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ESTIMATING GROWTH CONTRIBUTIONS BY STRUCTURAL DECOMPOSITION OF INPUT-OUTPUT TABLES*

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This paper presents a case-study to demonstrate the calculation methods of growth contributions using structural decompositions of input-output tables and their Hungarian applications. Although the required data are available with a considerable time-lag, results show that taking backward linkages through demand for inputs and value chain multipliers into account can significantly alter the picture on the growth effects of industries and final demand categories by the conventional approach based on quarterly GDP calculations. This can be instructive for analysts and policy- and decision-makers not only in Hungary, but also in other countries. The study was performed by using public macroeconomic and sectoral data obtained from the Hungarian Central Statistical Office.

Keywords: economic growth, Input-Output model, Structural Decomposition Analysis (SDA)

JEL classification indices: C67, E01, F43, O41, O47

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INTRODUCTION

Decomposing real GDP changes is important information for macro analysts and policymakers, and its significance can be channelled through the media to reach the general public as well. It is no coincidence that contribution to growth tables by the production and expenditure approach[1] are among the most frequently cited data of statistical offices.

Techniques for calculating growth contributions can be understod from the meta-data published together with the official data,[1,2] or, in more detail, from academic publications.[3] This paper, however, differs in several respects. The focus is not on the partial effects behind the most current quarterly GDP volume index and the related chain-linking problems (Anwar – Szőkéné 2010). Instead, structural decomposition analysis (SDA) of input-output tables is used here for measuring growth contributions. The aim of this study is to present a less known and less employed application of the method on Hungarian data.

Input-output tables are published with a much longer time-lag than flash estimates of GDP. Therefore, the case study is not on the last quarter, but, according to the annual horizon and the publication schedule of input-output tables,[4] on an earlier year. For analysing GDP volume change, two successive years' input-output tables are needed, of which the latter is expressed at previous year prices. At the time of writing, 2012 was the most recent year for which, based on data available, and using regular mathematical transformations and updating-balancing techniques, I could generate a relatively reliable constant price input-output table.

With input-output tables, the chance to analyse a deeper structure of the economy can compensate for less up-to-date current information. With the methods presented here, one can detect not only the direct effects of the changes in the branches' own value added levels and the final products flowing to different sectors, but considering the domestic demand driven backward linkages, one can also estimate the multiplicative growth effect of the final demand of each industry. This is the rationale for Leontief's demand-pull input-output model.

Section 1 gives a description of the input-output tables applied in the case study and the methods used for generating them. Section 2 shows how conventional contribution breakdown can be connected to the input-output data set, giving reference values for later SDA results. Hereinafter, not only the data, but also

1 In Hungary STADAT Tables 3.1.19 and 3.1.20 on page http://www.ksh.hu/stadat_infra_3_1.

2 http://www.ksh.hu/docs/eng/modsz/modsz31.html

3 E.g. Anwar – Szőkéné (2010) reviews the methods of calculating growth contributions used in Hungary, and their interpretations and applications.

4 According to the European guidelines and practice, input-output tables are published by NCSO every five years, with a three-year time lag.

the underlying economic model is needed; for this, Section 3 reviews the sufficient theoretical and technical background. Section 4 defines structural decomposition analysis, synthesises its essentials, limitations, applications, and general considerations that must be taken into account when performing a GDP growth SDA. In Sections 5 and 6, we decompose 2012's growth in two dimensions. First, according to the terms of the value added SDA equation, we separate the effects of the changes in value added ratios, domestic input coefficients, and final demand, and then dig deeper still into the texture of the economy for the latter two. In Section 6, the investigation will be carried out with an alternative formula that allocates value added and its changes not where they appear, but according to the multiplicative effects of the final demand (changes) of industries. Here, industries' contribution to economic growth is not the value added appearing in companies of each industry, but the value added generated by their final demand and its multiplication through upstream value chains, i.e, GDP changes in all supplying domestic links involved. Results show that GDP production and growth effects of supply chains calculated with this method can differ significantly from the reference values set up in Section 2. Section 7 discusses the results, and Section 8 summarises the limits and benefits of estimating growth contributions by structural decomposition of input-output tables.

1. INPUT-OUTPUT TABLES

At the time of writing, the latest industry-by-industry input-output (IO) table published by the HCSO is available for the year 2010.[5] This is produced from the supply and use tables[6] by the "fixed product sales structure" transformation (Eurostat 2008: 351, Model D),[7] calculated with 88 industries and published in a

[5] Dissemination database / National accounts, GDP / Input-output tables, supply and use tables / Symmetric input-output table (industry by industry), at current basic prices NACE Rev. 2 (ESA2010) (technical code PP1109).

[6] I.b. PP1101, PP1102 and PP1104.

[7] The system of supply and use tables offer a flexible framework for generating product-by-product, or industry-by-industry tables. The choice of the table type should be made according to the purpose of the analysis. Product-by-product tables for technological studies are more homogeneous in the cost structure, while industry-by-industry tables for industrial analysis are closer to the data sources and market transactions; they can be linked to the national accounts more easily and are more reliable in value added ratios. Seeing that production approach growth contributions are based on industries' value added, this study requires the latter for compatibility. *Eurostat* (2008) gives two methods for both types. Although the methods of "fix industry sales structure" (Model C) and "fixed product sales structure" (Model D) are both based on fairly soft assumptions, the second one is recommended by the manual, which

65 by 65 aggregation depth. Supply and use tables at current prices are available also for the subsequent two years, so using these and the previous method I could generate current price IO tables for 2011 and 2012 as well. Although sectors 68A (Imputed rents of owner-occupied dwellings) and 68B (Real estate activities, excluding imputed rents) have rather different input-structures and value added shares, and 68A is used only in household consumption, data available for next steps required their unification, so from this point I worked with 64 industries.

The former detailed dataset at previous year's prices was not available; consequently, a constant price table for 2012 was developed from the 2012 year current price table with the RAS method (Miller – Blair 2009: sections 7.4.1–3)[8] using the previous year price margins available in tables with technical codes PP1101, PP1102, GPKF04, GPKA03, and GPKB04 in the dissemination database and STADAT Table 3.1.18 (*Figure 1*).[9,10]

Although margins are available for 2013–2014 too, updating for these years, even for current price tables, can only be done by RAS or other estimating techniques. This would make the results more precarious. For this reason, I use 2011

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eliminates unfeasible negative values in the matrix of direct requirements. Like most statistical offices, HCSO has since long been using this method to generate industry-by-industry input-output tables. On the application of the "fix product sales structure" method in Hungary, see also Boda el al. (1989). The pure application of Model D, of course, is a simplification of the method by which statistical offices produce official industry-by-industry tables. In addition to the use of the supply and use tables and of Model C or D, depending on the basic data available and the structure of the economy, they mix these methods, use many external information (which make some cells of the to be estimated input-output table exogenous), and also apply RAS-like methods to eliminate the remaining discrepancies in the estimated input-output table. Countries that mainly produce only this type of tables choose more complex techniques.

8 Besides the classical RAS, linear and quadratic programming techniques are also used for updating and balancing input-output tables (see, for example, Lahr – Mesnard 2004 or Jackson – Murray 2004), and RAS has several (non-sign preserving, zero, and negative margin operable) extensions or generalisations (see, for example, the study of Lenzen et al. 2014, or the additive RAS of Révész 2001). Due to its simplicity, however, conventional RAS is still the most widespread balancing method. Since no conditions occurred in our case study that make it impossible to use (for example, a negative margin of change in stocks), I wrote an Excel VBA function for classical RAS and worked with it.

9 Because of the lack of a consistent public database of price indices for the products of each 64 industries, at least in domestic use and export breakdown, cells in the same rows were not deflated differently before using RAS. Iteration simply started from the current price table. By resolving this simplification, of course, more precise results can be gained.

10 Although dealing with the effects of changes in the sectoral import coefficients explicitly and distinguishing competitive and non-competitive imports would be essential, especially in the case of an open economy such as Hungary, import matrices were discarded also because of the lack of data for previous year price margins.

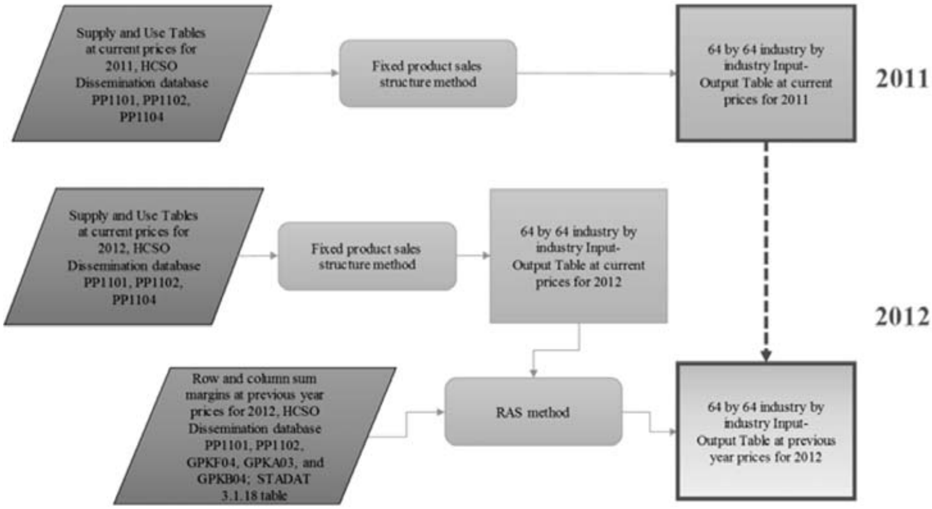


Figure 1. Generating input-output tables

current price and 2012 previous year price IO tables for demonstrating of the application of SDA, whereby we can analyse economic growth and growth contributions of the year 2012.

Due to the size of the tables, *Table 1* shows the simplified, four industry, three final demand component and only one value added row version of these, which will help in the demonstration and comprehension of the decomposition methods as well as comparisons between the numbers by conventional and SDA techniques. In spite of the short form presentation of the data and intermittently of the results as well, calculations are made in 64 industries break-down.

To give a brief overview, the rows of the IO tables show the sales of companies of a given industry to other domestic firms for intermediate use, sales to households and other domestic sectors as final use (consumption and investment), and sales to foreign countries (export). Agricultural producers, for example, sold a total of HUF 564 billion to other agricultural firms, HUF 719 billion to manufacturing companies, HUF 4 billion to construction, and HUF 101 billion to services in the base year of 2011. Households purchased a total of HUF 317 billion and other domestic sectors HUF 242 billion for final demand purposes from agricultural producers, while HUF 652 billion went overseas as exports.

While the rows show the structure of industry output, reading the columns reveals the input side. Domestic manufacturing (B-E), for example, was supplied by domestic agriculture, manufacturing, construction, and services by HUF 719, 3,558, 67 and 2,382 billion, respectively, and by HUF 12,683 billion of imports in 2011. Besides imports and taxes less subsidies on products, the bottom rows show that manufacturing industry had a total use of HUF 25,822 billion, which is equal to its total supply (the sum of the manufacturing row), whereby HUF 6,206 billion value added was generated.

2. CONVENTIONAL GROWTH CONTRIBUTIONS

The data required for calculating growth contributions by the conventional method can be acquired from the IO tables as well.

Arranging industries' value added and taxes less subsidies on products (cross-hatched cells in *Table 1*) to *Table 2,* branches' value added and the whole economy's GDP changes can be obtained as the differences of constant price current and base year numbers. Expressing these in proportion to base year gross domestic product, we have the growth contributions of industries in a percentage form, which are exactly the same as the statistics in the STADAT Table 3.1.19 referred to above.

To quantify demand-side effects, we need to assemble the components of the well-known expenditure approach GDP identity (dark grey cells in *Table 1*). Totals of household consumption, other domestic final use, and export can be found in the sums of the same columns. The last cells of the fifth rows are subtracted from them, which are the sums of all intermediate and final use of imports. Using these, similarly to the production approach in the upper table of *Table 2,* we can calculate growth contributions of demand components as well. The results differ slightly from STADAT Table 3.1.20 only because of the difference in the valuation methods of the national accounts and the IO table compilation.[11] The method is the same.

For the compatibility of the result from the conventional method reviewed above and from the SDA in Sections 5 and 6, some changes were made in *Table 2* that do not affect the main point. First, seeing that the growth effects of industries are of great importance, we omit taxes less subsidies, and express contributions not for the GDP, but the fully industry-related gross value added (GVA). Although percentage GVA contributions differ somewhat from those based on GDP, the relative weights of branches remain the same. Furthermore, these numbers are directly comparable to the results gained from the IO model.

[11] Import is valued at fob (free on board) parity in national accounts, and at cif (cost, insurance and freight) in the input-output tables. Cif/fob adjustments, direct purchases abroad by residents, and purchases on domestic territory by non-residents cause differences in trade and household consumption.

