Estimating Growth Contributions by Structural Decomposition of Input-Output Tables[1,2]

Short running title: Growth Contributions by IO 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 supplier relations and value chain multipliers into account can significantly alter the picture on growth effects of industries and final demand categories by the conventional approach based on quarterly GDP calculations. This can be instructive for analysts, 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's (HCSO) dissemination database and STADAT tables.

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Factoring real GDP changes is important information for macro analysts and policymakers, and its significance can be channelled through them and the media to reach the general public, as well. It is no coincidence that contribution to growth tables by the production and expenditure approach[4] are among the most frequently cited sources of statistical offices. They are the basis of all reports after the publication of the latest growth data.

Techniques for calculating growth contributions can be learned from the methodological background of the tables referred to above,[5] or in more detail, from statistical studies and other professional publications.[6] This paper, however, differs from those in several respects. The focus is not on the part effects behind the most current quarterly GDP volume index and the

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[2] This paper is a revised and expanded version of the presentation held on the Conference of European Statistics Stakeholders, Budapest, 20–21 October, and a study published in the Hungarian Statistical Review (*Koppány* (2016)).

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

[5] http://www.ksh.hu/docs/eng/modsz/modsz31.html

[6] *Anwar–Szőkéné* (2010) reviews the methods of calculating growth contributions used in Hungary, and the interpretations and applications of them.

related chain-linking problems. Instead, structural decomposition analysis (SDA) of input-output tables is used here for measuring growth contributions. The aim of this study is to present an application of the method less known and unused for this purpose in Hungary.

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,[7] 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 this paper, 2012 was the most current 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 current information. With the methods presented here, one can detect not only the direct effects of the changes of branches' own value added levels and the final products flowing to different sectors, but considering the domestic purchaser-supplier relations 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. Sections 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 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 section 5 and 6 we factor 2012's growth in two dimensions. First, according to the terms of value added SDA equation, we separate the effects of the changes in value added ratios, domestic supplier coefficients, and final demand, and then delve 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, 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 of all supplying domestic links involved, gives industries' contribution to economic growth. Results shows that GDP production and growth effects of supply chains calculated with this method can differ significantly from 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 this paper, the latest industry by industry input-output table published by the HCSO is valid for the year 2010.[8] This is produced from the supply and use tables[9] by the

[7] According to the European guidelines and practice, input-output tables are published by NCSO every five years, with a three-year time lag.
[8] 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)
[9] I.b. PP1101, PP1102 and PP1104.

"fixed product sales structure" transformation (*Eurostat* (2008), p. 351., Model D), [10] calculated with 88 industries and published in a 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 input-output 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 unification of them, 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)[11] using the previous year price margins available in tables with technical codes PP1101, PP1102, GPKF04, GPKA03, and GPKB04 in dissemination database, and STADAT 3.1.18 table (see Figure 1).[12,13]

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 current price and 2012 previous year price input-output tables for the demonstration of the application of SDA, by which we can analyse economic growth and growth contributions of the year 2012.

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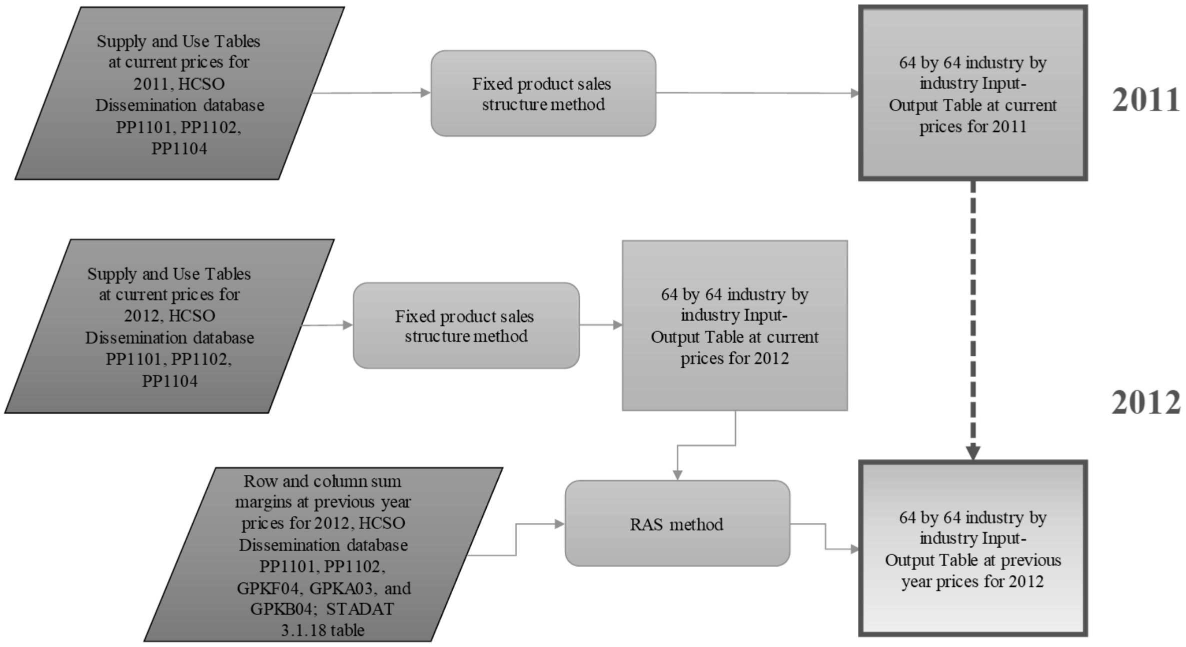
[10] System of supply and use tables offer a flexible framework for generating product by product, or industry by industry tables. The choice of the table type should be made according to the purpose of the analysis. Product by product tables for technological studies are more homogenous in the cost structure, 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, for compatibility, this study requires the latter. *Eurostat* (2008) gives two methods for both types. Although methods „*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 eliminates unfeasible negative values in the matrix of direct requirements. Like most statistical offices, HCSO has 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, 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 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. Mainly those countries that produce only this type of tables choose more complex techniques.

