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Decomposition of GDP growth in European countries

Different methods tell different stories

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Abstract in English

The composition of economic growth can be analyzed in two different ways. In the ‘traditional method’ for the decomposition of GDP growth, total imports are deducted from exports. This approach underestimates the importance of exports for the growth in GDP, and overestimates the importance of domestic expenditure categories. In the alternative methodology proposed in this paper, imports are allocated to all expenditure categories. Although this ‘import-adjusted method’ is more complex than the ‘traditional method’, it has the considerable advantage that the contributions of the expenditure categories to GDP growth provide a better understanding of why GDP growth decelerates or accelerates. The methodology for calculating the import content of final demand, and the implications for the decomposition of real GDP growth, are discussed. For six individual European countries and the euro area, the paper shows that applying the alternative methodology provides rather a different economic story.

Key words: GDP growth, contribution demand categories, imports
JEL code: C67, O40

Abstract in Dutch

De bijdragen van afzonderlijke bestedingscategorieën aan de economische groei kunnen op twee manieren worden bepaald. Internationaal wordt veelal een methode gebruikt waarbij de totale invoer in mindering wordt gebracht op de uitvoer. Dit leidt tot een onderschatting van de bijdrage aan de BBP-groei van de uitvoer en een overschatting van de bijdragen van de binnenlandse bestedingscategorieën. De reden is dat er ook ten behoeve van de consumptie, investeringen en overheidsbestedingen finale en intermediaire goederen en diensten worden geïmporteerd. De in Nederland veelvuldig toegepaste methode houdt hiermee rekening. Deze methode is weliswaar complexer dan de internationale methode, maar heeft het belangrijke voordeel dat de uitkomsten een betere verklaring bieden voor de BBP-groei en de verandering daarvan. Dit paper beschrijft de in Nederland gangbare methode en past deze toe op zes individuele landen en het eurogebied. Het blijkt dat het voor het economische verhaal achter de economische groei tamelijk veel uitmaakt van welke methode gebruik wordt gemaakt.

Steekwoorden: BBP-groei, bijdrage bestedingscategorieën, invoer

Contents

Summary

Two different methods can be applied in analysing the contributions to economic growth. The traditional method, applied mainly by national and international institutes and organisations, allocates imports exclusively to exports. This paper presents an alternative methodology that gives a better decomposition of the sources of economic growth. This alternative method is called the 'import-adjusted' method, because in this method the contributions to GDP growth of all expenditure categories are adjusted for the imports needed to sell the products.

Each of the methods tells rather a different story about the driving expenditure categories of economic growth. The story behind an acceleration or deceleration of GDP growth is different as well. Generally speaking, the traditional approach underestimates the importance of exports for the growth in GDP, and overestimates the importance of domestic expenditure categories. The reason is that final and intermediary goods and services are imported not only for exports, but also for domestic expenditures.

Although this import-adjusted method is more complex than the traditional method, it offers the considerable advantage that the contributions of the expenditure categories to GDP growth provide a better understanding of economic growth and the reasons why GDP growth decelerates or accelerates.

In the calculation of the contribution of the various expenditure categories to GDP growth using the import-adjusted method, total imports have to be attributed to all expenditure categories. This can be done by using ratios derived from what is known as a Cumulated Production Structure (CPS) matrix, which can be calculated by eliminating domestic intermediary demand in the Input-Output table. Strictly speaking, the import-adjusted method can be applied for any country that has at least one Input-Output table. The availability of more Input-Output information leads to more refined calculations and more exact results.

This paper discusses the methodology for calculating the import content of final demand and the implications for the decomposition of real GDP growth. For six individual European countries and the euro area, the paper shows that applying the alternative methodology provides rather ea different economic story.

1 Introduction

Which expenditure categories are the driving forces behind the economic growth of a country or region? This question is often raised in publications or speeches from national and international economic institutions about the short-term economic outlook. In most cases, this question is answered using a methodology that calculates the contribution of exports to GDP growth as the contribution of net exports, while the contributions of domestic demand are not corrected for (final) imports. However, this traditional methodology for calculating the contribution of demand categories to GDP growth can easily lead to misinterpretations about the expenditure categories that are really driving the (changes in) economic growth.

This paper discusses the advantages and disadvantages of both this 'traditional method' and an alternative methodology ('import-adjusted method') to quantify the contributions to economic growth. The core issue underlying the two different approaches is whether imports are allocated exclusively to exports or also to domestic expenditure categories.