Table 1. Simplified input-output tables for Hungary

Simplified input-output table for base year 2011 at current prices (in billion HUF)

Industries	Intermediate consumption					Final use				Total use / output
	A Agriculture, forestry and fishing	B-E Mining; manufacturing, etc.	F Construction	G-T Services	Total intermediate consumption	Household final consumption expenditures	Other domestic final demand	Export	Total final use	
A Agriculture, forestry and fishing	564	719	4	101	1 389	317	242	652	1 211	2 600
B-E Mining; manufacturing etc.	352	3 558	422	1 746	6 077	2 260	737	16 747	19 744	25 822
F Construction	3	67	63	217	349	26	1 947	98	2 071	2 420
G-T Services	256	2 382	447	6 077	9 163	7 583	6 819	3 979	18 382	27 545
Import	285	12 683	456	3 061	16 485	2 239	1 942	1 961	6 142	22 627
Taxes less subsidies on products	33	206	40	756	1 036	2 649	378	183	3 211	4 246
Total intermediate / final use	1 493	19 616	1 432	11 958	34 499	15 076	12 065	23 620	50 761	85 260
Gross value added	1 106	6 206	988	15 586	23 887					
Output	2 600	25 822	2 420	27 545	58 386					

Table 1. continued

Simplified input-output table for current year 2012 at previous year prices (in billion HUF)

Industries	Intermediate consumption					Final use				Total use / output
	A Agriculture, forestry and fishing	B-E Mining; manufacturing, etc.	F Construction	G-T Services	Total intermediate consumption	Household final consumption expenditures	Other domestic final demand	Export	Total final use	
A Agriculture, forestry and fishing	499	721	4	90	1 314	296	82	642	1 020	2 334
B-E Mining; manufacturing etc.	353	3 153	363	1 640	5 509	2 250	677	16 158	19 085	24 593
F Construction	3	58	70	218	349	23	1 779	104	1 906	2 255
G-T Services	257	2 272	419	5 787	8 735	7 514	6 761	3 963	18 238	26 973
Import	305	12 123	436	2 905	15 769	2 015	1 899	2 218	6 132	21 901
Taxes less subsidies on products	44	198	37	741	1 021	2 622	368	188	3 178	4 199
Total intermediate / final use	1 460	18 525	1 329	11 381	32 695	14 721	11 566	23 273	49 560	82 255
Gross value added	874	6 068	926	15 592	23 460					
Output	2 334	24 593	2 255	26 973	56 155					

Table 2. Conventional GDP growth contributions

Production approach contributions to GDP growth based on industries own value added (in billion HUF and %)

Industries	Base year, 2011 (at current prices)	Current year, 2012 (at previous year prices)	Change	
			in value (billion HUF)	in proportion to base total (%)
A Agriculture, forestry and fishing	1 106	874	–232	–0,82
B-E Mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply, etc.	6 206	6 068	–138	–0,49
F Construction	988	926	–63	–0,22
G-T Services	15 586	15 592	5	0,02
Taxes less subsidies on products	4 246	4 199	–48	–0,17
Gross domestic product (at purchaser's prices)	28 134	27 659	–475	–1,69

Expenditure approach contributions to GDP growth (in billion HUF and %)

Components of final use		Base year, 2011 (at current prices)	Current year, 2012 (at previous year prices)	Change	
				in value (billion HUF)	in proportion to base total ()
Household final consumption expenditures		15 076	14 721	–355	–1,26
Other domestic final demand		12 065	11 566	–500	–1,78
of which	Final consumption expenditures by non-profit organisations serving households (NPISH)	444	448	4	0,01
	Final consumption expenditures by government	5 847	5 761	–85	–0,30
	Gross fixed capital formation	5 569	5 324	–245	–0,87
	Changes in inventories	206	33	–173	–0,62
Export		23 620	23 273	–347	–1,23
Import (-)		–22 627	–21 902	725	2,58
Gross domestic product (at purchaser's prices)		28 134	27 657	–476	–1,69

A second modification is that the direct import content of the final demand components is ignored in the expenditure table, so only final use from domestic sources is taken into account. The import row includes only intermediate consumption henceforth.[12] A decrease/increase in the final demand for domestic products can, of course, increase/decrease the intermediate use from imports, which latter has an adverse effect on GVA. Thus, growth contributions of domestic product demand components indicated in *Table 2* can be imprecise. The assessment of their value added effect depends on the industry mix of final demand change, the domestic and foreign backward linkages of the concerned industries, and companies' value added ratios. Multiplicative processes taking place can be kept track of by the IO model, and estimating the contribution of the various final demand components can be made by a structural decomposition analysis. These techniques will be covered in the following sections.

When comparing SDA and the conventional method, the values of *Table 3* will serve as reference points. These are the growth contributions calculated separately from the supply- and demand-side surface of the economy, from the margins of the IO tables. Only such calculations can be accomplished using current quarterly GDP statistics, which ignore the interconnections between industries captured by the numbers in the light grey shaded cells of *Table 1*. A more profound study based on these can penetrate deeper into growth relationships and discover details that cannot be revealed from above. For this, however, we need to recall some basic equations of the IO model and the derivation of value added multipliers.

3. BASIC INPUT-OUTPUT MODELLING[13]

For mathematical analysis, the most important parts of the IO tables are the aforementioned light grey square matrices of direct requirements of intermediate inputs. They will be denoted by $\mathbf{Z}^0$ and $\mathbf{Z}^1$ (superscripts indicate the relating time periods, 0 is for the base, and 1 for the current year).

We will use the notation $\mathbf{F}$ for the matrices of the final demand for domestic products (for the sake of simplicity, we temporarily abandon period superscripts in Section 3) and $\mathbf{v'}$ for the row vectors of the value added of domestic industries.

12 For the sake of switching from GDP to GVA, we correct with product taxes of intermediate consumption also in this row. For the calculation methods of the GDP effects of final demand categories in detail, see Hoekstra – Helm (2010).

13 This summary in just a few paragraphs is very concise. For the input-output model, the classification, calculation, and application of multipliers in detail, see Ambargis – Mead (2012), Miller – Blair (2009: Chapters 2 and 6), and Zalai (2012).

Table 3. Contributions to GVA growth

Production approach contributions to GVA growth based on industries own value added (in billion HUF and %)

Industries	Gross value added		Change	
	Base year, 2011 (v^0)	Current year, 2012 (at prev year prices) (v^1)	in value (billion HUF) (Δv)	in proportion to base total (%)
A Agriculture, forestry and fishing	1 106	874	–232	–0,97
B-E Mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply, etc.	6 206	6 068	–138	–0,58
F Construction	988	926	–63	–0,26
G-T Services	15 586	15 592	5	0,02
Gross value added total	23 887	23 460	–427	–1,79

Expenditures approach contributions of final demand for domestic products to GVA growth (in billion HUF and %)

Components of final use		Base year, 2011 (at current prices)	Current year, 2012 (at previous year prices)	Change	
				in value (billion HUF)	in proportion to base total (%)
Household final consumption expenditures for domestic products		10 187	10 084	–103	–0,43
Other domestic final demand for domestic products		9 745	9 299	–447	–1,87
of which	Final consumption expenditures by non-profit organisations serving households (NPISH)	443	447	4	0,02
	Final consumption expenditures by government	5 511	5 475	–36	–0,15
	Gross fixed capital formation	3 784	3 488	–296	–1,24
	Changes in inventories	7	–111	–118	–0,50
Export from domestic products		21 476	20 867	–609	–2,55
Intermediate use from imports and taxes less subsidies on intermediate products (-)		–17 521	–16 789	732	3,06
Gross value added total		23 887	23 460	–427	–1,79

Results will be obtained as column vectors, thus the value added vectors in the IO tables are the transpose (transpose is denoted by ′).

Column vectors **x** of total output can be found in the right margin of the tables (their transposes are in the bottom row), and **f** column vectors of total final use (the row sums of **F**s) are the last but one.

The **A** matrix of direct domestic requirement or technical/technological coefficients is generated as the division of the cells of **Z** by the relating element of **x'**, i. e. the column sums of the IO table (using matrix operations $\mathbf{A} = \mathbf{Z}\langle\mathbf{x}\rangle^{-1}$, where $\langle\mathbf{x}\rangle$ is the diagonal matrix of industry outputs, and $\langle\mathbf{x}\rangle^{-1}$ is its inverse). The a_{ij} elements of **A** show the amount of supplies needed from *i*th domestic industry for a unit of *j*th domestic industry's output.

Value added ratios of industries can be obtained similarly by the equation $\mathbf{c}' = \mathbf{v}' \langle\mathbf{x}\rangle^{-1} \langle\mathbf{x}\rangle^{-1}$.

The model is closed with the formula $\mathbf{Ax} + \mathbf{f} = \mathbf{x}$, of which $\mathbf{Ax}$ gives the value of intermediate consumptions, and **f** the final uses, thus the equation, starting with matrix **A** defined from the input side, provides the equilibrium of production and use from the output side in the end.

After some rearrangements $\mathbf{x} = (\mathbf{1} - \mathbf{A})^{-1}\mathbf{f}$ can be expressed,[14] which is the fundamental equation of the demand-driven (pull) IO model, where endogenous output adjusts to the exogenous final demand. The first term of the right hand side is the famous Leontief inverse, which we denote by **L**.

The Leontief inverse involves not only the direct effects of final demand changes, but indirect backward linkage effects too, which can generate further output changes in the original final demand and other supplier industries as well. Column sums of **L** give the total production effect that one additional unit of final demand in the given column industry can generate in all sectors of the economy. These column sums are called total output multipliers.

In this study, not output, but value added multipliers have a particular importance. They can be generated by multiplying industry multipliers in the columns of **L** by industry value added ratios ($\mathbf{c}'\mathbf{L}$).[15]

Column vectors **v** of industry values added in *Table 3* can be obtained by the

$$\mathbf{v} = \langle\mathbf{c}\rangle\mathbf{Lf} \tag{1}$$

14 Subtracting $\mathbf{Ax}$ from both sides of $\mathbf{Ax} + \mathbf{f} = \mathbf{x}$ yields $\mathbf{f} = \mathbf{x} - \mathbf{Ax} = (\mathbf{I} - \mathbf{A})\mathbf{x}$, where **I** is the identity matrix. Premultiplying both sides of this by the inverse of $(\mathbf{I} - \mathbf{A})$, i.e. $(\mathbf{I} - \mathbf{A})^{-1}$ we obtain $(\mathbf{I} - \mathbf{A})^{-1}\mathbf{f} = \mathbf{x}$.

15 Multipliers have several types according to the closure of the model. This study works with only the open input-output model and the associated Type 1 multipliers.

matrix equation, i.e. the product of the diagonal matrix of value added ratios, the Leontief inverse, and the vector of final demand for the given period. This is the basic equation for the structural decomposition of value added changes and growth.

4. STRUCTURAL DECOMPOSITION ANALYSIS IN GENERAL

According to Rose – Casler (1996), Dietzenbacher-Hoekstra (2002), Dietzenbacher (2004), and Révész (2013), the following consensus definition can be composed for the decomposition technique used in this paper. SDA is a comparative static method of analysing the structural changes of economies by the IO model. The aim of the investigation is factorising the temporal changes or regional differences of an economic phenomenon that can be examined by the IO method for a better understanding of the driving forces behind them. The analysis is based on the well-known standardisation method of comparative statics: decomposing the variance goes by changing the determinants one by one in the equation, while the others are held constant close at some reference values. SDA is in close relation with standardisation and index number analysis, and can be considered as their extension to IO tables for capturing indirect and induced effects as well.

Révész (2013) and Boda – Révész (1990) warn that difficulties can occur in interpreting decompositions. Components separated from each other should not necessarily be regarded as causes or driving forces. This is evident in regional comparisons, but often also the case in temporal changes. In a number of economic phenomena, the *post hoc, ergo propter hoc* rule of formal logic does not apply; the consequence emerges before the time of realising the cause because the cause becomes measurable later than the effect. Even if the causality really exists, its direction does not necessarily follow from the time of realisation. In several cases, determinants are not independent, or the decomposition does not reach root causes, or two factors in the decomposition have a third, common driving force not included (or not even observed).[16] Therefore, one has to be cautious when

[16] Révész (2013) illustrates these with the following two examples: (i) Consumption vector is the product of total consumption and the composition of the consumption basket. These, however, cannot be regarded as absolutely independent, final factors. The driving force behind the changes may be the fluctuation of the incomes, which, according to the preferences, affects the total level of consumption expenditures; this, in turn, influences the structure (for example, a shift occurs towards superior or inferior goods). (ii) Employment is the product of the labour intensity and the production level, but both can be affected by price changes.

evaluating components since many random and indirect effects can occur, and the direction of causality becomes ambiguous.

In spite of the constraints listed above, SDA is a widely used method. The number of studies on this topic has increased spectacularly since the 1980s. Applications encompass analyses of output, employment, value added, or a part of the latter, for example, labour incomes. The technique can be applied not only for the narrowly defined economic categories, but also for energy and environmental variables, as an IO model itself does.[17] Rose – Casler (1996) and Miller – Blair (2009) give more details on the method and review its applications.