[11] Besides the classical RAS, linear and quadratic programming techniques are also in use 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)), as well. 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.

[12] 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.

[13] 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 such an open economy like Hungary, import matrices were discarded also because of the lack of data for previous year price margins.

Figure 1. Generating input-output tables



Due to the size of the tables, Table group 1 shows the simplified, four industry, three final demand component and only one value added row version of these, which will be of assistance to us in the demonstration and comprehension of the decomposition methods, and 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 on 64 industry levels.

To give a brief overview, rows of the input-output 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 564 billion to other agricultural firms, 719 billion to manufacturing companies, 4 to construction, and 101 billion to services in the base year of 2011. Households purchased a total of 317, and other domestic sectors 242 billion HUF (Hungarian Forint) for final demand purposes from agricultural producers. 652 billion went overseas as exports.

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

Arranging industries' values added and taxes less subsidies on products (crosshatched 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 growth contributions of industries in a percentage form, which are exactly the same as the statistics in STADAT 3.1.19 table 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. Last cells of the fifth rows is 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 group 2, we can calculate growth contributions of demand components as well. Results differ slightly from STADAT 3.1.20 only because of the variance of national account and input-output table valuation standards.[14] The method is the same.

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

A second modification is that direct import content of 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.[15] Changes in the final demand for domestic products can, of course, alter the intermediate use from imports, which has an adverse effect on GVA. Thus, growth contributions of domestic product demand components indicated in Table 2 can be imprecise. Assessment of their value added effect depends on the industry mix of final demand change, domestic and foreign supply chains of the concerned industries, and companies' value added ratios. Multiplicative processes taking place can be kept track of by the input-output model, and factoring the changes can be made by a structural decomposition analysis. These techniques will be covered in the following sections.

When comparing SDA and the conventional method, 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 input-output 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 highlighted cells of Table 1. A more profound investigation based on these can penetrate deeper into the growth relationships and discover details that cannot be revealed from above. For this, however, we need to recall some basic equations of the input-output model and the derivation of value added multipliers.

[14] 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.

[15] For the sake of switching from GDP to GVA we correct with product taxes of intermediate consumption also in this row. For calculating methods of GDP effects of final demand categories in detail see *Hoekstra-Helm* (2010).

Table group 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; manufactu-ring 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					

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; manufactu-ring 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 group 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%**

Table group 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%**

3 Basic input-output modelling[16]

For mathematical analysis, the most important parts of the input-output tables are the forementioned 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 **F** for the matrices of 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. Results will be obtained as column vectors, so the value added vectors in the input-output tables are the transpose of them (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 $\mathbf{x}'$, i. e. the column sums of the input-output 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 the inverse of it). 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 $\mathbf{c}' = \mathbf{v}'\langle\mathbf{x}\rangle^{-1}$.

The model is closed with the formula $\mathbf{Ax} + \mathbf{f} = \mathbf{x}$, of which **Ax** gives the value of intermediate consumptions, and **f** the final uses, so 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 $\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f}$ can be expressed,[17] which is the fundamental equation of the demand-driven (pull) input-output 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**.

Leontief inverse involves not only the direct effects of final demand changes, but indirect value chain consequences, too, which can generate further output variations 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 ($\mathbf{c}'\mathbf{L}$).[18]

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

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

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 structural decomposition of value added changes and growth.

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[16] 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) (Chapter 2 and 6), and *Zalai* (2012).

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

[18] 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.

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 factoring technique used in this paper. SDA is a comparative static method of analysing the structural changes of economies by input-output model. The aim of the investigation is factorising temporal changes or regional differences of an economic phenomenon that can be examined by the input-output method for a better understanding of the driving forces behind them. The analysis is based on the well-known ceteris paribus principle of comparative statics: factoring the variance goes by changing the determinants one by one in the equation, while the others are fixed at some reference values. SDA is in near relation with standardisation and index number analysis, and can be considered as their extension to input-output 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, the direction of it 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).[19] So these suggest the need to be cautious when evaluating components, as much random and indirect effect 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 narrow defined economic categories, but also for energy and environmental variables, as an input-output model itself does.[20] *Rose–Casler* (1996) and *Miller–Blair* (2009) give more details on the method and overview its applications.

For the aim of this paper, former value added investigations are relevant. Among them we have some studies on nominal (for example *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

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[19] *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.

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

year-by-year economic growth are discovered here. Regarding the depth of the decomposition we're not trying to exceed studies with 3-4 levels, and occasionally 10 or more "final" determinants. With the data available, this is not viable. The aim of this study is to present such application of the method less known and unused for estimating growth contributions in Hungary.

To show the main points of the technique, consider the fundamental equation of the input-output 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:

$$\Delta\mathbf{x} = (\Delta\mathbf{L})\mathbf{f}_1 + \mathbf{L}_0(\Delta\mathbf{f})\,, \tag{3}$$

$$\Delta\mathbf{x} = (\Delta\mathbf{L})\mathbf{f}_0 + \mathbf{L}_1(\Delta\mathbf{f})\,, \tag{4}$$

$$\Delta\mathbf{x} = (\Delta\mathbf{L})\mathbf{f}_1 + \mathbf{L}_1(\Delta\mathbf{f}) - (\Delta\mathbf{L})(\Delta\mathbf{f})\text{, and} \tag{5}$$

$$\Delta\mathbf{x} = (\Delta\mathbf{L})\mathbf{f}_0 + \mathbf{L}_0(\Delta\mathbf{f}) + (\Delta\mathbf{L})(\Delta\mathbf{f})\,, \tag{6}$$

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 part 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:[21]

$$\Delta\mathbf{x} = (1/2)(\Delta\mathbf{L})(\mathbf{f}_0 + \mathbf{f}_1) + (1/2)(\mathbf{L}_0 + \mathbf{L}_1)\Delta\mathbf{f}\,.^{22} \tag{7}$$

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 permutations 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, so by weighting them according to their frequency, the same result is obtained. Dietzenbacher and Los, however, analysed empirically the sensitivity of the

[21] *Révész* (2013) denotes that in certain cases (for example in exponential processes) this kind of equidistribution is questionable, claiming that one or an other factor changed first, so 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, admits that halving the interaction is a reasonable simplification in most cases, which does not significantly distort the results.

