the simple income multiplier at current and constant prices is not very different. Finally, the most striking feature is the evolution of the *type I income multiplier* for goods. It decreases by 0.19%-point at constant prices, but by only 0.04%-point at current prices.

At this aggregation level, multipliers seem to be very stable over time, even over a ten year period. Looking at evolutions of multipliers at current or constant prices does not lead to fundamental different conclusions.

3.2. Detailed industries breakdown

As has been explained before, the computation of input-output tables and multipliers has been carried out at the detailed level of some 130 homogenous industries (products). At this level of detail, a number of conclusions can be drawn concerning the (different) evolution of multipliers calculated at current and constant prices.

The central question is to what extent computing multipliers at current and constant prices leads to different measures. A first way to answer this question is to compare the ranking of industries according to both measures. In the table below, Spearman's rank correlation coefficients are given for the five types of multipliers considered here. The rank of the industries has been expressed both in terms of the level of the multiplier (in 1995) and the variation (delta) of the multiplier over time.

Table 4 Rank correlations between multipliers at current and constant prices
Level 1995 and evolution 1995-2005

Spearman's rank correlation	OM-S	IM-S	IM-I	EM-S	EM-I
Rank level 1995 (CUP / COP)	93.4%	97.2%	90.9%	93.0%	98.5%
Rank delta 1995-2005 (CUP / COP)	83.8%	73.1%	59.0%	57.5%	92.3%

Source: FPB

Ranking the industries based on the level of the multiplier, all correlations are higher than 90%, while ranking them on the basis of the delta, correlations are lower and vary more. The smallest correlation coefficients are observed for the type I income multiplier and the simple employment multiplier.

Another way to look at the question is to consider the sign of the evolution of the multipliers (+ for increase, - for decrease). The table below gives the percentage of cases (industries) for which changes 1995-2005 of current and constant price multipliers have the same sign.

Table 5 Percentage of industries for which changes of current and constant price multipliers have the same sign
1995-2005

	OM-S	IM-S	IM-I	EM-S	EM-I
Equal sign delta (COP / CUP)	82.9%	85.4%	77.2%	87.0%	90.2%

Source: FPB

Depending on the type of multiplier, the percentage of industries evolving in the same sense at current and at constant prices, varies between 77% and 90%. The lowest percentage is again observed for the type I income multiplier.

4. Conclusion

Input-output tables, and multipliers derived from these tables, allow to carry out impact studies, in particular in a context where interactions between industries are explicitly taken into account. Looking at the evolution of multipliers over time aims at assessing technological changes as reflected in changes in production structures. For a proper measurement and understanding of the changes in the production structure over time, it is necessary to calculate constant price multipliers. In fact, the evolution of current price multipliers is not only determined by 'real' changes in production technologies, but also by relative price changes.

Based on a consistent time series of current and constant price supply and use tables and input-output tables for Belgium, the evolution of current and constant price multipliers over the period 1995-2005 was compared for three types of final demand multipliers: output, income and employment multipliers. For the latter two, both absolute (simple) multipliers and relative (type I) multipliers are computed. The calculations have been carried out at a very detailed industry level (of some 130 homogenous industries).

Looking at the results at a very aggregated level (goods/services breakdown) leads to the overall conclusion that evolution of multipliers at current and constant prices is not fundamentally different. In both cases, at this aggregation level, multipliers are very stable over time, even over a ten year period. At the detailed industries level, the results show a mixed picture. In particular for the type I income multipliers, results are quite different at constant prices as compared to current prices.

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