For the aim of this paper, former value added investigations are relevant. Among them there are some studies on nominal (e.g. Osterhaven – Linden (1997), which analyse 8 countries of the European Community with 25 industry tables of 1975 and 1985), and others on real value added and growth decomposition. These include the most frequently cited paper of the field, Skolka (1989), who compares Austria's 1964 and 1976 economies in respect to output, value added, and employment. Skola analyses volume changes and inflates the 1964 table to 1976 prices. Among recent studies, Pei et al. (2012) investigate China's real GDP growth between 2002 and 2007, especially the contributions of manufacturing industries.

The SDA presented in this paper differs from previous ones; rather than analysing changes in GDP production of a 5–10 year or even longer period, the short run effects, driving forces of year-by-year economic growth are discovered here. Regarding the depth of the decomposition we are not trying to exceed studies with 3–4 levels, and occasionally 10 or more "final" determinants. With the data available, this is not possible. The aim of this study is to present a less known and less employed application of the method for estimating growth contributions in Hungary.

To show the main points of the technique, consider the fundamental equation of the IO model derived in the previous section. According to this, output equals the matrix product of the Leontief inverse and the vector of final use:

$$\mathbf{x} = \mathbf{L}\mathbf{f}. \tag{2}$$

Change of output can be factorised in the following ways:

$$\Delta\mathbf{x} = (\Delta\mathbf{L})\mathbf{f}^1 + \mathbf{L}^0(\Delta\mathbf{f}), \tag{3}$$

$$\Delta\mathbf{x} = (\Delta\mathbf{L})\mathbf{f}^0 + \mathbf{L}^1(\Delta\mathbf{f}), \tag{4}$$

[17] Among Hungarian researchers, Révész applied the SDA technique for analysing the differences and changes of Hungarian and Romanian energy consumption (Révész – Ragalie 1996).

$$\Delta\mathbf{x} = (\Delta\mathbf{L})\mathbf{f}^1 + \mathbf{L}^1(\Delta\mathbf{f}) - (\Delta\mathbf{L})(\Delta\mathbf{f}), \text{ and} \tag{5}$$

$$\Delta\mathbf{x} = (\Delta\mathbf{L})\mathbf{f}^0 + \mathbf{L}^0(\Delta\mathbf{f}) + (\Delta\mathbf{L})(\Delta\mathbf{f}), \tag{6}$$

where the terms of equations (3) and (4) use different time period weights, and equations (5) and (6) use the same period ones. For this reason, the latter two have a negative or positive $(\Delta\mathbf{L})(\Delta\mathbf{f})$ interaction term. Considering that different decompositions result in different partial effects: analysts generally use the simple arithmetic mean of (3) and (4), which assigns one half of the interaction to the first, and the other half to the second term:[18]

$$\Delta\mathbf{x} = (1/2)(\Delta\mathbf{L})(\mathbf{f}^0 + \mathbf{f}^1) + (1/2)(\mathbf{L}^0 + \mathbf{L}^1)\Delta\mathbf{f}.^{19} \tag{7}$$

The situation is more complicated in the case of more than two variables, like in ours, where the value added vectors under investigation are products of three terms according to equation $\mathbf{v} = \langle\mathbf{c}\rangle\mathbf{L}\mathbf{f}$. Polar decompositions composed according to (3) and (4), weighted from current to base period

$$\Delta\mathbf{v} = \langle\Delta\mathbf{c}\rangle\mathbf{L}^1\mathbf{f}^1 + \langle\mathbf{c}^0\rangle(\Delta\mathbf{L})\mathbf{f}^1 + \langle\mathbf{c}^0\rangle\mathbf{L}^0\Delta\mathbf{f}, \tag{8}$$

and pacing from base to current period

$$\Delta\mathbf{v} = \langle\Delta\mathbf{c}\rangle\mathbf{L}^0\mathbf{f}^0 + \langle\mathbf{c}^1\rangle(\Delta\mathbf{L})\mathbf{f}^0 + \langle\mathbf{c}^1\rangle\mathbf{L}^1\Delta\mathbf{f}, \tag{9}$$

do not comprise all possible formulation part effects.

One solution for this problem is to take the average of all possible formulas. Unfortunately, the number of decompositions increases quickly with the number of determinants. Dietzenbacher – Los (1998) pointed out that by applying an *n*-term decomposition equation formulated according to (3) or (4) for all permuta-

18 Révész (2013) notes that in certain cases (for example in exponential processes), this kind of equidistribution is questionable, claiming that one or another factor changed first, and thus the effects of the second one should be measured at the new value of the first one. In Fernández-Vázquez et al. (2008), the allocation of the interaction term is a function of the relative rate of climb of the factors. Révész, however, acknowledges that halving the interaction is a reasonable simplification in most cases, which does not significantly distort the results.

19 Because of the vector-type solutions, SDAs usually operate with additive formulae similar to Equation (7), where the total change is the sum of the part effects. In the case of scalars, one can use multiplicative (index) formulae as well, where total change is the product of the part effects. A good example of this is the study of Dietzenbacher el al. (2004), which investigates the shift of the share of labour incomes in the US GDP between 1982 and 1997.

tions of 1, 2, …, n indices, then arranging them back to their original order, we have n possible part effect formulations, of which, added Rormose (2011), only 2^{n-1} are different, and thus by weighting them according to their frequency, the same result is obtained. Dietzenbacher – Los (1998), however, analysed empirically the sensitivity of the results to the full or part formulation, and found that the average of the polar decompositions is a good approximation of the mean of all possible forms. Thus, the difference of the value added vectors can be broken down by

$$\Delta\mathbf{v} = \langle \Delta\mathbf{c} \rangle \underline{\mathbf{L}}\,\underline{\mathbf{f}} + \langle \underline{\mathbf{c}} \rangle \Delta\mathbf{L}\underline{\mathbf{f}} + \langle \underline{\mathbf{c}} \rangle \underline{\mathbf{L}}\Delta\mathbf{f}, \tag{10}$$

where the _ underscore means the average of the values of the benchmark and current years.

The other method is to bracket two adjacent terms of the three-term product, and handle this as a single component. Subsequently, with the two (the composite and the single) decomposed, greater depth is possible, and the composite term can be separated into the two original factors in the same way. This is known as nested or hierarchical decomposition.[20] The choice between the two possible hierarchical decompositions should be made on economic considerations. Reasons of bracketing can be separation of rates and levels, direct and indirect factors, or volume and price effects. No general recipe exists: the best way must be found uniquely according to the given problem (Révész 2013). In Sections 5 and 6, we will use both polar and nested decompositions.

A further problem, as Dietzenbacher – Los (2000) point out, is that SDA typically presumes the independence of factors;[21] however, this does not (necessarily)

[20] It must be noted that two possible hierarchical decompositions of Equation

$$\Delta\mathbf{v} = \langle \Delta\mathbf{c} \rangle (\underline{\mathbf{Lf}}) + \langle \underline{\mathbf{c}} \rangle (\mathbf{Lf}) = \langle \Delta\mathbf{c} \rangle \underline{\mathbf{L}}\,\underline{\mathbf{f}} + \langle \underline{\mathbf{c}} \rangle \Delta\mathbf{L}\underline{\mathbf{f}} + \langle \underline{\mathbf{c}} \rangle \underline{\mathbf{L}}\Delta\mathbf{f}, \text{ and}$$

$$\Delta\mathbf{v} = \Delta(\langle \mathbf{c} \rangle \mathbf{L})\underline{\mathbf{f}} + \underline{\langle \mathbf{c} \rangle \mathbf{L}}\Delta\mathbf{f} = \langle \Delta\mathbf{c} \rangle \underline{\mathbf{L}}\,\underline{\mathbf{f}} + \langle \underline{\mathbf{c}} \rangle \Delta\mathbf{L}\underline{\mathbf{f}} + \underline{\langle \mathbf{c} \rangle \mathbf{L}}\Delta\mathbf{f}$$

are not equal in most cases (especially if **c**, **L** and **f** each changed), and also differ from Equation (10) since $\underline{\mathbf{L}}\,\underline{\mathbf{f}} \neq \underline{\mathbf{Lf}}$ *and* $\langle \underline{\mathbf{c}} \rangle \underline{\mathbf{L}} \neq \underline{\langle \mathbf{c} \rangle \mathbf{L}}$ and generally hold. This suggests a reconsideration of Dietzenbacher – Los's (1998) finding that polar decompositions indeed can only be an approximation of the mean of all possible forms.

[21] As the anonymous referee of this paper notes, this statement is questionable. In general, rather SDA may be regarded to answer the question of "What would be if – holding other factors constant – one factor changed only?". True enough, when we know more about the relationship of the factors, we may interpret this as an effect or cause. Just referring to the example: in some cases (e.g. in cases of free, know-how like technology diffusion when the physical capital and labour behind the value added cannot be assumed to have changed), the change in an input coefficient does cause the symmetric change in the value added share (at least at constant prices). In such cases, Equation (10) is not a real answer to the problem of separating the "effects" of changes in the intermediate input coefficients and the value added share. In

hold in respect to **c** and **L**. The value added ratio of an industry can only change if the sum of coefficients of imports, net taxes on products, and direct domestic requirements moves in the opposite direction. The matter of dependent determinants is discussed in detail by Deitzenbacher – Los (2000); they give possible solutions to several cases of dependence. The problem is answered here by the method used in Pei et al. (2012),[22] with the following formula:

$$\mathbf{v} = \langle \mathbf{c} \rangle (\mathbf{I} - \tilde{\mathbf{A}}(\mathbf{I} - \langle \mathbf{c} \rangle))^{-1} \mathbf{f}, \tag{11}$$

where $\tilde{\mathbf{A}} = \mathbf{A}(\mathbf{I} - \langle \mathbf{c} \rangle)^{-1}$. In the matrix $\tilde{\mathbf{A}}$, we have the ratios of direct domestic requirement coefficients and total intermediate consumption quotients. This allows us to separate the effects of the change of value added ratios first, holding relative domestic and import supplies constant, and then having the changed value added ratios, we can detect the growth consequences of supply chain changes.

5. STRUCTURAL DECOMPOSITION OF INDUSTRIES' OWN VALUE ADDED CHANGES (SDA#1)

For the decomposition of the volume change of value added, two models will be developed in this paper. SDA#1 investigates the variations of $\mathbf{v}^0$ and $\mathbf{v}^1$ from *Table 3:*

$$\Delta \mathbf{v} = \mathbf{v}^1 - \mathbf{v}^0 = \langle \mathbf{c}^1 \rangle \mathbf{L}(\tilde{\mathbf{A}}^1, \mathbf{c}^1)\mathbf{f}^1 - \langle \mathbf{c}^0 \rangle \mathbf{L}(\tilde{\mathbf{A}}^0, \mathbf{c}^0)\mathbf{f}^0, \tag{12}$$

where $\mathbf{L}(\tilde{\mathbf{A}}^t, \mathbf{c}^t) = (\mathbf{I} - \tilde{\mathbf{A}}^t(\mathbf{I} - \langle \mathbf{c}^t \rangle))^{-1}$. (If $\tilde{\mathbf{A}}$ and **c** apply to the same period *t*, simply $\mathbf{L}^t$ is used for the Leontief inverse.)

Value added of the two years can differ due to three reasons: (i) value added ratios have changed (i.e. vector **c** has modified by $\Delta\mathbf{c}$), (ii) direct domestic requirement coefficients have altered ($\Delta\tilde{\mathbf{A}}$), and, for this reason, the Leontief inverse has varied, and finally (iii) final demand has changed ($\Delta\mathbf{f}$). If we take the average of polar decompositions, we obtain

fact, Equation (10) fully accounts for the changes in the value added share, while the changes in the intermediate input coefficients are viewed only as a zero-sum game in which their effects more or less cancel each out.