In the Netherlands, the Dutch Central Bank, CPB and Statistics Netherlands have applied the alternative method since 1988.[1] At least since 1999, this approach is also applied in Canada, by Statistics Canada.[2] More recently, institutions in France and Denmark have published forecasts with a decomposition of GDP growth using this import-adjusted method.[3] The application of the 'traditional method' and the 'import-adjusted method' frequently produces very different answers about the expenditure categories driving economic growth.

Section 2 unveils the differences between both methods. Section 3 explores the import-adjusted method. The outcomes of both methods for the period 2003-2007 for Germany, France, Italy, Spain, Belgium, the Netherlands and the euro area are presented in section 4. Finally, the last section summarizes the most important findings, and discusses the advantages and limitations of the approach used in this paper. Technical and statistical details are described in three appendices.

[1] For this reason, in earlier publications this approach was called the 'Dutch method' (see Kranendonk and Verbruggen, 2005).

[2] Cameron and Cross (1999) and Cross (2002) use the concept 'Value-added contributions'.

[3] See DGTPE (2006), which refers to 'IO-based contribution', and Box 1 in Ministry of Finance Denmark (2006), which refers to 'contribution net of its content'.

2 Two methods in general terms

By definition, Gross Domestic Product (GDP) equals final expenditures less total imports. This produces the following well-known formula:

(1) $Y = C + I + G + E - M$,

where

Y = gross domestic product (GDP)
C = private consumption
I = investment
G = government expenditures
E = exports
M = imports

In the calculation of the contribution of the expenditure categories to GDP (or to growth in GDP), imports should be deducted from the expenditure categories. The way in which this is done constitutes the crucial difference between the two methods. International institutions, including OECD, EC, IMF and ECB, subtract the (negative) contribution of imports exclusively from the contribution of exports. In that case, the contributions of domestic demand (household consumption, investment and government expenditures) to GDP growth are equal to

(2a) $(C/Y)_{-1}.\overset{\circ}{c}$
(2b) $(I/Y)_{-1}.\overset{\circ}{i}$
(2c) $(G/Y)_{-1}.\overset{\circ}{g}$,

where a little circle above a variable indicates a percentage change. The contribution from abroad is determined as

(2d) $(E/Y)_{-1}.\overset{\circ}{e} - (M/Y)_{-1}.\overset{\circ}{m}$.

The advantages of this approach are its simplicity and the fact that it is clear at first sight what the (net) contribution of foreign trade has been to economic growth. The main drawback, however, is that this approach provides limited insight into the actual contribution of the expenditure categories to GDP growth. After all, imports are used for domestic expenditures as well. That happens not only through imports of final goods and services, but also through the import of intermediary goods and services to businesses that sell products domestically. Taking this into account, as is done in the ‘import-adjusted method’, improves the comparability of

contributions to the separate expenditure categories comprising economic growth, while better insight is provided into the background or composition of the economic development.
In the alternative approach, imports are divided into separate components:

(3) $M = MC + MI + MG + ME$,

where

MC = final and intermediate imports for private consumption

MI = final and intermediate imports for investments

MG = final and intermediate imports for government consumption

ME = final and intermediate imports for exports

The real contributions of the demand categories can, in theory, be calculated as

(4) $(X/Y)_{-1}.\overset{\circ}{x} - (Mx/Y)_{-1}.\overset{\circ}{mx}$,

where x is c, i, g or e.

3 The import-adjusted method in greater detail

The shares and growth rates of import components needed for the above-mentioned calculation are not readily available. This limitation is exacerbated by the fact that import intensities are not constant over time. This section first discusses a method to estimate the contributions of total imports to the distinguished demand categories. The volatility of import intensities, and ways in which to cope with that phenomenon, are discussed later in the section.

3.1 CPS matrix for base year

In the calculation of the contribution of the various expenditure categories to economic growth using the import-adjusted method, total imports have to be attributed to all expenditure categories. This can be done by using ratios derived from what is known as a Cumulated Production Structure (CPS) matrix.[4] This matrix indicates for the expenditure categories the composition of output by gross value-added components (such as wages, profits and depreciation allowances) and the (final and intermediary) imports. The CPS matrix is calculated by eliminating domestic intermediary demand in the Input-Output table (see Appendix A).[5]