[22] Because of the vector-type solutions, SDAs usually operate with additive formulae similar to (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 US GDP between 1982 and 1997.

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.[23] 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 recipes exist; 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 is, as *Dietzenbacher–Los* (2000) point out, that SDA typically presumes the independence of factors;[24] however, this does not (necessarily) 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 and Los; they give possible solutions to several cases of dependence. The problem is answered here by the method used in *Pei et al* (2012),[25] with the following formula:

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

where $\tilde{\mathbf{A}} = \mathbf{A}\left(\mathbf{I} - \langle\mathbf{c}\rangle\right)^{-1}$. 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 invariant, then having the changed value added ratios, we can detect the growth consequences of supply chain changes.

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[23] It must be noted that two possible hierarchical decompositions of (1)

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

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

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 $\langle\underline{\mathbf{c}}\rangle\underline{\mathbf{L}} \neq \underline{\langle\mathbf{c}\rangle\mathbf{L}}$ generally hold. This suggests reconsideration of Dietzenbacher and Los's finding that polar decompositions indeed can only be an approximation of the mean of all possible forms.

[24] As the anonymous referee of this paper notes, this statement is questionable. In general, rather SDA may be regarded to answer the "What would be if – holding other factors constant – one factor changed only?" question. True, 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, formula (10) is not a real answer for the problem of separating the "effects" of changes in the intermediate input coefficients and the value added share. In fact formula (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 moreless cancel each out.

[25] 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.

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 $\mathbf{L}(\tilde{\mathbf{A}}^t,\mathbf{c}^t) = \left(\mathbf{I} - \tilde{\mathbf{A}}^t\left(\mathbf{I} - \langle\mathbf{c}^t\rangle\right)\right)^{-1}$. (If $\tilde{\mathbf{A}}$ and $\mathbf{c}$ 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 $\mathbf{c}$ has modified by $\Delta\mathbf{c}$), (ii) direct domestic requirement coefficients have altered ($\Delta\tilde{\mathbf{A}}$), and, for this reason, Leontief inverse has varied, and finally (iii) final demand has changed ($\Delta\mathbf{f}$). If we take the average of polar decomposition, we obtain

$$\begin{aligned}\Delta\mathbf{v} = &\underbrace{(1/2)\left\{\left[\langle\mathbf{c}^1\rangle\mathbf{L}(\tilde{\mathbf{A}}^0,\mathbf{c}^1) - \langle\mathbf{c}^0\rangle\mathbf{L}(\tilde{\mathbf{A}}^0,\mathbf{c}^0)\right]\mathbf{f}^0 + \left[\langle\mathbf{c}^1\rangle\mathbf{L}(\tilde{\mathbf{A}}^1,\mathbf{c}^1) - \langle\mathbf{c}^0\rangle\mathbf{L}(\tilde{\mathbf{A}}^1,\mathbf{c}^0)\right]\mathbf{f}^1\right\}}_{\text{effect of the change in value added ratios}} + \\ &+\underbrace{(1/2)\left\{\langle\mathbf{c}^1\rangle\left[\mathbf{L}(\tilde{\mathbf{A}}^1,\mathbf{c}^1) - \mathbf{L}(\tilde{\mathbf{A}}^0,\mathbf{c}^1)\right]\mathbf{f}^0 + \langle\mathbf{c}^0\rangle\left[\mathbf{L}(\tilde{\mathbf{A}}^1,\mathbf{c}^0) - \mathbf{L}(\tilde{\mathbf{A}}^0,\mathbf{c}^0)\right]\mathbf{f}^1\right\}}_{\text{effect of the change in domestic direct requirement coefficients}} + \\ &+\underbrace{(1/2)\left[\langle\mathbf{c}^1\rangle\mathbf{L}^1 + \langle\mathbf{c}^0\rangle\mathbf{L}^0\right](\Delta\mathbf{f})}_{\text{effect of the change in final demand}}.\end{aligned} \tag{13}$$

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:

$$\begin{aligned}(1/4)\sum_{j=1}^{n}\Big\{&\langle\mathbf{c}^1\rangle\left[\mathbf{L}(\tilde{\mathbf{A}}^1,\mathbf{c}^1)(\Delta\mathbf{A}_{(j)})\mathbf{L}(\tilde{\mathbf{A}}^0,\mathbf{c}^1) + \mathbf{L}(\tilde{\mathbf{A}}^0,\mathbf{c}^1)(\Delta\mathbf{A}_{(j)})\mathbf{L}(\tilde{\mathbf{A}}^1,\mathbf{c}^1)\right]\mathbf{f}^0 + \\ &+\langle\mathbf{c}^0\rangle\left[\mathbf{L}(\tilde{\mathbf{A}}^1,\mathbf{c}^0)(\Delta\mathbf{A}_{(j)})\mathbf{L}(\tilde{\mathbf{A}}^0,\mathbf{c}^0) + \mathbf{L}(\tilde{\mathbf{A}}^0,\mathbf{c}^0)(\Delta\mathbf{A}_{(j)})\mathbf{L}(\tilde{\mathbf{A}}^1,\mathbf{c}^0)\right]\mathbf{f}^1\Big\}.\end{aligned} \tag{16}$$

Further factoring of the change in final demand to its components can be accomplished most simply by replacing $\mathbf{f}$ by $\mathbf{F}$ in the third term of (13):

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

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

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

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

where $\mathbf{y}^t$ is the vector of the total final demand in 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 $\mathbf{F}(\mathbf{y}^t,\mathbf{B}^t) = \mathbf{B}^t \left\langle \mathbf{y}^t \right\rangle$.

The design of the SDA can be reviewed in Figure 2. Results gained by using equations (12)–(19) in Table 4 will be reviewed later with the help of Figure 3.[26] At this point we notice only that 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.