22 For a detailed Dietzenbacher-type decomposition, I could have relied on assessments regarding import rates. For the Pei formula, only value added ratios are needed, which are exactly computable based on public statistics.

$$\Delta\mathbf{v} = \underbrace{(1/2)\left\{\left[\left\langle\mathbf{c}^1\right\rangle\mathbf{L}(\tilde{\mathbf{A}}^0,\mathbf{c}^1) - \left\langle\mathbf{c}^0\right\rangle\mathbf{L}(\tilde{\mathbf{A}}^0,\mathbf{c}^0)\right]\mathbf{f}^0 + \left[\left\langle\mathbf{c}^1\right\rangle\mathbf{L}(\tilde{\mathbf{A}}^1,\mathbf{c}^1) - \left\langle\mathbf{c}^0\right\rangle\mathbf{L}(\tilde{\mathbf{A}}^1,\mathbf{c}^0)\right]\mathbf{f}^1\right\}}_{\text{effect of the change in value added ratios}} +$$

$$+\underbrace{(1/2)\left\{\left\langle\mathbf{c}^1\right\rangle\left[\mathbf{L}(\tilde{\mathbf{A}}^1,\mathbf{c}^1) - \mathbf{L}(\tilde{\mathbf{A}}^0,\mathbf{c}^1)\right]\mathbf{f}^0 + \left\langle\mathbf{c}^0\right\rangle\left[\mathbf{L}(\tilde{\mathbf{A}}^1,\mathbf{c}^0) - \mathbf{L}(\tilde{\mathbf{A}}^0,\mathbf{c}^0)\right]\mathbf{f}^1\right\}}_{\text{effect of the change in domestic direct requirement coefficients}} +$$

$$+\underbrace{(1/2)\left[\left\langle\mathbf{c}^1\right\rangle\mathbf{L}^1 + \left\langle\mathbf{c}^0\right\rangle\mathbf{L}^0\right](\Delta\mathbf{f})}_{\text{effect of the change in final demand}}. \tag{13}$$

Effects of changes in direct requirements are factorised further according to industries where technical coefficient modification caused them. For this, we utilise

$$\mathbf{L}^1 - \mathbf{L}^0 = \mathbf{L}^1\left(\mathbf{I} - (\mathbf{I} - \mathbf{A}^1)\mathbf{L}^0\right) = \mathbf{L}^1\left((\mathbf{I} - \mathbf{A}^0) - (\mathbf{I} - \mathbf{A}^1)\right)\mathbf{L}^0 = \mathbf{L}^1\Delta\mathbf{A}\mathbf{L}^0, \text{ and} \tag{14}$$

$$\mathbf{L}^1 - \mathbf{L}^0 = \left(\mathbf{I} - \mathbf{L}^0(\mathbf{I} - \mathbf{A}^1)\right)\mathbf{L}^1 = \mathbf{L}^0\left((\mathbf{I} - \mathbf{A}^0) - (\mathbf{I} - \mathbf{A}^1)\right)\mathbf{L}^1 = \mathbf{L}^0\Delta\mathbf{A}\mathbf{L}^1. \tag{15}$$

Applying the average of (14) and (15) to the part between square brackets of the second term of (13), and having matrix $\Delta\tilde{\mathbf{A}}$ as the sum of the following matrices derived from its columns j

$$\Delta\tilde{\mathbf{A}}_{(j)} = \begin{bmatrix} 0 & \dots & \Delta\tilde{a}_{1j} & \dots & 0 \\ \vdots & & \vdots & & \vdots \\ 0 & \cdots & \Delta\tilde{a}_{nj} & \dots & 0 \end{bmatrix},$$

$\Delta\tilde{\mathbf{A}} = \Delta\tilde{\mathbf{A}}_{(1)} + \ldots + \Delta\tilde{\mathbf{A}}_{(j)} + \ldots + \Delta\tilde{\mathbf{A}}_{(n)} = \sum_{j=1}^{n}\Delta\tilde{\mathbf{A}}_{(j)}$, where n is the number of industries, we will have:

$$(1/4)\sum_{j=1}^{n}\left\{\left\langle\mathbf{c}^1\right\rangle\left[\mathbf{L}(\tilde{\mathbf{A}}^1,\mathbf{c}^1)(\Delta\mathbf{A}_{(j)})\mathbf{L}(\tilde{\mathbf{A}}^0,\mathbf{c}^1) + \mathbf{L}(\tilde{\mathbf{A}}^0,\mathbf{c}^1)(\Delta\mathbf{A}_{(j)})\mathbf{L}(\tilde{\mathbf{A}}^1,\mathbf{c}^1)\right]\mathbf{f}^0 + \right.$$

$$\left. + \left\langle\mathbf{c}^0\right\rangle\left[\mathbf{L}(\tilde{\mathbf{A}}^1,\mathbf{c}^0)(\Delta\mathbf{A}_{(j)})\mathbf{L}(\tilde{\mathbf{A}}^0,\mathbf{c}^0) + \mathbf{L}(\tilde{\mathbf{A}}^0,\mathbf{c}^0)(\Delta\mathbf{A}_{(j)})\mathbf{L}(\tilde{\mathbf{A}}^1,\mathbf{c}^0)\right]\mathbf{f}^1\right\}. \tag{16}$$

Further decomposing of the change in final demand to its components can be accomplished most simply by replacing **f** by **F** in the third term of :

$$(1/2)\left[\left\langle\mathbf{c}^1\right\rangle\mathbf{L}^1 + \left\langle\mathbf{c}^0\right\rangle\mathbf{L}^0\right](\Delta\mathbf{F}) \tag{17}$$

Column sums of the matrix obtained from (17) give the value added effects of the final demand components, which can be decomposed to partial effects caused by the changes in levels with formula (18), and in the industry mix by (19):

$$(1/4)(\langle \mathbf{c}^1 \rangle \mathbf{L}^1 + \langle \mathbf{c}^0 \rangle \mathbf{L}^0)(\mathbf{F}(\mathbf{y}^1, \mathbf{B}^1) - \mathbf{F}(\mathbf{y}^0, \mathbf{B}^1) + \mathbf{F}(\mathbf{y}^1, \mathbf{B}^0) - \mathbf{F}(\mathbf{y}^0, \mathbf{B}^0)), \text{ and} \quad (18)$$

$$(1/4)(\langle \mathbf{c}^1 \rangle \mathbf{L}^1 + \langle \mathbf{c}^0 \rangle \mathbf{L}^0)(\mathbf{F}(\mathbf{y}^1, \mathbf{B}^1) - \mathbf{F}(\mathbf{y}^1, \mathbf{B}^0) + \mathbf{F}(\mathbf{y}^0, \mathbf{B}^1) - \mathbf{F}(\mathbf{y}^0, \mathbf{B}^0)), \quad (19)$$

where $\mathbf{y}^t$ is the vector of the total final demand by different components (column sums of $\mathbf{F}^t$), $\mathbf{B}^t$ is the bridge matrix for the industry structure of the final demand components (its elements are quotients of the cells of $\mathbf{F}^t$ and its column sums) in period *t*, and $\mathbf{F}(\mathbf{y}^t, \mathbf{B}^t) = \mathbf{B}^t \langle \mathbf{y}^t \rangle$.

The design of the SDA can be reviewed in *Figure 2*. Results gained by using equations – in *Table 4* will be reviewed later with the help of *Figure 3*.[23] At this point, we notice only that the growth contributions of final demand components, due to the different approach, show a significant variance from the reference values of *Table 3*. Growth contributions of the industries, although SDA allows a more detailed insight, are exactly the same on the whole. In order to reveal new aspects of 2012 growth from the supply side as well, we perform the variance analysis with a modified version of the basic equation.

6. STRUCTURAL DECOMPOSITION OF SUPPLY CHAINS' VALUE ADDED CHANGES (SDA#2)

SDA#1, similarly to earlier studies, decomposed industries' own value added to the factors discussed in the previous section. A method similar to this section's SDA#2 model can be found in Pei et al. (2012). The analysis is performed here by the equation

$$\overline{\mathbf{v}} = \langle (\mathbf{c})' \mathbf{L} \rangle \mathbf{f}, \quad (20)$$

which differs mathematically from the previous basic formula in that the product of the vector of value added ratios and the Leontief inverse is generated first.

[23] The decomposition presented here, of course, is not the single way to factorise value added changes. See, for example, the models of the previously cited Dietzenbacher – Los (2000), which eliminate the effects of the changes in import rates and domestic requirement coefficients as well, or the final demand formulation used in Miller – Blair (2009) and many other studies for detaching (i) level, (ii) distribution, and (iii) product mix effects. My reasons for diverging from Dietzenbacher – Los (2000), have been explained in note 21. In the case of final demand, I chose a sector, then level and mix hierarchy for comparison to *Table 3*. Inside exports, the level, relation (EU, non-EU, of which both distinguished countries or groups of countries), and industry mix hierarchy would have been the most practical; however, this was not accomplishable because of the lack of detailed data consistent with the input-output valuation.

Figure 2. SDA#1 design

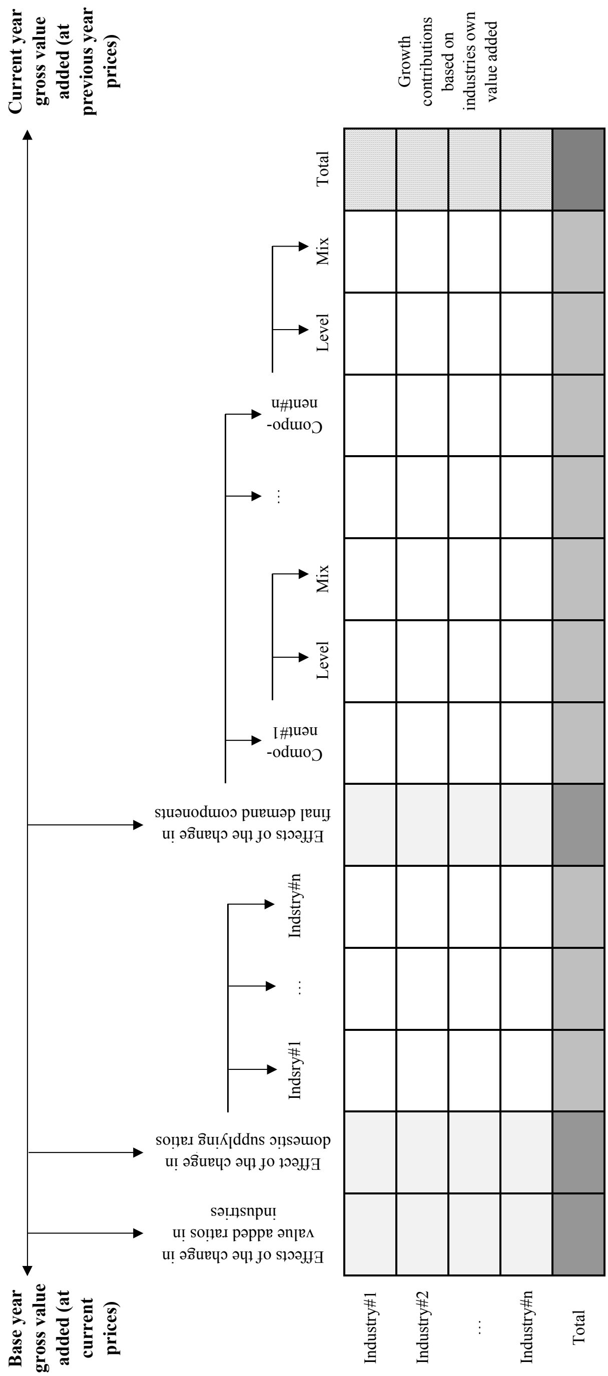


Table 4. Result of SDA#1

Growth contributions from structural decomposition of input-output tables (in billion HUF and %, in proportion to base year total gross value added)*

Industries	Growth effects																	
	Effects of the changes in value added ratios	Effects of the changes in domestic direct requirement coefficients					Effects of the changes in final demand									Total	Grand total	
		A Agri-ture	B-E Manu-facturing	F Cons-truction	G-U Serv-ices	Total	Household final consumption			Other domestic final demand			Export				billion HUF	%
							Level	Mix	Total	Level	Mix	Total	Level	Mix	Total			
Changes in industries value added: A Agriculture, forestry, etc.	–103.9	–26.5	–9.6	0.1	–5.7	–41.7	–3.5	–6.5	–9.9	–675.7	588.4	–87.4	–15.5	26.3	10.8	–86.5	–232.1	–0.97
B-E Mining; manufacturing, etc.	51.3	–0.9	–79.7	–8.3	–13.1	–102.1	–10.1	–6.2	–16.4	153.8	–198.1	–44.3	–131.5	105.2	–26.3	–87.0	–137.8	–0.58
of which BDE Mining, energy and public utilites	–9.9	–0.4	–17.3	–0.7	–7.5	–25.8	–4.2	–18.6	–22.8	11.7	–21.7	–10.0	–9.8	19.3	9.5	–23.3	–58.9	–0.25
of which C Manufacturing	61.2	–0.5	–62.4	–7.7	–5.7	–76.3	–5.9	12.4	6.5	142.1	–176.4	–34.4	–121.7	85.8	–35.9	–63.7	–78.8	–0.33
F Construction	1.1	0.0	–3.1	5.0	4.7	6.6	–0.6	–1.2	–1.8	32.3	–104.0	–71.7	–2.1	5.3	3.1	–70.3	–62.7	–0.26
G-U Services	185.6	1.2	–38.4	1.2	–6.1	–42.1	–60.8	10.2	–50.6	–173.9	72.8	–101.1	–112.6	126.1	13.4	–138.3	5.2	0.02
of which GI Trade, repair of motor vehicles and motorcycles, accommodation and food service activities	75.9	–1.2	–15.6	–5.0	–9.6	–31.3	–15.0	–2.1	–17.1	–59.8	32.1	–27.7	–27.2	9.0	–18.2	–63.0	–18.4	–0.08
of which H Transportation and storage	48.6	0.5	1.3	2.3	–36.0	–31.9	–3.8	–4.4	–8.3	–14.8	–7.8	–22.6	–22.0	52.8	30.9	–0.0	16.7	0.07
of which J Information and communication	3.8	0.6	0.9	3.9	6.7	12.1	–4.8	18.7	13.9	–17.5	–6.6	–24.1	–14.2	21.6	7.4	–2.8	13.2	0.06
of which K Financial and insurance activities	–6.8	0.5	–4.0	0.6	–1.0	–3.9	–7.1	10.4	3.3	–16.4	7.8	–8.6	–6.5	–7.5	–14.0	–19.3	–30.0	–0.13
of which L Real estate activities	22.7	–1.1	–16.8	–2.1	–7.2	–27.2	–15.3	6.7	–8.6	–13.6	–2.7	–16.3	–5.7	–1.0	–6.7	–31.6	–36.1	–0.15
of which MN Professional, scientific and technical activities; administrative and support service activities	17.5	1.0	–9.3	–0.0	15.1	6.8	–5.3	–5.4	–10.7	–27.4	17.6	–9.8	–31.6	43.7	12.0	–8.5	15.9	0.07
of which OPQ Public administration and defence, compulsory social security, education; human health and social work activities	12.5	0.6	4.8	1.2	26.7	33.4	–5.5	3.9	–1.6	–22.2	34.2	11.9	–3.9	9.9	6.1	16.4	62.3	0.26
of which R-T Arts, entertainment and recrea-tion, repair of household goods and other services	11.4	0.1	0.4	0.4	–0.9	–0.1	–4.0	–17.6	–21.5	–2.2	–1.8	–4.0	–1.5	–2.6	–4.1	–29.6	–18.3	–0.08
Total: billion HUF	134.0	–26.2	–130.8	–2.0	–20.3	–179.3	–74.9	–3.7	–78.6	–663.5	359.0	–304.5	–261.7	262.8	1.0	–382.1	–427.3	–1.79
Total: %	0.56	–0.11	–0.55	–0.01	–0.08	–0.75	–0.31	–0.02	–0.33	–2.78	1.50	–1.27	–1.10	1.10	0.00	–1.60	–1.79	