In matrix algebra, the CPS matrix formula looks like the following:[6]

$$(5) \qquad CPS = P \,.\, (I - A)^{-1} \,.\, F + W \,,$$

where

CPS = Cumulated Production Structure Matrix (in value terms)
P = matrix of primary input coefficients
I = unit matrix
A = matrix of domestically produced intermediary demand
F = matrix of domestically produced final demand (in value terms)
W = matrix of primary inputs that are at the same time final demand (final imports, indirect taxes and subsidies on final sales, for example, in value terms)

[4] The GPS matrix derivation is based on Klein (1983). See Appendix A.
[5] For this purpose, valuation at market prices is assumed, so that the sum of gross value added per expenditure category is equal to GDP at market prices. This means that the contributions to GDP include the indirect taxes relating to the distinctive expenditure categories as well.
[6] See also CPB (1992), section 2, and Appendix I.

Table 3.1 contains the CPS matrix of the German economy for the year 2000. The columns show the four expenditure- or output categories: private consumption, government consumption, investments and exports. The rows show total demand divided into domestic production and final- and intermediate imports. Unfortunately, the lack of relevant Input-Output tables prevents a more detailed approach to the demand categories.[7]

Table 3.1 Cumulated Production Structure matrix for Germany, 2000

	Private consumption	Government consumption	Investments	Exports	Total
	billions of euros				
GDP (1)	962	361	320	419	2063
Imports (2)	221	31	130	251	632
- Final	106	4	70	94	274
- Intermediate	116	27	59	157	358
Total demand (3)	1184	392	449	670	2694
	%				
Average import intensity (2) : (3)	19	8	29	37	23

This table illustrates that import intensity of exports and investments in Germany is higher than that of consumption. This is relevant for almost all European countries.

3.2 Volatility of import intensities

If the several import intensities were constant over time, then the data from the CPS matrix could easily be used for a base year to calculate the contribution of the demand components to GDP growth. Unfortunately, they are not. The arguments for the import intensities not being constant over time are as follows:

- Globalisation and international specialisation lead to growth figures of imports and exports that are, on average, higher than the growth of GDP and domestic demand;
- Changing relative prices can cause (temporary) higher or lower import intensities;
- Total demand and imports have different price developments;
- Temporarily high- or low rates of capacity utilization can lead to more or less imports;
- Import intensity of aggregates can fluctuate because of different developments of components. In the Netherlands, for example, imports for private consumption depend mainly on the development of durable consumption goods, which is rather volatile.

[7] Eurostat - website www.ec.europa.eu/eurostat, theme 'Economy and finance', 'ESA 95 Input-Output tables'.

In the case of volatile import intensities, however, the intensities in a specific base year could be applied in the calculation, but the results would provide only a rough indication of the demand components' contribution to GDP growth. More precise results call for the use of real *marginal* import intensities, indicating which part of changes of yearly demand has led to additional imports and which part was domestically produced. Calculation of yearly real *marginal* import intensities requires yearly Input-Output tables in constant prices. These are, to the best of our knowledge, available for the Netherlands only for the period 1988-2006. As shown in the box, the *marginal* import intensities for the Netherlands are rather volatile, an outcome that can be expected for other (European) countries. If Input-Output tables in constant prices were available for these countries, we could calculate exactly the contribution to GDP growth of the several demand components. They are not available, however. Applying a method that we have developed, which indirectly produces real marginal import intensities, allows this problem to be solved. This method is described in greater detail in Appendix B. Here, only the outlines are sketched.

The method works as follows: all countries analysed in this research have a nominal Input-Output table for the year 2000. This Input-Output table is used to calculate a CPS matrix for 2000. National Accounts data for the volume growth rates of GDP, for the demand components and for imports are used to construct a CPS matrix for the year 2005, in prices of 2000. This approach uses information about the import intensities to fill in the inner part of the CPS matrix— in other words, to allocate total demand in imports and value-added, under the restriction of observed total imports and GDP. These two CPS matrices allow the derivation of the real marginal import intensities for all the European countries and the euro area. Because the import intensities refer to a period of 5 years, they are called *average* real marginal import intensities.

As noted above, the availability of Input-Output tables in constant prices would lead to a more exact analysis. Our own calculation of the marginal import intensities yields only an approximation of the decomposition of GDP growth. This approximation, however, gives a better picture of the contributions of the various demand components to GPD growth than the traditional method does, where all imports are simply deducted from exports.