[26] Decomposition presented here, of course, is not the one and only 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 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 and Los, have been explained in footnote 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

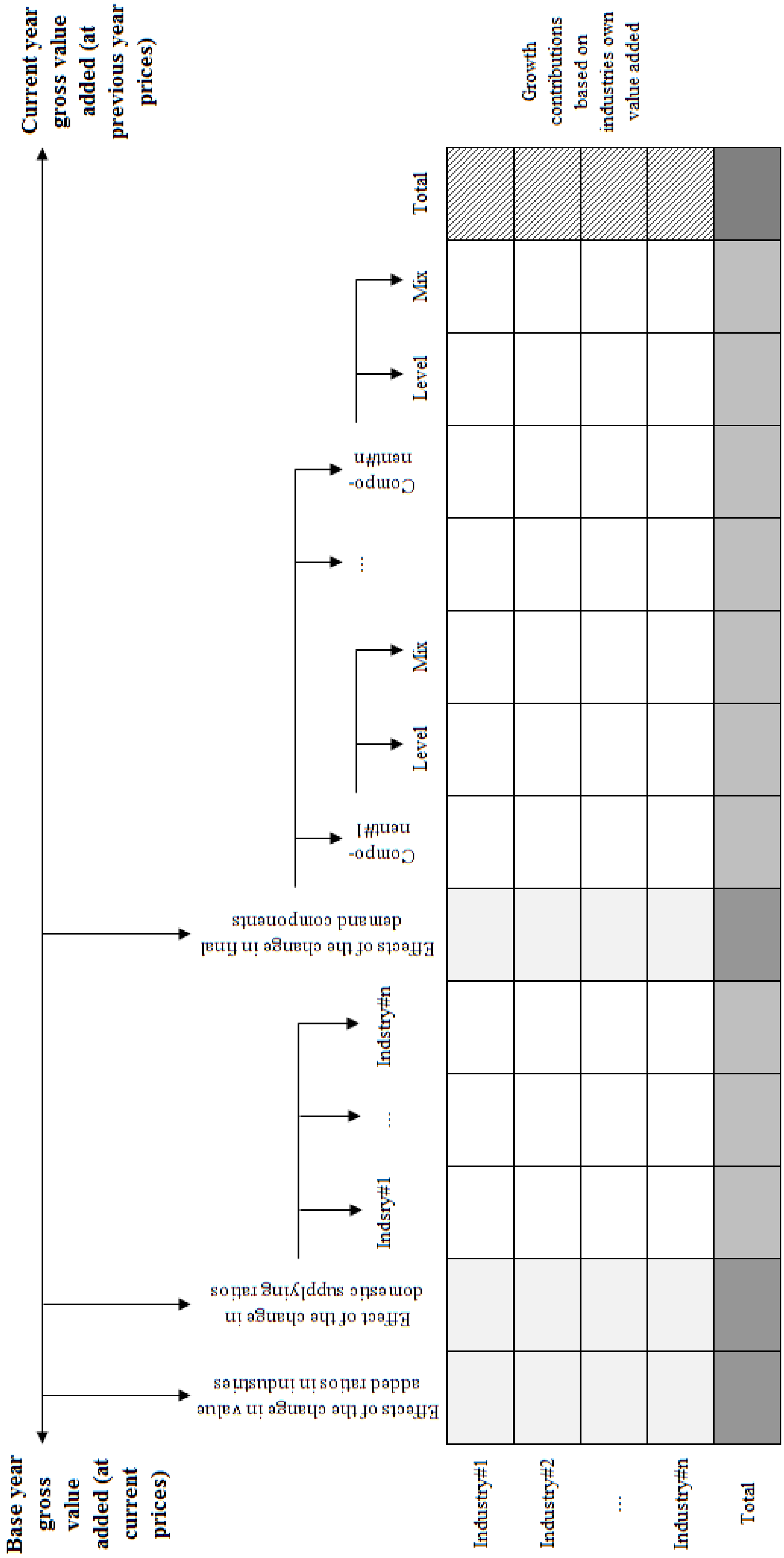


Table 4. Result of SDA#1

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: A Agri-ture	B-E Manu-facturing	F Cons-truction	G-U Services	Total	Effects of the changes in final demand: Household final consumption: Level	Mix	Total	Other domestic final demand: Level	Mix	Total	Export: Level	Mix	Total	Total	Grand total: billion HUF	%
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%
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%
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%
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%
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%
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%
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%
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%
R-T Arts, entertainment and recreation, 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%	

* *Calculations were performed with a 64 by 64 input-output table (not indicated henceforth).*

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

$$\bar{\mathbf{v}} = \left\langle (\mathbf{c})' \mathbf{L} \right\rangle \mathbf{f} \,, \tag{20}$$

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. 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 **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, on one hand, that 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.[27] On the other hand, in spite of their relevance, no multiplier tables are available in Hungary in a public form, neither for the last published input-output table for 2010, nor for the archive 2008.[28]

Data in the short form Table 5 serve for an easy comparison to Table 3. Detailed results of the use of equation (20) according to the system (12)–(19) 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 ($\bar{\mathbf{v}}^0$)	Current year, 2012 (at previous year prices) ($\bar{\mathbf{v}}^1$)	in value (billion HUF) ($\Delta\bar{\mathbf{v}}$)	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%

[27] 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.

[28] Detailed analysis of input-output tables and publishing of multipliers are a relatively rare occurrence 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 with grey 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 (v^0)	Current year, 2012 (at previous year prices) (v^1)	Change	Base year, 2011 (v^{-0})	Current year (at previous year prices) (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
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

Table 6 (continued)

Value added of industries and supply chains, value added multipliers and final outputs (rank numbers with grey 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 ($\mathbf{v}^{-0}$)	Current year (at previous year prices) ($\mathbf{v}^{-1}$)	Change	Base year, 2011	Current year, 2012	Change	Base year, 2011	Current year, 2012	Change
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
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
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

Table 6 (continued)