This results in the vector of value added multipliers of several industries, which express the value added effect of an additional unit of final demand in the relating industry. Subsequently, the product of the diagonal matrix of the multipliers and the final demand vector gives the results. Vectors $\bar{\mathbf{v}}$, in contrast to former vectors $\mathbf{v}$, allocate domestic value added to industries not on the basis of where they appear, but according to all the direct and indirect nationwide effects that an industry's final demand can have. Using this model, we have a somewhat different production approach, which also yields significant deviations from conventional growth contributions in certain industries.

Table 6 shows the value added vectors calculated by Equations (1) and (20), the value added multiplicators, and final outputs of the industries. I have inserted the detailed table in full here, the reason for this being that, on the one hand, value added multipliers are important indicators for forecasting and industrial policy, showing the way and amplitude of change of the economy's total value added caused by one additional unit of final use in a certain industry.[24] On the other hand, in spite of their relevance, no multiplier tables are available in Hungary in a public form, either for the last published IO table for 2010, or for the archive 2008.[25]

Data in the short form in *Table 5* serve for an easy comparison with *Table 3*. The detailed results of the use of Equation according to the system – can be found in *Table 7*.

Table 5. Production approach growth contributions by SDA#2

Production approach contributions to GVA growth based on final demand industry supply chains' value added (in billion HUF and %)

Industries	Gross value added		Change	
	Base year, 2011 $(\bar{v}^0)$	Current year, 2012 (at previous year prices) $(\bar{v}^1)$	in value (billion HUF) $(\Delta\bar{v})$	in proportion to base total (%)
A Agriculture, forestry and fishing	877	690	–187	–0.78
B-E Mining and quarrying; manufacturing, etc.	7 336	7 192	–144	–0.60
F Construction	1 341	1 238	–104	–0.43
G-T Services	14 333	14 340	7	0.03
Gross value added total	23 887	23 460	–427	–1.79

24 Naturally, if the assumptions of the input-output model are met, that there are no restrictions on the supply side, and the input coefficients remain unchanged.

25 Detailed analyses of input-output tables and publishing of multipliers are relatively rare in Hungary. The last publication of this nature relates to the table for year 2000 (Nyitrainé – Forgon 2004).

Table 6. Value added of industries and final demand industry supply chains, value added multipliers, and final outputs

Value added of industries and supply chains, value added multipliers and final outputs (rank numbers in parentheses)

Final demand industries	Industry's own value added (in billion HUF)			Value added of the final demand industry supply chain (in billion HUF)			Value added multiplier			Output for final use (in billion HUF)		
	Base year, 2011 ($\mathbf{v}^0$)	Current year, 2012 (at previous year prices) ($\mathbf{v}^1$)	Change	Base year, 2011 ($\bar{\mathbf{v}}^0$)	Current year (at previous year prices) ($\bar{\mathbf{v}}^1$)	Change	Base year, 2011	Current year, 2012	Change	Base year, 2011	Current year, 2012	Change
01: Crop and animal production, hunting and related service activities	1 045 846 (5)	815 086 (8)	–230 760 (64)	825 401 (10)	637 390 (13)	–188 011 (64)	0.719 (29)	0.668 (37)	–0.051	1 147 405 (12)	954 126 (15)	–193 279
02: Forestry and logging	56 018 (56)	54 797 (55)	–1 221 (29)	45 921 (54)	47 975 (52)	2 054 (24)	0.807 (13)	0.805 (18)	–0.002	56 928 (55)	59 619 (54)	2 691
03: Fishing and aquaculture	4 618 (61)	4 514 (62)	–104 (25)	5 511 (60)	4 846 (61)	–666 (36)	0.780 (23)	0.765 (25)	–0.015	7 062 (61)	6 333 (61)	–729
05-09: Mining and quarrying	60 866 (54)	48 598 (56)	–12 268 (53)	25 750 (56)	27 265 (57)	1 515 (26)	0.719 (30)	0.715 (31)	–0.004	35 815 (57)	38 114 (56)	2 299
10-12: Manufacture of food, beverages and tobacco products	533 698 (17)	552 696 (15)	18 998 (9)	1 144 868 (7)	1 162 410 (6)	17 542 (8)	0.589 (43)	0.567 (44)	–0.022	1 943 925 (6)	2 048 857 (4)	104 932
13-15: Manufacture of textiles, wearing apparel and leather products	125 614 (46)	117 723 (47)	–7 891 (43)	148 286 (39)	139 428 (40)	–8 858 (47)	0.450 (52)	0.459 (51)	0.008	329 188 (31)	304 059 (32)	–25 129
16: Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	59 619 (55)	55 891 (54)	–3 728 (38)	66 898 (49)	64 562 (49)	–2 336 (37)	0.511 (49)	0.511 (49)	–0.000	130 972 (48)	126 426 (49)	–4 546
17: Manufacture of paper and paper products	81 745 (51)	82 667 (51)	922 (20)	97 502 (47)	83 547 (47)	–13 955 (54)	0.361 (55)	0.384 (55)	0.023	269 956 (36)	217 469 (39)	–52 488
18: Printing and reproduction of recorded media	72 505 (53)	66 888 (53)	–5 617 (42)	18 405 (59)	18 534 (59)	129 (28)	0.558 (45)	0.546 (45)	–0.011	33 013 (58)	33 921 (58)	908
19: Manufacture of coke and refined petroleum products	296 122 (25)	278 957 (26)	–17 165 (57)	260 556 (27)	243 260 (29)	–17 296 (56)	0.244 (61)	0.237 (62)	–0.008	1 066 507 (14)	1 028 011 (13)	–38 496
20: Manufacture of chemicals and chemical products	157 185 (38)	154 035 (38)	–3 150 (37)	268 457 (26)	275 372 (25)	6 916 (18)	0.337 (57)	0.336 (58)	–0.002	795 889 (18)	820 746 (17)	24 857
21: Manufacture of basic pharmaceutical products and pharmaceutical preparations	397 016 (22)	388 586 (22)	–8 430 (45)	431 182 (15)	430 773 (16)	–408 (34)	0.580 (44)	0.576 (43)	–0.003	744 021 (19)	747 744 (19)	3 723
22: Manufacture of rubber and plastic products	301 517 (24)	316 092 (24)	14 575 (11)	339 849 (19)	355 843 (19)	15 994 (9)	0.410 (53)	0.412 (54)	0.002	828 751 (16)	863 907 (16)	35 156
23: Manufacture of other non-metallic mineral products	163 441 (36)	150 465 (41)	–12 976 (55)	165 143 (38)	155 379 (38)	–9 764 (49)	0.528 (46)	0.515 (48)	–0.012	313 013 (32)	301 584 (33)	–11 429

Table 6. continued

Final demand industries	Industry's own value added (in billion HUF)			Value added of the final demand industry supply chain (in billion HUF)			Value added multiplier			Output for final use (in billion HUF)		
	Base year, 2011 ($\mathbf{v}^0$)	Current year, 2012 (at previous year prices) ($\mathbf{v}^1$)	Change	Base year, 2011 ($\bar{\mathbf{v}}^0$)	Current year (at previous year prices) ($\bar{\mathbf{v}}^1$)	Change	Base year, 2011	Current year, 2012	Change	Base year, 2011	Current year, 2012	Change
24: Manufacture of basic metals	131 623 (45)	122 401 (46)	–9 222 (47)	178 724 (34)	165 679 (35)	–13 045 (53)	0.325 (59)	0.311 (59)	–0.015	549 360 (22)	533 337 (22)	–16 024
25: Manufacture of fabricated metal products, except machinery and equipment	365 426 (23)	375 704 (23)	10 278 (15)	328 588 (20)	328 579 (21)	–9 (32)	0.525 (47)	0.546 (46)	0.021	626 200 (21)	601 563 (21)	–24 637
26: Manufacture of computer, electronic and optical products	545 245 (16)	433 243 (19)	–112 002 (63)	750 628 (12)	577 937 (14)	–172 690 (63)	0.182 (63)	0.184 (63)	0.002	4 116 444 (1)	3 135 070 (2)	–981 374
27: Manufacture of electrical equipment	214 263 (31)	203 894 (34)	–10 369 (48)	276 910 (24)	273 318 (26)	–3 592 (38)	0.337 (58)	0.339 (57)	0.002	821 568 (17)	807 002 (18)	–14 566
28: Manufacture of machinery and equipment n.e.c.	701 026 (12)	704 988 (11)	3 962 (17)	780 815 (11)	795 966 (10)	15 151 (12)	0.466 (51)	0.457 (52)	–0.009	1 677 035 (8)	1 741 673 (7)	64 638
29: Manufacture of motor vehicles, trailers and semi-trailers	815 521 (8)	857 566 (7)	42 045 (1)	1 031 958 (8)	1 099 743 (8)	67 785 (1)	0.271 (60)	0.268 (60)	–0.003	3 804 090 (2)	4 102 077 (1)	297 987
30: Manufacture of other transport equipment	38 062 (59)	35 981 (59)	–2 081 (34)	52 976 (52)	48 124 (51)	–4 852 (42)	0.471 (50)	0.501 (50)	0.030	112 443 (50)	96 037 (50)	–16 406
31-32: Manufacture of furniture; other manufacturing	151 631 (41)	155 188 (36)	3 557 (18)	195 832 (33)	200 864 (32)	5 032 (20)	0.516 (48)	0.528 (47)	0.012	379 437 (26)	380 619 (27)	1 183
33: Repair and installation of machinery and equipment	125 397 (47)	144 873 (42)	19 476 (8)	68 538 (48)	92 205 (46)	23 667 (7)	0.611 (42)	0.635 (41)	0.024	112 152 (51)	145 272 (47)	33 121
35: Electricity, gas, steam and air conditioning supply	574 588 (14)	551 519 (16)	–23 069 (59)	426 201 (17)	387 599 (18)	–38 603 (59)	0.630 (41)	0.600 (42)	–0.030	676 647 (20)	646 306 (20)	–30 341
36: Water collection, treatment and supply	117 754 (48)	115 410 (48)	–2 344 (35)	106 759 (45)	106 711 (45)	–48 (33)	0.773 (26)	0.769 (24)	–0.003	138 185 (47)	138 682 (48)	497
37-39: Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services	176 280 (35)	155 028 (37)	–21 252 (58)	171 120 (36)	158 601 (36)	–12 519 (52)	0.714 (32)	0.700 (32)	–0.014	239 675 (39)	226 437 (37)	–13 238
41-43: Construction	988 251 (6)	925 577 (6)	–62 674 (62)	1 341 462 (3)	1 237 688 (3)	–103 775 (62)	0.648 (40)	0.649 (39)	0.002	2 071 006 (4)	1 906 268 (6)	–164 737
45: Wholesale and retail trade and repair of motor vehicles and motorcycles	224 063 (29)	240 006 (27)	15 943 (10)	243 054 (30)	248 497 (28)	5 443 (19)	0.677 (38)	0.686 (36)	0.009	359 218 (28)	362 311 (28)	3 093
46: Wholesale trade, except of motor vehicles and motorcycles	1 284 852 (3)	1 226 644 (3)	–58 208 (61)	1 213 878 (5)	1 165 007 (5)	–48 870 (60)	0.694 (35)	0.697 (33)	0.003	1 748 712 (7)	1 670 738 (8)	–77 973