Volatility of import intensity in the Netherlands

Input-Output (IO) tables contain important information on the structure of the production and the import intensities of countries. Statistics Netherlands has published IO-tables back to 1969 in nominal values, and back to 1988 in prices of the previous year. For this study, a calculation was made of which part of final demand originates from domestic production and which part is imported. Application of an IO-table in current prices for specific years allows the *average import intensity* for each demand category to be calculated. A time-series analysis for this statistic over a longer period provides insight into the relevance of globalisation and import penetration of a country. However, for the analysis of the effect of the business cycle for the import intensity, another statistic is more relevant, i.e. the *real marginal import intensity*. This variable quantifies which part of the *real growth* of final demand is imported.

Expressed as a formula, the definitions of both measures for import intensity are
nominal import intensity : $Mx(t) / X(t)$

real marginal import intensity: $[Mx^{cp}(t) - Mx(t-1)] / [X^{cp}(t) - X(t-1)]$

where,

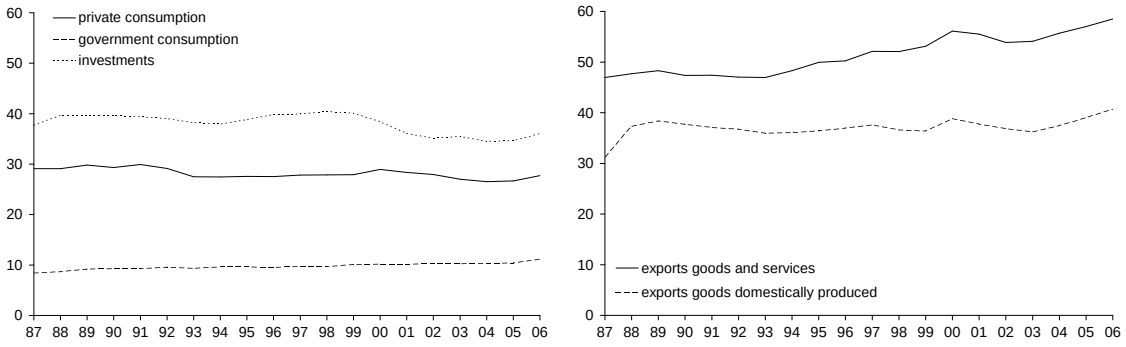
cp : constant prices of previous year

Mx : import content of demand factor X

X : demand categories private consumption, government consumption, investments and exports

The first two graphs show that the nominal import intensities for domestic demand and exports of goods produced in the Netherlands are rather stable in time. The increase for total exports can be explained by the strong increase of the share of re-exports in total exports.

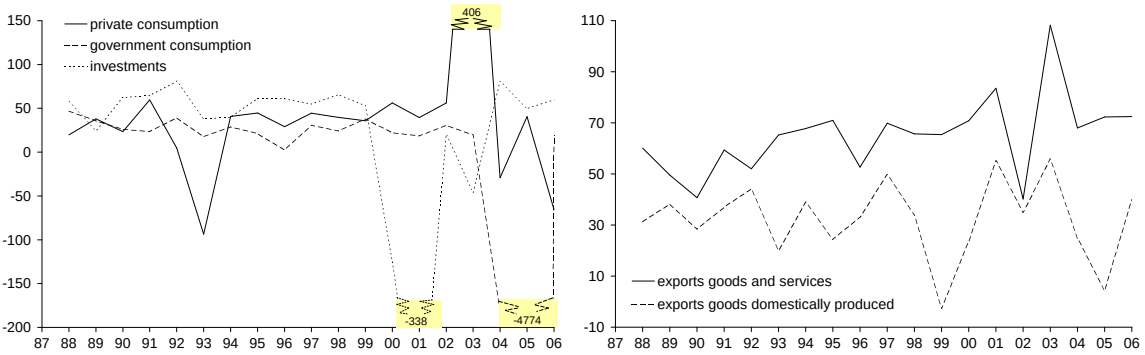
Nominal import intensity in the Netherlands, 1988-2006



The second set of graphs illustrates the volatility of the marginal import intensity in real terms from year to year. In years with exceptionally low growth of a particular demand factor, the denominator of the import ratio can be close to zero and the quote unusually high (in absolute terms). Those observations are omitted from the graphs.

Volatility of import intensity in the Netherlands (continued)

Real marginal import intensity in the Netherlands, 1988-2006



For domestic demand, the average marginal import intensities for the period 1988-2006 are higher than the nominal intensities. This illustrates the ongoing import penetration in real terms. Because prices of domestic demand increase on average more than the relevant import prices do, the nominal import intensities rise either negligibly or not at all.