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

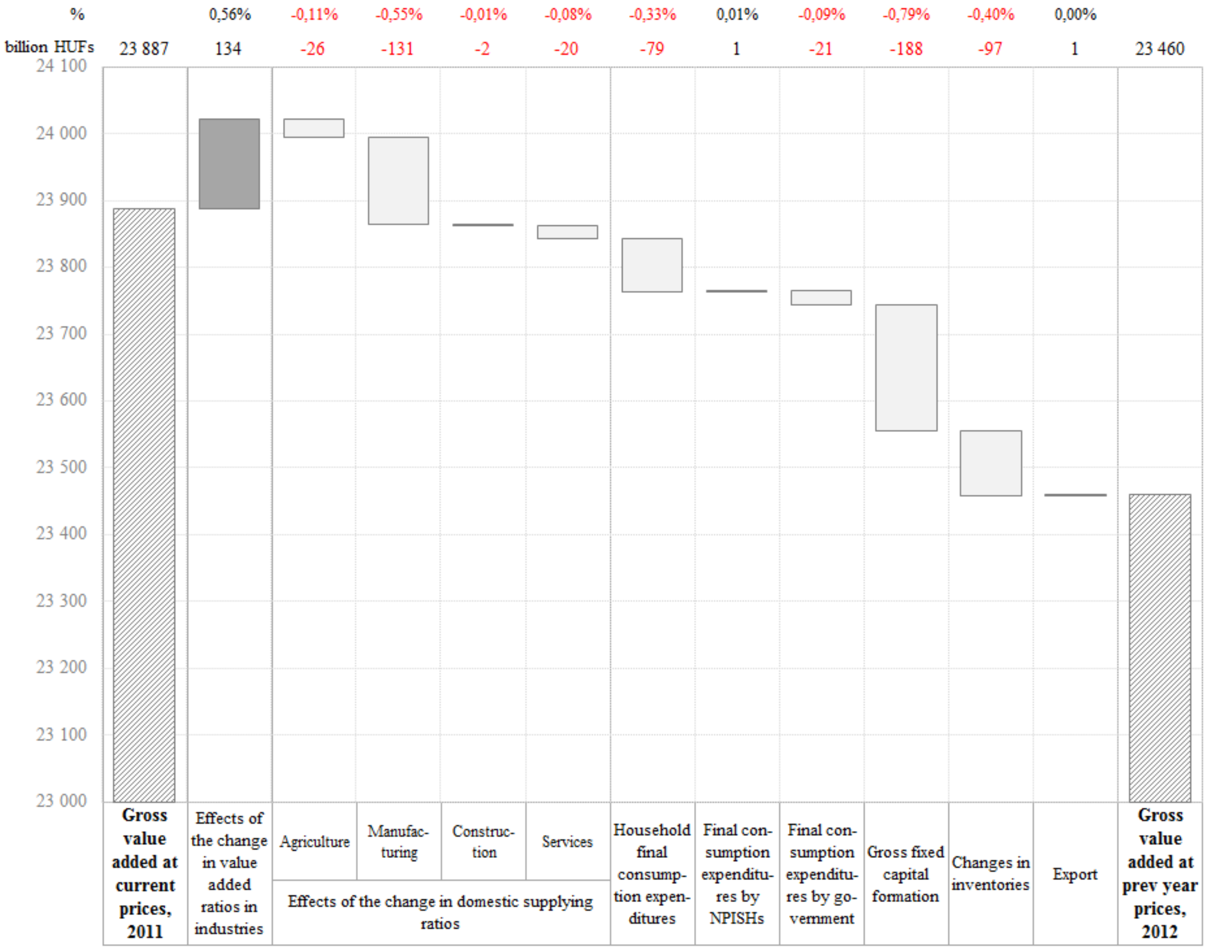
Final demand industries	Industry's own value added (in billion HUF)			Value added of the final demand industry supply chain (in billion HUF)			Value added multiplier			Output for final use (in billion HUF)		
	Base year, 2011 ($\mathbf{v}^0$)	Current year, 2012 (at previous year prices) ($\mathbf{v}^1$)	Change	Base year, 2011 ($\mathbf{v}^{-0}$)	Current year (at previous year prices) ($\mathbf{v}^{-1}$)	Change	Base year, 2011	Current year, 2012	Change	Base year, 2011	Current year, 2012	Change
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
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 of the results

Figures 3 and 4 help 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 2012 growth. Shifts in domestic direct requirements, particularly those of manufacturing, and the fall in final demand decreased 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 an average of two years, we can say changes in export hardly affected the growth on the whole. Cutdown of domestic final use of domestic products, mainly the decrease in investments, was the greatest retractive force. The growth effect order of the components of domestic final demand in SDA, however, is the same as in Table 3.

Figure 3. Column sum SDA results



An in-depth discussion of the various industry part effects behind the column sums,[29] 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 the one hand, on its final output, and on the other hand, on its value added multiplier. Agriculture, for example, sells more for intermediate, than final use, so, despite its relatively high multiplier, it has a lower value added from final demand supply chains than its own realized measure (a part of the latter, in supply chain approach, will be accounted to other industries, for which agriculture is a supplier). Supply chain values added of manufacturing and construction, however, far exceed their own one. These are due to the prodigious production and export volumes of the key growth manufacturing sub-branches, and the high multiplier value of construction. Hence, decline of the final demand for construction, in Table 5, decreased economic growth more than the fall in its own value added in Table 3.

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 indusries 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 activites 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 a 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 an ascent from second to 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 occurred in the sector, and the approximately 1 000 billion HUF decline in the sales of the top four companies, final output of the industry fell by almost one quarter (Table 6), so that 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 to the Hungarian economy, multiplicative effects of these contractions can be detected as the difference between -0,47% and -0,72% growth contribution rates (Figure 4).

[29] This can be analysed at length using Table 4. Notice 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 further decompositions of them) in the columns.