Table 6. continued

Final demand industries	Industry's own value added (in billion HUF)			Value added of the final demand industry supply chain (in billion HUF)			Value added multiplier			Output for final use (in billion HUF)		
	Base year, 2011 ($\mathbf{v}^0$)	Current year, 2012 (at previous year prices) ($\mathbf{v}^1$)	Change	Base year, 2011 ($\mathbf{v}^{-0}$)	Current year (at previous year prices) ($\mathbf{v}^{-1}$)	Change	Base year, 2011	Current year, 2012	Change	Base year, 2011	Current year, 2012	Change
47: Retail trade, except of motor vehicles and motorcycles	920 759 (7)	946 657 (5)	25 898 (4)	1 229 007 (4)	1 220 866 (4)	–8 141 (46)	0.783 (22)	0.787 (22)	0.005	1 570 573 (9)	1 551 043 (9)	–19 530
49: Land transport and transport via pipelines	705 188 (11)	704 009 (12)	–1 179 (28)	707 651 (13)	709 238 (11)	1 586 (25)	0.651 (39)	0.646 (40)	–0.005	1 087 473 (13)	1 097 749 (12)	10 276
50: Water transport	3 064 (63)	4 999 (61)	1 935 (19)	5 419 (61)	8 231 (60)	2 812 (23)	0.381 (54)	0.440 (53)	0.059	14 210 (60)	18 704 (60)	4 493
51: Air transport	43 120 (57)	41 749 (57)	–1 371 (30)	61 322 (50)	45 755 (53)	–15 566 (55)	0.243 (62)	0.240 (61)	–0.003	252 445 (37)	190 580 (42)	–61 864
52: Warehousing and support activities for transportation	564 948 (15)	587 696 (14)	22 748 (6)	286 620 (23)	326 211 (22)	39 590 (2)	0.785 (19)	0.811 (16)	0.026	365 232 (27)	402 239 (26)	37 007
53: Postal and courier activities	143 644 (42)	138 198 (43)	–5 446 (41)	54 892 (51)	50 896 (50)	–3 996 (39)	0.839 (7)	0.840 (8)	0.000	65 411 (53)	60 626 (53)	–4 785
55-56: Accommodation and food service activities	431 096 (20)	429 039 (20)	–2 057 (33)	685 091 (14)	684 552 (12)	–539 (35)	0.700 (33)	0.696 (34)	–0.004	978 593 (15)	983 299 (14)	4 706
58: Publishing activities	116 683 (49)	108 336 (49)	–8 347 (44)	114 262 (44)	107 680 (44)	–6 582 (45)	0.722 (28)	0.726 (30)	0.004	158 260 (46)	148 315 (46)	–9 945
59-60: Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities	225 809 (28)	214 320 (31)	–11 489 (52)	210 014 (31)	188 313 (33)	–21 701 (58)	0.688 (36)	0.661 (38)	–0.027	305 221 (34)	284 854 (35)	–20 367
61: Telecommunications	451 609 (19)	451 026 (18)	–583 (27)	419 514 (18)	435 011 (15)	15 496 (11)	0.817 (12)	0.828 (9)	0.011	513 689 (24)	525 378 (23)	11 689
62-63: Computer programming, consultancy and related activities; information service activities	474 526 (18)	508 105 (17)	33 579 (2)	305 953 (21)	334 830 (20)	28 877 (6)	0.779 (24)	0.806 (17)	0.027	392 877 (25)	415 377 (25)	22 500
64: Financial service activities, except insurance and pension funding	775 768 (9)	764 690 (9)	–11 078 (51)	428 037 (16)	423 695 (17)	–4 342 (41)	0.818 (11)	0.827 (10)	0.008	522 965 (23)	512 346 (24)	–10 620
65: Insurance, reinsurance and pension funding, except compulsory social security	138 094 (43)	127 600 (45)	–10 494 (49)	176 785 (35)	167 382 (34)	–9 404 (48)	0.777 (25)	0.763 (26)	–0.014	227 468 (40)	219 420 (38)	–8 048
66: Activities auxiliary to financial services and insurance activities	162 316 (37)	153 876 (39)	–8 440 (46)	23 663 (58)	27 614 (55)	3 951 (21)	0.896 (4)	0.907 (4)	0.011	26 398 (59)	30 444 (59)	4 046
68: Real estate activities and imputed rents of owner-occupied dwellings	2 007 622 (2)	1 971 533 (2)	–36 089 (60)	1 767 625 (2)	1 757 780 (2)	–9 845 (50)	0.877 (5)	0.885 (5)	0.009	2 016 540 (5)	1 985 183 (5)	–31 357

Table 6. continued

Final demand industries	Industry's own value added (in billion HUF)			Value added of the final demand industry supply chain (in billion HUF)			Value added multiplier			Output for final use (in billion HUF)		
	Base year, 2011 ($\mathbf{v}^0$)	Current year, 2012 (at previous year prices) ($\mathbf{v}^1$)	Change	Base year, 2011 ($\bar{\mathbf{v}}^0$)	Current year (at previous year prices) ($\bar{\mathbf{v}}^1$)	Change	Base year, 2011	Current year, 2012	Change	Base year, 2011	Current year, 2012	Change
69-70: Legal and accounting activities; activities of head offices; management consultancy activities	622 847 (13)	612 160 (13)	–10 687 (50)	244 599 (29)	278 118 (24)	33 519 (4)	0.820 (10)	0.824 (12)	0.004	298 167 (35)	337 324 (30)	39 157
71: Architectural and engineering activities; technical testing and analysis	292 872 (26)	292 314 (25)	–558 (26)	127 499 (41)	138 237 (41)	10 738 (14)	0.798 (15)	0.813 (15)	0.015	159 798 (45)	170 102 (44)	10 304
72: Scientific research and development	195 491 (33)	215 424 (29)	19 933 (7)	205 282 (32)	220 994 (31)	15 712 (10)	0.838 (8)	0.851 (7)	0.012	244 893 (38)	259 819 (36)	14 926
73: Advertising and market research	105 427 (50)	92 581 (50)	–12 846 (54)	49 982 (53)	44 868 (54)	–5 114 (43)	0.783 (20)	0.787 (23)	0.004	63 820 (54)	57 005 (55)	–6 815
74-75: Other professional, scientific and technical activities; veterinary activities	154 656 (40)	155 226 (35)	570 (21)	100 353 (46)	131 853 (43)	31 500 (5)	0.789 (17)	0.817 (14)	0.029	127 249 (49)	161 347 (45)	34 098
77: Rental and leasing activities	187 160 (34)	212 966 (32)	25 806 (5)	118 489 (43)	155 823 (37)	37 334 (3)	0.716 (31)	0.753 (27)	0.037	165 437 (44)	206 995 (40)	41 558
78: Employment activities	156 918 (39)	152 428 (40)	–4 490 (39)	4 167 (62)	4 235 (62)	68 (29)	0.932 (2)	0.929 (2)	–0.003	4 472 (62)	4 557 (62)	85
79: Travel agency, tour operator reservation service and related activities	28 861 (60)	28 982 (60)	121 (22)	24 559 (57)	25 778 (58)	1 219 (27)	0.355 (56)	0.375 (56)	0.021	69 241 (52)	68 701 (52)	–540
80-82: Security and investigation activities; services to buildings and landscape activities; office administrative, office support and other business support activities	420 895 (21)	418 904 (21)	–1 991 (32)	165 603 (37)	75 259 (48)	–90 344 (61)	0.786 (18)	0.792 (20)	0.007	210 755 (41)	94 977 (51)	–115 778
84: Public administration and defence; compulsory social security	2 035 806 (1)	2 048 799 (1)	12 993 (12)	2 236 854 (1)	2 246 396 (1)	9 542 (16)	0.876 (6)	0.873 (6)	–0.003	2 553 425 (3)	2 574 495 (3)	21 070
85: Education	1 073 299 (4)	1 100 880 (4)	27 581 (3)	1 146 728 (6)	1 159 131 (7)	12 403 (13)	0.898 (3)	0.909 (3)	0.011	1 276 843 (10)	1 275 175 (10)	–1 668
86: Human health activities	726 864 (10)	737 735 (10)	10 871 (13)	854 980 (9)	858 807 (9)	3 827 (22)	0.728 (27)	0.728 (28)	0.000	1 175 006 (11)	1 180 013 (11)	5 007
87-88: Social work activities	218 885 (30)	229 715 (28)	10 830 (14)	273 714 (25)	281 164 (23)	7 450 (17)	0.783 (21)	0.791 (21)	0.008	349 656 (30)	355 332 (29)	5 676

Table 6. continued

Final demand industries	Industry's own value added (in billion HUF)			Value added of the final demand industry supply chain (in billion HUF)			Value added multiplier			Output for final use (in billion HUF)		
	Base year, 2011 ($\mathbf{v}^0$)	Current year, 2012 (at previous year prices) ($\mathbf{v}^1$)	Change	Base year, 2011 ($\bar{\mathbf{v}}^0$)	Current year (at previous year prices) ($\bar{\mathbf{v}}^1$)	Change	Base year, 2011	Current year, 2012	Change	Base year, 2011	Current year, 2012	Change
90-92: Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities	211 721 (32)	208 595 (33)	–3 126 (36)	286 659 (22)	268 659 (27)	–18 000 (57)	0.801 (14)	0.817 (13)	0.016	357 860 (29)	328 668 (31)	–29 192
93: Sports activities and amusement and recreation activities	75 161 (52)	79 909 (52)	4 748 (16)	125 953 (42)	136 290 (42)	10 337 (15)	0.699 (34)	0.694 (35)	–0.005	180 137 (43)	196 295 (41)	16 158
94: Activities of membership organisations	135 526 (44)	130 517 (44)	–5 009 (40)	145 232 (40)	141 233 (39)	–3 999 (40)	0.797 (16)	0.801 (19)	0.004	182 189 (42)	176 375 (43)	–5 815
95: Repair of computers and personal and household goods	39 758 (58)	37 807 (58)	–1 951 (31)	33 119 (55)	27 550 (56)	–5 569 (44)	0.683 (37)	0.727 (29)	0.044	48 460 (56)	37 879 (57)	–10 581
96: Other personal service activities	227 557 (27)	214 560 (30)	–12 997 (56)	252 944 (28)	240 804 (30)	–12 140 (51)	0.828 (9)	0.827 (11)	–0.002	305 391 (33)	291 297 (34)	–14 095
97-98: Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	3 631 (62)	3 689 (63)	58 (23)	3 631 (63)	3 689 (63)	58 (30)	1.000 (1)	1.000 (1)	0.000	3 631 (63)	3 689 (63)	58
99: Activities of extra-territorial organisations and bodies	0 (64)	0 (64)	0 (24)	0 (64)	0 (64)	0 (31)	0.000 (64)	0.000 (64)	0.000	0 (64)	0 (64)	0
Total	23 887 373	23 460 041	–427 332	23 887 373	23 460 041	–427 332				41 408 403	40 249 908	–1 158 495

7. DISCUSSION

Figures 3 and *4* help to give an overall assessment. The waterfall chart below shows that according to the most important column sums of the SDA, the change of value added ratios have the only significant positive effect on the 2012 growth. Shifts in domestic input requirements, particularly those of manufacturing, and the fall in final demand decreased the total value added.

Benchmark *Tables 2* and *3* indicated export as a considerable negative factor, which was overcompensated by the more declining import. Thus, from the demand side, international trade was the only positive force. SDA results indicate these differently. Taking the industry mix of export and the multiplication processes through the value chains into account and fixing the supplier structure and value added ratios at the average of two years, we can say changes in export hardly affected the growth on the whole. The cutdown of the domestic final use of domestic products, mainly the decrease in investments, was the greatest pull-back force. The growth effect order of the components of domestic final demand in SDA, however, is the same as in *Table 3*.

An in-depth discussion of the various industry partial effects behind the column sums,[26] and unfolding the complexities of the levels and mixes is beyond the limits of this paper; however, highlighting variances between industries' own value added and those of their supply chains definitely deserves mention. These can be followed by a row-by-row comparison of *Tables 3* and *5*.

Value added production of an industry, according to the "accounting" used in SDA#2, depends on its final output on the one hand, and on its value added multiplier on the other. For example, agriculture sells more for intermediate, than final use, and thus, despite its relatively high multiplier, it has a lower value added from final demand supply chains than its own realised measure (a part of the latter, in a supply chain approach, will be accounted to other industries, for which agriculture is a supplier). Supply chain values added of manufacturing and construction, however, exceed by far their own one. These are due to the prodigious production and export volumes of the key sub-branches of manufacturing, and the high multiplier value of construction. Hence, the decline in the final demand for construction in *Table* 5 decreased economic growth more than the fall in its own value added in *Table 3*.