Average imports in the Netherlands, 1988-2006

	Nominal	Real marginal
Private consumption	28	36
Government consumption	10	25
Investments	38	61
Export of goods and services	51	67
of which goods domestically produced	37	34

3.3 Calculating the contributions to GDP growth

The calculation of the contributions is done in two steps. In the first step the average real marginal import intensities are applied. As discussed in the previous section, these intensities are volatile and not appropriate for each separate year. Applying these intensities will thus lead to a sum of imports that may differ from total imports. This residual should be 'divided' in the second step— for example, *pro rata* across the imports for the expenditure categories applying marginal import shares.[8]

An alternative for this two-step procedure is a method that constructs CPS matrices for all years in constant prices, using some spreader procedure. This is, from a technical point of view, a rather simple procedure, but it has the disadvantage that the residual is spread, based on the structure in some base year. The two-step procedure is preferable because it gives explicit information about the residual. Large residuals give the message that the applied import quotes

[8] GDP shares were used as weights for the residuals in the original approach for the Netherlands (Kranendonk and Verbruggen, 2005). In that case, a large part of the residuals could be allocated to a demand category featuring a low import intensity. It is thus better to use import shares for the allocation of the residuals. These weights are derived from table B.4, Appendix B.

do not sum to total imports. Such situations occur when the import intensities differ significantly from their historical average (for reasons mentioned in subsection 3.2). This approach can be summarized in the following formulas:

(6) $contr_i^{\,p} = (demand_i - mfi) \,.\, (100 - \alpha_i) / 100$

(7) $contr_i^{\,f} = 100 \,.\, [contr_i^{\,p} + \beta_i \, (y - \sum contr_i^{\,p})] / Y_{-1}$,

where

$demand_i$ = volume change (Δ) of demand category i, in billions of euros

$contr_i^{\,p}$ = preliminary contribution of expenditure category i to volume change (Δ) of GDP (i.e. before dividing the residual)

$contr_i^{\,f}$ = final contribution of expenditure category i to volume growth rate (%) of GDP (i.e. after dividing the residual)

α_i = import intensity of expenditure category i, excluding final imports

β_i = share of expenditure category i in total imports

mfi = final imports for expenditure category i

y = volume change (Δ) of GDP, in billions of euros

Y = Gross Domestic Product (GDP), in billions of euros

These formulas refer to a situation in which additional information is available about the development of final imports. This variable is set equal to zero when such information is absent, and the parameters α and β should be based on the marginal CPS matrix: row (2) for the β's and row (4) for the α's (see table B.1 in Appendix B).[9] Appendix B presents detailed information on the parameters α (table B.3) and β (table B.4) as well. It also contains figures that illustrate the size of the residuals from the first step.

[9] When information on final imports is applied, the α's should be based on the quote of only intermediate imports as a percentage of total demand.

4 Results

This section compares the results of the import-adjusted method with those of the traditional method. The calculations are based on OECD data from the Economic Outlook of June 2007. This database contains time series for GDP, consumption, investments, exports and imports in prices of a base year. Figures 4.1-4.7 show the allocation of GDP growth for the years 2003-2007 for Germany, France, Italy, Spain, Belgium, the Netherlands and the euro area. Appendix C describes the data used.

The differences are significant. Each of the methods tells rather a different story about the driving expenditure categories of economic growth. For France and Spain, the traditional method suggests that the contribution to GDP growth from abroad is almost always negative, whereas the import-adjusted method indicates that exports did contribute positively (or at least not negatively) to economic growth. Even stronger is the difference for Belgium. The import-adjusted method shows that around 50% of the GDP growth originates from abroad— quite different from the zero or negative indication suggested by the traditional method. The differences between both methods are relatively small for Germany and Italy, although the contribution of exports to GDP growth in 2006 and 2007 is much higher in the import-adjusted method than in the traditional method. The import-adjusted method shows that more than half of the German and Italian economic growth in these years can be attributed to exports, while in the traditional method this contribution is about one-third. In the Netherlands, the traditional method suggests that the contribution of exports to GDP growth is decreasing in the period 2004-2007, while according to the import-adjusted method this contribution is rather stable and very significant.