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

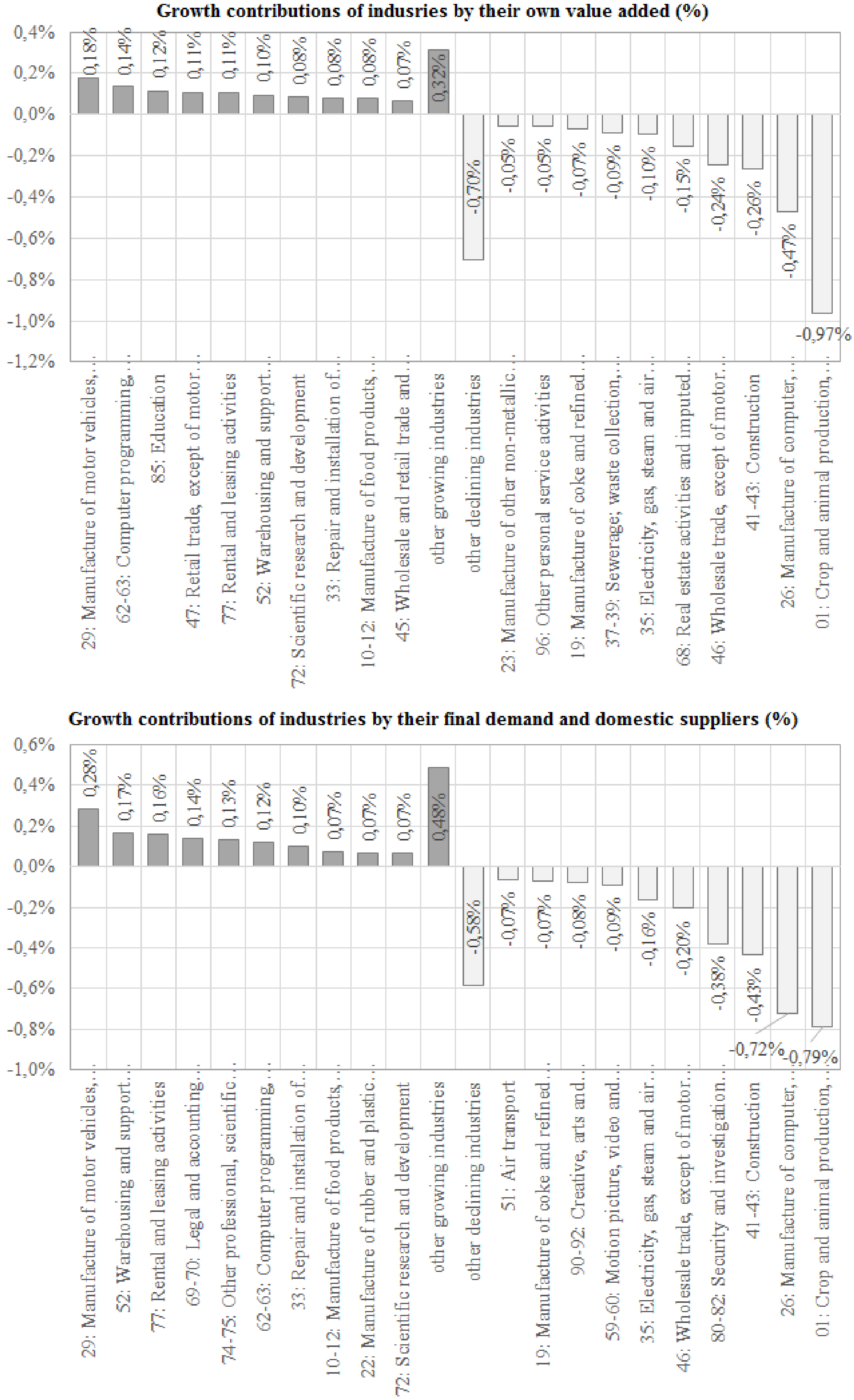


Table 7. Results of SDA#2

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

Final demand industries	Value added of the supply chain: Base year, 2011 (v^{-0})	Value added of the supply chain: Current year, 2012 (at previous year prices) (v^{-1})	Growth effects: Effect of the changes in value added ratios	Growth effects: Effects of the changes in domestic direct requirement coefficients	Effects of changes in final demand: Household final consumption expenditures	Effects of changes in final demand: Final consumption expenditures by NPISHs	Effects of changes in final demand: Final consumption expenditures by government	Effects of changes in final demand: Gross fixed capital formation	Effects of changes in final demand: Changes in inventories	Effects of changes in final demand: Export	Effects of changes in final demand: Total	Grand total: billion HUF	Grand total: %
A Agriculture, forestry and fishing	876,8	690,2	-36,0	-18,2	-14,9	-0,0	0,0	-10,5	-100,3	-6,8	-132,5	-186,6	-0,78%
of which 01: Crop and animal production, hunting and related service activities	825,4	637,4	-35,9	-18,0	-15,7	0,0	0,1	-10,0	-100,8	-7,7	-134,1	-188,0	-0,79%
02: Forestry and logging	45,9	48,0	0,0	-0,2	1,4	-0,0	-0,1	-0,7	0,7	0,9	2,2	2,1	0,01%
03: Fishing and aquaculture	5,5	4,8	-0,1	-0,0	-0,6	0,0	0,0	0,1	-0,2	0,0	-0,6	-0,7	0,00%
B-E Mining and quarrying; manufacturing etc.	7 335,9	7 191,7	39,3	-115,3	-17,5	-0,1	-12,6	-12,6	-11,7	-13,8	-68,2	-144,2	-0,60%
of which 05-09: Mining and quarrying	25,7	27,3	-0,7	0,5	-3,7	0,0	-0,6	-1,9	3,2	4,6	1,6	1,5	0,01%
10-12: Manufacture of food, beverages and tobacco products	1 144,9	1 162,4	-13,1	-30,0	5,7	-0,1	0,3	0,0	-15,1	69,7	60,6	17,6	0,07%
13-15: Manufacture of textiles, wearing apparel and leather products	148,3	139,4	0,7	1,9	7,5	0,0	-0,0	-0,2	-3,3	-15,4	-11,4	-8,9	-0,04%
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	0,1	-0,2	-0,4	0,0	-0,0	-0,9	0,3	-1,3	-2,3	-2,3	-0,01%
17: Manufacture of paper and paper products	97,5	83,5	6,6	-1,0	2,0	-0,0	-0,0	-0,1	-2,0	-19,5	-19,6	-14,0	-0,06%
18: Printing and reproduction of recorded media	18,4	18,5	-0,3	-0,1	-0,1	0,0	0,0	-0,0	-0,0	0,5	0,5	0,1	0,00%
19: Manufacture of coke and refined petroleum products	260,6	243,3	5,3	-13,3	0,5	0,0	-0,9	-1,8	-1,0	-6,2	-9,3	-17,3	-0,07%
20: Manufacture of chemicals and chemical products	268,5	275,4	-2,8	1,3	1,7	0,0	-0,1	-0,5	1,0	6,2	8,4	6,9	0,03%
21: Manufacture of basic pharmaceutical products and pharmaceutical preparations	431,2	430,8	-4,3	1,8	-5,6	-0,1	-5,5	-1,3	-1,6	16,2	2,1	-0,4	0,00%