[26] This can be analysed at length using *Table 4*. Note, that SDA give results for the demand and supply side not in a separated way, but in a two-dimensional cross-tab, which comprises both sides; industry effects in the rows, and final demand, supply chain, and value added ratio effects (and their further decompositions) in the columns.

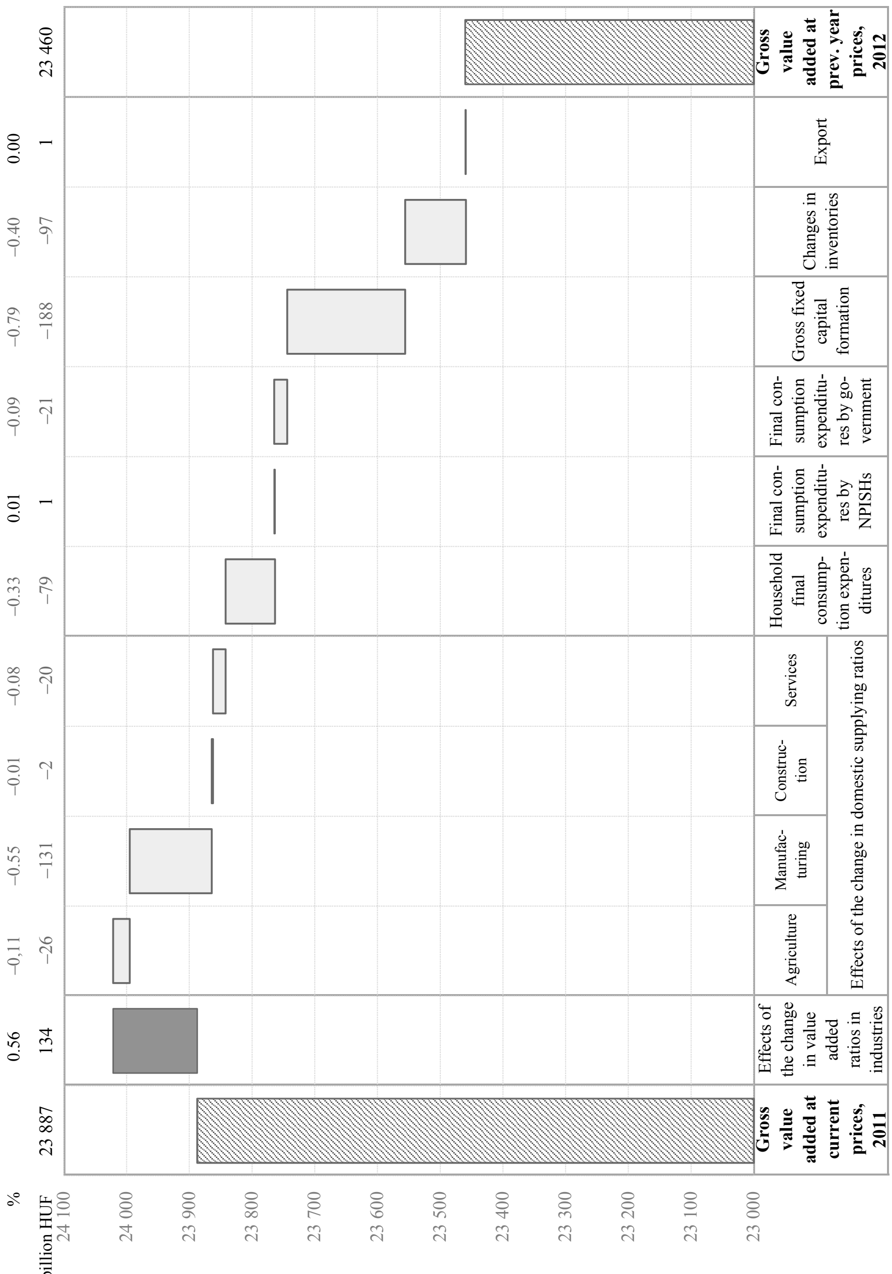


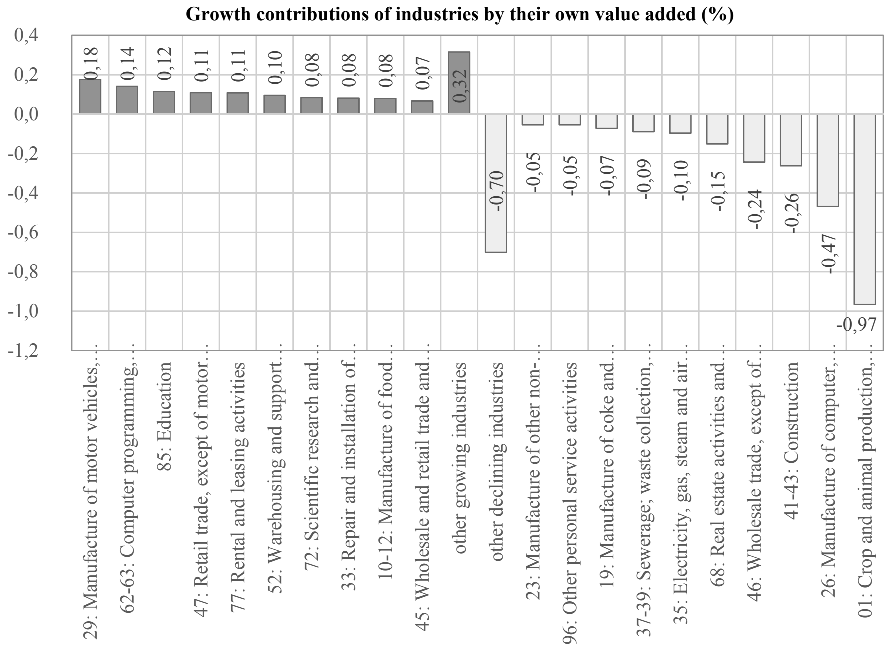
Figure 3. Column sum SDA results

Figure 4 shows the effect of the most and least growth-contributing industries in 2012 estimated by both methods. When making a comparison of the lists of the first and last ten industries of the upper and lower diagram, a significant overlap can be seen. The most and least own value added growth-contributing industries generally have the greatest effects through their supply chains too. The ranking between them, however, is somewhat different. Warehousing and support activities for transportation, for example, is second by its supply chains, and only sixth with its own value added.

The ranking is headed by the manufacture of motor vehicle in both cases, although value according to the second approach was more than one and a half times higher. Growth contribution of the automotive industry by its own value added was 0.176%; however, it bore a 0.284% effect through its suppliers, in spite of its almost minimum and somewhat decreasing multiplier value in *Table 6,* caused by its high import and low domestic supply and value added rates. Nevertheless, low and declining multipliers, coupled with a high and increasing export volume, resulted in a rise from the second to the first position in the ranking of final use effect in *Table 5,* the direct and indirect consequences of which, according to *Table 7,* overcompensated the negative growth effects of declining domestic supplying rates.

At the other end of the ranking, we cannot neglect the huge negative contribution of the manufacture of computer, electronic and optical products, Hungary's greatest industry in 2011 measured by output and exports. Due to the dislocations, contractions, and realignments in the sector, and the approximately 1 000 billion HUF decline in the sales of the top four companies, the final output of the industry fell by almost one quarter (*Table 6*), and thus the fall of its export (*Table 7*) is responsible for more than 40% of the decrease of the total value added. In spite of its low embeddedness in the Hungarian economy, the multiplicative effects of these contractions can be detected as the difference between –0.47% and –0.72% growth contribution rates (*Figure 4*).

One-half of the fall in the total value added showed up in agriculture. Looking at it from the demand side (*Table 7*), we find that one-quarter of the fall in the total value added was caused by the decrease of the stocks of domestic agricultural products. This phenomenon highlights the nature and role of the "changes in inventories" column of the IO table, which also absorbs the statistical errors and omissions, and the problem of short-term or long-term indicators, depending, in particular, on whether the calculations were made in an economy in equilibrium or not. Also, the value added share of the agriculture (and possibly of other sectors) is rather dependent on the weather and/or on other conditions (e.g. epidemics in the animal stock, embargos). These have to be borne in mind, especially when looking for the right direction of the causality in the decomposition results.



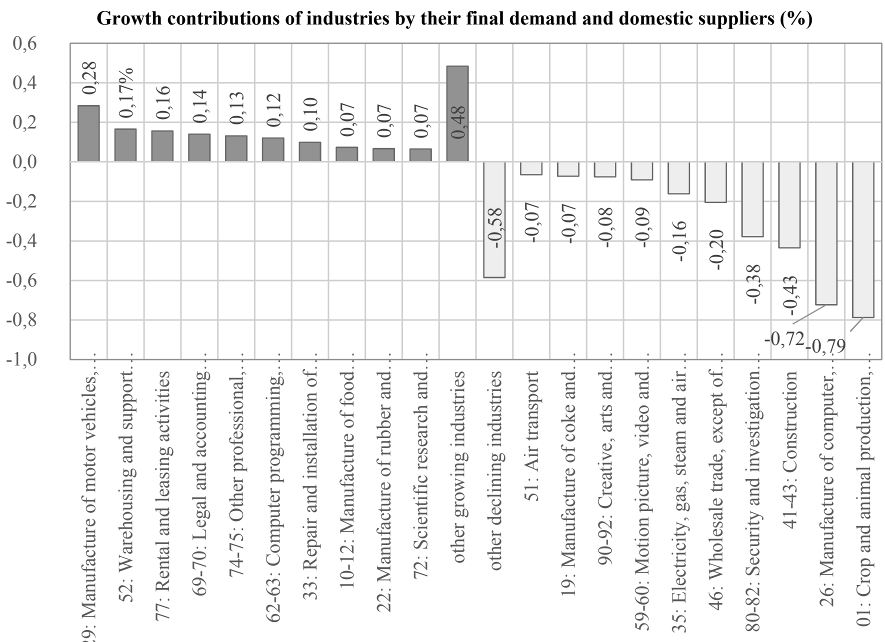


Figure 4. The most and least growth-contributing industries in 2012

Table 7. Results of SDA#2

Growth contributions of final demand industries supply chains (in billion HUF)

Final demand industries			Value added of the supply chain: Base year, 2011 $(\mathbf{v}^{-0})$	Value added of the supply chain: Current year, 2012 (at previous year prices) $(\mathbf{v}^{-1})$
Value added level and change generated by industries final use output and supply chain	A Agriculture, forestry and fishing		876.8	690.2
	of which	01: Crop and animal production, hunting and related service activities	825.4	637.4
		02: Forestry and logging	45.9	48.0
		03: Fishing and aquaculture	5.5	4.8
	B-E Mining and quarrying; manufacturing, etc.		7 335.9	7 191.7
	of which	05-09: Mining and quarrying	25.7	27.3
		10-12: Manufacture of food, beverages and tobacco products	1 144.9	1 162.4
		13-15: Manufacture of textiles, wearing apparel and leather products	148.3	139.4
		16: Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	66.9	64.6
		17: Manufacture of paper and paper products	97.5	83.5
		18: Printing and reproduction of recorded media	18.4	18.5
		19: Manufacture of coke and refined petroleum products	260.6	243.3
		20: Manufacture of chemicals and chemical products	268.5	275.4
		21: Manufacture of basic pharmaceutical products and pharmaceutical preparations	431.2	430.8
		22: Manufacture of rubber and plastic products	339.8	355.8
		23: Manufacture of other non-metallic mineral products	165.1	155.4
		24: Manufacture of basic metals	178.7	165.7
		25: Manufacture of fabricated metal products, except machinery and equipment	328.6	328.6
		26: Manufacture of computer, electronic and optical products	750.6	578.0
		27: Manufacture of electrical equipment	276.9	273.3
		28: Manufacture of machinery and equipment n.e.c.	780.8	796.0
		29: Manufacture of motor vehicles, trailers and semi-trailers	1 032.0	1 099.8
		30: Manufacture of other transport equipment	53.0	48.1
		31-32: Manufacture of furniture; other manufacturing	195.8	200.9
		33: Repair and installation of machinery and equipment	68.5	92.2
		35: Electricity, gas, steam and air conditioning supply	426.2	387.6
		36: Water collection, treatment and supply	106.8	106.7
		37-39: Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services	171.1	158.6
	F Construction		1 341.5	1 237.7
	G-U Services		14 333.1	14 340.4