22: Manufacture of rubber and plastic products	339,8	355,8	7,3	-5,8	0,8	0,0	-0,1	-0,3	-0,4	14,4	14,4	16,0	0,07%
23: Manufacture of other non-metallic mineral products	165,1	155,4	0,6	-4,4	-0,7	0,0	-0,1	-3,2	-3,0	1,0	-6,0	-9,8	-0,04%
24: Manufacture of basic metals	178,7	165,7	1,8	-9,7	0,1	0,0	-0,0	-0,4	-3,0	-1,7	-5,1	-13,0	-0,05%
25: Manufacture of fabricated metal products, except machinery and equipment	328,6	328,6	15,5	-2,3	0,2	0,0	-0,0	-2,0	-11,5	0,1	-13,2	-0,0	0,00%
26: Manufacture of computer, electronic and optical products	750,6	578,0	18,9	-11,6	-0,9	0,0	-0,3	-0,9	0,3	-178,0	-179,9	-172,7	-0,72%
27: Manufacture of electrical equipment	276,9	273,3	-1,6	2,9	0,2	0,0	-0,1	-1,2	-0,1	-3,7	-4,9	-3,6	-0,02%
28: Manufacture of machinery and equipment n.e.c.	780,8	796,0	-9,7	-4,9	3,6	0,0	0,3	3,5	5,7	16,7	29,8	15,2	0,06%
29: Manufacture of motor vehicles, trailers and semi-trailers	1 032,0	1 099,8	4,6	-17,1	4,2	0,0	0,2	-3,3	15,7	63,6	80,4	67,8	0,28%
30: Manufacture of other transport equipment	53,0	48,1	1,3	1,9	-1,1	0,0	-0,6	0,2	3,1	-9,5	-8,0	-4,9	-0,02%
31-32: Manufacture of furniture; other manufacturing	195,8	200,9	4,3	0,1	-1,6	0,0	-0,4	-2,0	-0,8	5,4	0,6	5,0	0,02%
33: Repair and installation of machinery and equipment	68,5	92,2	3,5	-0,4	-0,0	0,0	0,1	6,9	0,2	13,5	20,6	23,7	0,10%
35: Electricity, gas, steam and air conditioning supply	426,2	387,6	3,2	-23,1	-28,4	0,0	-2,2	-1,6	0,2	13,3	-18,7	-38,6	-0,16%
36: Water collection, treatment and supply	106,8	106,7	0,2	-0,6	-1,0	0,0	0,3	-0,5	0,1	1,5	0,4	-0,0	0,00%
37-39: Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services	171,1	158,6	-2,1	-1,1	-0,7	0,0	-2,7	-1,0	0,1	-5,0	-9,4	-12,5	-0,05%
F Construction	1 341,5	1 237,7	8,0	-4,9	-1,8	0,0	-0,5	-124,6	16,2	4,0	-106,8	-103,8	-0,43%
G-U Services	14 333,1	14 340,4	122,7	-40,9	-44,5	1,4	-7,7	-40,6	-0,9	17,7	-74,5	7,3	0,03%
of which 45: Trade and repair of motor vehicles and motorcycles	243,1	248,5	7,6	-4,3	-8,3	0,0	0,6	-1,5	-0,0	11,3	2,1	5,4	0,02%
46: Wholesale trade, except of motor vehicles and motorcycles	1 213,9	1 165,0	11,1	-5,7	-13,9	0,3	-6,9	-9,3	-1,5	-23,1	-54,3	-48,9	-0,20%
47: Retail trade, except of motor vehicles and motorcycles	1 229,0	1 220,9	14,8	-7,6	-8,5	0,0	-4,5	0,7	-0,2	-2,9	-15,3	-8,1	-0,03%
49: Land transport and transport via pipelines	707,7	709,2	3,7	-8,8	5,3	-0,0	-12,1	-0,2	0,1	13,6	6,6	1,6	0,01%
50: Water transport	5,4	8,2	0,9	0,0	0,4	0,0	-0,0	0,0	0,0	1,4	1,8	2,8	0,01%
51: Air transport	61,3	45,8	9,1	-9,8	-3,8	-0,0	0,2	-0,0	0,0	-11,3	-14,9	-15,6	-0,07%

Value added level and change generated by industries final use output and supply chain

Table 7 (continued)