Growth effects										
Effect of the changes in value added ratios	Effects of the changes in domestic direct requirement coefficients	Effects of changes in final demand						Total	Grand total	
		House-hold final consumption expenditures	Final consumption expenditures by NPISHs	Final consumption expenditures by government	Gross fixed capital formation	Changes in inventories	Export		billion HUF	%
–36.0	–18.2	–14.9	–0.0	0.0	–10.5	–100.3	–6.8	–132.5	–186.6	–0.78
–35.9	–18.0	–15.7	0.0	0.1	–10.0	–100.8	–7.7	–134.1	–188.0	–0.79
0.0	–0.2	1.4	–0.0	–0.1	–0.7	0.7	0.9	2.2	2.1	0.01
–0.1	–0.0	–0.6	0.0	0.0	0.1	–0.2	0.0	–0.6	–0.7	0.00
39.3	–115.3	–17.5	–0.1	–12.6	–12.6	–11.7	–13.8	–68.2	–144.2	–0.60
–0.7	0.5	–3.7	0.0	–0.6	–1.9	3.2	4.6	1.6	1.5	0.01
–13.1	–30.0	5.7	–0.1	0.3	0.0	–15.1	69.7	60.6	17.6	0.07
0.7	1.9	7.5	0.0	–0.0	–0.2	–3.3	–15.4	–11.4	–8.9	–0.04
0.1	–0.2	–0.4	0.0	–0.0	–0.9	0.3	–1.3	–2.3	–2.3	–0.01
6.6	–1.0	2.0	–0.0	–0.0	–0.1	–2.0	–19.5	–19.6	–14.0	–0.06
–0.3	–0.1	–0.1	0.0	0.0	–0.0	–0.0	0.5	0.5	0.1	0.00
5.3	–13.3	0.5	0.0	–0.9	–1.8	–1.0	–6.2	–9.3	–17.3	–0.07
–2.8	1.3	1.7	0.0	–0.1	–0.5	1.0	6.2	8.4	6.9	0.03
–4.3	1.8	–5.6	–0.1	–5.5	–1.3	–1.6	16.2	2.1	–0.4	0.00
7.3	–5.8	0.8	0.0	–0.1	–0.3	–0.4	14.4	14.4	16.0	0.07
0.6	–4.4	–0.7	0.0	–0.1	–3.2	–3.0	1.0	–6.0	–9.8	–0.04
1.8	–9.7	0.1	0.0	–0.0	–0.4	–3.0	–1.7	–5.1	–13.0	–0.05
15.5	–2.3	0.2	0.0	–0.0	–2.0	–11.5	0.1	–13.2	–0.0	0.00
18.9	–11.6	–0.9	0.0	–0.3	–0.9	0.3	–178.0	–179.9	–172.7	–0.72
–1.6	2.9	0.2	0.0	–0.1	–1.2	–0.1	–3.7	–4.9	–3.6	–0.02
–9.7	–4.9	3.6	0.0	0.3	3.5	5.7	16.7	29.8	15.2	0.06
4.6	–17.1	4.2	0.0	0.2	–3.3	15.7	63.6	80.4	67.8	0.28
1.3	1.9	–1.1	0.0	–0.6	0.2	3.1	–9.5	–8.0	–4.9	–0.02
4.3	0.1	–1.6	0.0	–0.4	–2.0	–0.8	5.4	0.6	5.0	0.02
3.5	–0.4	–0.0	0.0	0.1	6.9	0.2	13.5	20.6	23.7	0.10
3.2	–23.1	–28.4	0.0	–2.2	–1.6	0.2	13.3	–18.7	–38.6	–0.16
0.2	–0.6	–1.0	0.0	0.3	–0.5	0.1	1.5	0.4	–0.0	0.00
–2.1	–1.1	–0.7	0.0	–2.7	–1.0	0.1	–5.0	–9.4	–12.5	–0.05
8.0	–4.9	–1.8	0.0	–0.5	–124.6	16.2	4.0	–106.8	–103.8	–0.43
122.7	–40.9	–44.5	1.4	–7.7	–40.6	–0.9	17.7	–74.5	7.3	0.03

Table 7. continued

Growth contributions of final demand industries supply chains (in billion HUF)

Final demand industries			Value added of the supply chain	
			Base year, 2011 ($\mathbf{v}^{-0}$)	Current year, 2012 (at previous year prices) ($\mathbf{v}^{-1}$)
Value added level and change generated by industries final use output and supply chain	of which	45: Trade and repair of motor vehicles and motorcycles	243.1	248.5
		46: Wholesale trade, except of motor vehicles and motorcycles	1 213.9	1 165.0
		47: Retail trade, except of motor vehicles and motorcycles	1 229.0	1 220.9
		49: Land transport and transport via pipelines	707.7	709.2
		50: Water transport	5.4	8.2
		51: Air transport	61.3	45.8
		52: Warehousing and support activities for transportation	286.6	326.2
		53: Postal and courier activities	54.9	50.9
		55-56: Accommodation and food service activities	685.1	684.6
		58: Publishing activities	114.3	107.7
		59-60: Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities	210.0	188.3
		61: Telecommunications	419.5	435.0
		62-63: Computer programming, consultancy and related activities; information service activities	306.0	334.8
		64: Financial service activities, except insurance and pension funding	428.0	423.7
		65: Insurance, reinsurance and pension funding, except compulsory social security	176.8	167.4
		66: Activities auxiliary to financial services and insurance activities	23.7	27.6
		68: Real estate activities and imputed rents of owner-occupied dwellings	1 767.6	1 757.8
		69-70: Legal and accounting activities; activities of head offices; management consultancy activities	244.6	278.1
		71: Architectural and engineering activities; technical testing and analysis	127.5	138.2
		72: Scientific research and development	205.3	221.0
		73: Advertising and market research	50.0	44.9
		74-75: Other professional, scientific and technical activities; veterinary activities	100.4	131.8
		77: Rental and leasing activities	118.5	155.8
		78: Employment activities	4.2	4.2
		79: Travel agency, tour operator reservation service and related activities	24.6	25.8
		80-82: Security and investigation activities; services to buildings and landscape activities; office administrative, office support and other business support activities	165.6	75.3
		84: Public administration and defence; compulsory social security	2 236.9	2 246.4
		85: Education	1 146.7	1 159.1
		86: Human health activities	855.0	858.8
		87-88: Social work activities	273.7	281.2
		90-92: Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities	286.7	268.7
		93: Sports activities and amusement and recreation activities	126.0	136.3
		94: Activities of membership organisations	145.2	141.2
		95: Repair of computers and personal and household goods	33.1	27.5
		96: Other personal service activities	252.9	240.8
		97-98: Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	3.6	3.7
Total			23 887.4	23 460.0

Growth effects										
Effect of the changes in value added ratios	Effects of the changes in domestic direct requirement coefficients	Effects of changes in final demand							Grand total	
		House-hold final consumption expenditures	Final consumption expenditures by NPISHs	Final consumption expenditures by government	Gross fixed capital formation	Changes in inventories	Export	Total	billion HUF	%
7.6	–4.3	–8.3	0.0	0.6	–1.5	–0.0	11.3	2.1	5.4	0.02
11.1	–5.7	–13.9	0.3	–6.9	–9.3	–1.5	–23.1	–54.3	–48.9	–0.20
14.8	–7.6	–8.5	0.0	–4.5	0.7	–0.2	–2.9	–15.3	–8.1	–0.03
3.7	–8.8	5.3	–0.0	–12.1	–0.2	0.1	13.6	6.6	1.6	0.01
0.9	0.0	0.4	0.0	–0.0	0.0	0.0	1.4	1.8	2.8	0.01
9.1	–9.8	–3.8	–0.0	0.2	–0.0	0.0	–11.3	–14.9	–15.6	–0.07
11.6	–1.5	–7.0	0.0	–2.4	–3.4	0.8	41.5	29.5	39.6	0.17
0.1	–0.1	–0.9	0.0	–0.1	0.0	0.0	–3.0	–4.0	–4.0	–0.02
3.0	–6.8	7.8	0.0	4.0	–0.7	–0.1	–7.7	3.3	–0.5	0.00
0.2	0.4	–3.5	–0.0	0.6	–1.3	–0.4	–2.5	–7.2	–6.6	–0.03
–9.6	1.7	7.1	–0.0	2.4	8.4	–0.0	–31.6	–13.7	–21.7	–0.09
6.6	–0.7	16.3	0.0	–7.6	–0.8	0.2	1.6	9.6	15.5	0.06
6.9	4.1	0.4	0.0	–1.3	–22.9	–0.0	41.6	17.8	28.9	0.12
2.6	1.8	10.2	0.0	0.1	–0.3	0.0	–18.8	–8.7	–4.3	–0.02
–0.5	–2.7	–6.8	0.0	0.0	–0.0	0.0	0.6	–6.2	–9.4	–0.04
0.3	0.0	4.1	0.0	–0.0	–0.1	0.0	–0.4	3.6	4.0	0.02
12.4	5.4	–7.8	0.0	–4.2	–9.1	0.1	–6.6	–27.6	–9.8	–0.04
2.4	–1.1	–1.3	0.0	0.4	–0.1	0.0	33.1	32.2	33.5	0.14
1.3	1.1	–0.4	–0.0	1.1	4.4	0.0	3.2	8.3	10.7	0.04
3.4	–0.3	0.6	0.0	–3.4	0.1	–0.1	15.4	12.6	15.7	0.07
–0.5	0.8	–0.4	0.0	–0.8	–0.7	–0.0	–3.6	–5.4	–5.1	–0.02
4.4	–0.3	–4.5	–0.0	–1.7	–0.5	0.2	33.9	27.4	31.5	0.13
3.7	3.1	–1.6	–0.0	0.3	–0.0	0.0	31.9	30.5	37.3	0.16
–0.0	0.0	–0.1	0.0	–0.0	–0.0	–0.0	0.2	0.1	0.1	0.00
1.8	–0.4	–0.2	0.0	0.0	–0.0	0.0	0.0	–0.2	1.2	0.01
0.9	0.1	1.0	0.0	10.4	–0.4	0.0	–102.5	–91.4	–90.3	–0.38
–5.4	–3.5	–2.1	0.0	14.3	–1.0	0.1	7.2	18.4	9.5	0.04
12.5	1.4	6.0	–5.3	–3.3	0.4	0.0	0.7	–1.5	12.4	0.05
6.9	–6.7	–7.4	–0.8	12.2	–0.2	0.0	–0.1	3.6	3.8	0.02
4.4	–1.4	2.0	4.5	–2.0	0.0	0.0	–0.0	4.5	7.5	0.03
4.7	0.9	–16.4	0.4	–5.6	–1.4	–0.0	–0.6	–23.6	–18.0	–0.08
0.1	–1.0	4.4	7.1	1.3	–0.0	–0.0	–1.5	11.3	10.3	0.04
0.6	0.0	0.2	–5.1	0.0	0.2	0.0	0.0	–4.6	–4.0	–0.02
1.6	0.3	–4.0	0.0	–0.0	–0.5	0.0	–3.0	–7.5	–5.6	–0.02
–0.9	0.4	–11.5	0.2	0.5	–0.4	0.0	–0.5	–11.7	–12.1	–0.05
0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.00
134.0	–179.3	–78.6	1.3	–20.8	–188.3	–96.7	1.0	–382.1	–427.3	–1.79

8. CONCLUSION: A COMPARISON OF THE PROS AND CONS

Like any method, the calculation of growth contributions by SDA has both its advantages and disadvantages. In conclusion we present a brief overview of these. The theoretical and methodological limitations are not repeated here; instead, difficulties evident from the choice of investigated periods are emphasised. The time-lag of several years in producing and publishing supply, use and IO tables, the assumptions, limitations, and inaccuracy of the models, and updating and approximation techniques impede an up to date and accurate operation of the analysis.[27] Undoubtedly, flash estimates of quarterly GDP by statistical offices also call for re-examinations and, sometimes, corrections; however, conventional methods of calculating growth contributions can be applied immediately, even by the most recent and simple structure data, providing very quick indicators for analysis and policy.

The structural decomposition of the factors of economic growth offers extra information to the standard production and expenditure approach contributions calculated independently from the changes of own value added of industries and the levels of final demand components. Conventional methods show only the surface from two separate sides. Both methods presented here, however, consider the multiplicative effects of final use from domestic output through the supply chains, and decompose them to part effects of changes in value added ratios, supplying structure and final demand, and further subcomponents. The effects are allocated between industries as well, thus the demand-side and the value added generation of the producers (in SDA#1) and supply chains (in SDA#2) are connected as two dimensions of growth, shown together in a crosstab format.

Different approaches yield different insights and significant variance in the results. Consequently, SDA, in spite of the time-lag of data and the imprecision of updating techniques, can be a useful complement to standard techniques. Structural decomposition and variance analysis of IO tables show a deeper structure of

27 The general reason of official statistics for constructing and publishing input-output tables only every five years is that the structures of the economies modify relatively slow. It might have been true for the past, but not for the future. Being on the verge of large-scale robotisation, virtualisation, internet of things (IoT), big data, and hopefully a green revolution, the world, including technological and economic structures, and thus the driving forces of growth will probably change faster than ever before. Statistical offices definitely perceive these phenomena and the simultaneous pressure from analysts and policymakers for the most current and high quality data on economic structures. Timely estimates of several statistical indicators, especially those of GDP, improved significantly in the last decades (Kokkinen-Wouters 2016). There must be some possibilities also in reducing the production time of input-output tables. A decrease of the time-lags will boost the applicability and the relevance of the growth decomposition analysis presented here.

the economy, thus offering a different approach to assessing the GDP generation and growth contributions of industries, supply chains, and final demand components for a better understanding of the driving forces of growth. As a complementary tool for growth analysis, it can support economic, development, and policy decisions of the private sector and the government.

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