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

Final demand industries	Value added of the supply chain		Growth effects									Grand total	
					Effects of changes in final demand								
	Base year, 2011 (v^{-0})	Current year, 2012 (at previous year prices) (v^{-1})	Effect of the changes in value added ratios	Effects of the changes in domestic direct requirement coefficients	Household final consumption expenditures	Final consumption expenditures by NPISHs	Final consumption expenditures by government	Gross fixed capital formation	Changes in inventories	Export	Total	billion HUF	%
Value added level and change generated by industries final use output and supply chain													
52: Warehousing and support activities for transportation	286,6	326,2	11,6	-1,5	-7,0	0,0	-2,4	-3,4	0,8	41,5	29,5	39,6	0,17%
53: Postal and courier activities	54,9	50,9	0,1	-0,1	-0,9	0,0	-0,1	0,0	0,0	-3,0	-4,0	-4,0	-0,02%
55-56: Accommodation and food service activities	685,1	684,6	3,0	-6,8	7,8	0,0	4,0	-0,7	-0,1	-7,7	3,3	-0,5	0,00%
58: Publishing activities	114,3	107,7	0,2	0,4	-3,5	-0,0	0,6	-1,3	-0,4	-2,5	-7,2	-6,6	-0,03%
59-60: Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities	210,0	188,3	-9,6	1,7	7,1	-0,0	2,4	8,4	-0,0	-31,6	-13,7	-21,7	-0,09%
61: Telecommunications	419,5	435,0	6,6	-0,7	16,3	0,0	-7,6	-0,8	0,2	1,6	9,6	15,5	0,06%
62-63: Computer programming, consultancy and related activities; information service activities	306,0	334,8	6,9	4,1	0,4	0,0	-1,3	-22,9	-0,0	41,6	17,8	28,9	0,12%
64: Financial service activities, except insurance and pension funding	428,0	423,7	2,6	1,8	10,2	0,0	0,1	-0,3	0,0	-18,8	-8,7	-4,3	-0,02%
65: Insurance, reinsurance and pension funding, except compulsory social security	176,8	167,4	-0,5	-2,7	-6,8	0,0	0,0	-0,0	0,0	0,6	-6,2	-9,4	-0,04%
66: Activities auxiliary to financial services and insurance activities	23,7	27,6	0,3	0,0	4,1	0,0	-0,0	-0,1	0,0	-0,4	3,6	4,0	0,02%
68: Real estate activities and imputed rents of owner-occupied dwellings	1 767,6	1 757,8	12,4	5,4	-7,8	0,0	-4,2	-9,1	0,1	-6,6	-27,6	-9,8	-0,04%
69-70: Legal and accounting activities; activities of head offices; management consultancy activities	244,6	278,1	2,4	-1,1	-1,3	0,0	0,4	-0,1	0,0	33,1	32,2	33,5	0,14%
71: Architectural and engineering activities; technical testing and analysis	127,5	138,2	1,3	1,1	-0,4	-0,0	1,1	4,4	0,0	3,2	8,3	10,7	0,04%
72: Scientific research and development	205,3	221,0	3,4	-0,3	0,6	0,0	-3,4	0,1	-0,1	15,4	12,6	15,7	0,07%
73: Advertising and market research	50,0	44,9	-0,5	0,8	-0,4	0,0	-0,8	-0,7	-0,0	-3,6	-5,4	-5,1	-0,02%
74-75: Other professional, scientific and technical activities; veterinary activities	100,4	131,8	4,4	-0,3	-4,5	-0,0	-1,7	-0,5	0,2	33,9	27,4	31,5	0,13%
77: Rental and leasing activities	118,5	155,8	3,7	3,1	-1,6	-0,0	0,3	-0,0	0,0	31,9	30,5	37,3	0,16%
78: Employment activities	4,2	4,2	-0,0	0,0	-0,1	0,0	-0,0	-0,0	-0,0	0,2	0,1	0,1	0,00%
79: Travel agency, tour operator reservation service and related activities	24,6	25,8	1,8	-0,4	-0,2	0,0	0,0	-0,0	0,0	0,0	-0,2	1,2	0,01%
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	0,9	0,1	1,0	0,0	10,4	-0,4	0,0	-102,5	-91,4	-90,3	-0,38%
84: Public administration and defence; compulsory social security	2 236,9	2 246,4	-5,4	-3,5	-2,1	0,0	14,3	-1,0	0,1	7,2	18,4	9,5	0,04%
85: Education	1 146,7	1 159,1	12,5	1,4	6,0	-5,3	-3,3	0,4	0,0	0,7	-1,5	12,4	0,05%
86: Human health activities	855,0	858,8	6,9	-6,7	-7,4	-0,8	12,2	-0,2	0,0	-0,1	3,6	3,8	0,02%
87-88: Social work activities	273,7	281,2	4,4	-1,4	2,0	4,5	-2,0	0,0	0,0	-0,0	4,5	7,5	0,03%
90-92: Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities	286,7	268,7	4,7	0,9	-16,4	0,4	-5,6	-1,4	-0,0	-0,6	-23,6	-18,0	-0,08%
93: Sports activities and amusement and recreation activities	126,0	136,3	0,1	-1,0	4,4	7,1	1,3	-0,0	-0,0	-1,5	11,3	10,3	0,04%
94: Activities of membership organisations	145,2	141,2	0,6	0,0	0,2	-5,1	0,0	0,2	0,0	0,0	-4,6	-4,0	-0,02%
95: Repair of computers and personal and household goods	33,1	27,5	1,6	0,3	-4,0	0,0	-0,0	-0,5	0,0	-3,0	-7,5	-5,6	-0,02%
96: Other personal service activities	252,9	240,8	-0,9	0,4	-11,5	0,2	0,5	-0,4	0,0	-0,5	-11,7	-12,1	-0,05%
97-98: Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	3,6	3,7	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,1	0,1	0,00%
Total	23 887,4	23 460,0	134,0	-179,3	-78,6	1,3	-20,8	-188,3	-96,7	1,0	-382,1	-427,3	-1,79%

The half of the fall in the total value added showed up in the agriculture. Looking 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 input-output table, which also absorbs the statistical errors and omissions, and the problem of short-term or long-term indicators, in particular 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 the 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.

8 Summary and comparison, pros and cons

The calculation of growth contributions by SDA, like any method, has both advantages and disadvantages. As a conclusion we present a brief overview of these. Theoretical and methodological limitations are not repeated here, instead, difficulties evident from the choice of investigated periods are emphasized. The time-lag of several years in producing and publishing supply, use and input-output tables, the assumptions, limitations, and imprecisions of the models, updating and approximation techniques impede an up to date and accurate operation of the analysis.[30] Undoubtedly, flash estimates of quarterly GDP by statistical offices also need re-examinations and sometimes corrections; however, conventional methods of calculating growth contributions can be applied immediately, even by the most current and simple structure data, providing very quick indicators for analysis and policy.

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 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, so 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 input-output tables show a deeper structure of the economy, thus offering a different approach to assessing GDP generation and growth contributions of industries, supply chains and

[30] 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 round the corner of the large scale robotization, virtualization, IoT, big data and hopefully 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 pressure from analysts and policymakers for the most current and high quality data on economic structures, at the same time. Timely estimates of several statistical indicators, especially those of GDP, improved significantly in the last decades (see *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.

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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