Figure 4.1 Contributions to GDP growth in Germany, 2003-2007

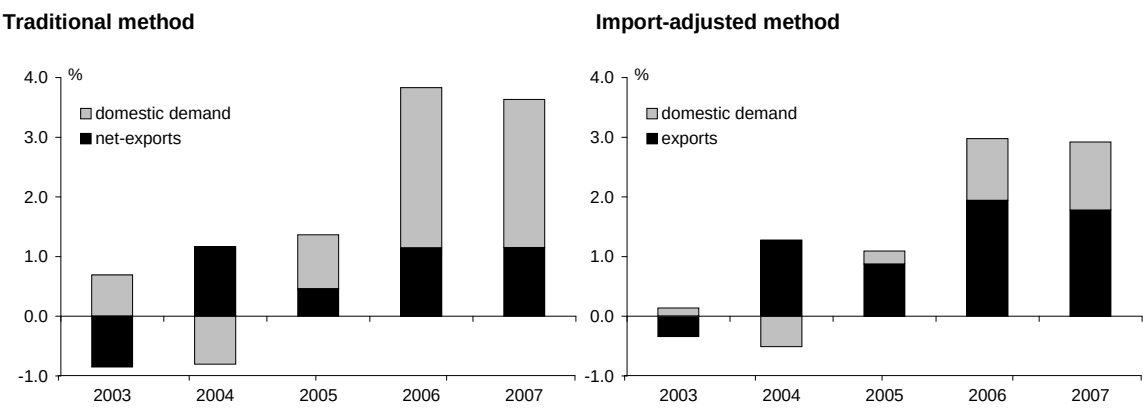


Figure 4.2 Contributions to GDP growth in France, 2003-2007

Traditional method **Import-adjusted method**

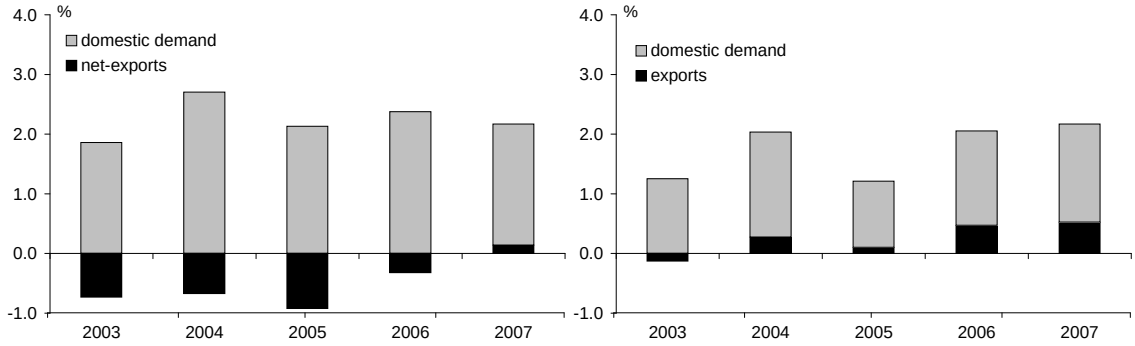


Figure 4.3 Contributions to GDP growth in Italy, 2003-2007

Traditional method **Import-adjusted method**

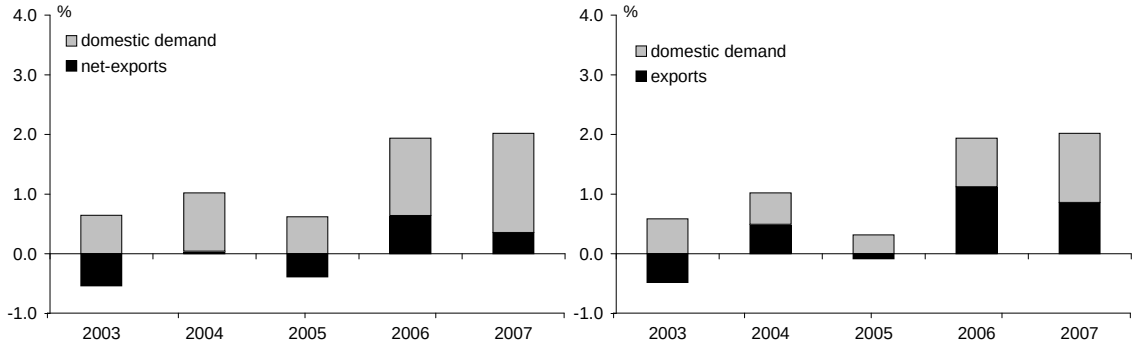


Figure 4.4 Contributions to GDP growth in Spain, 2003-2007

Traditional method **Import-adjusted method**

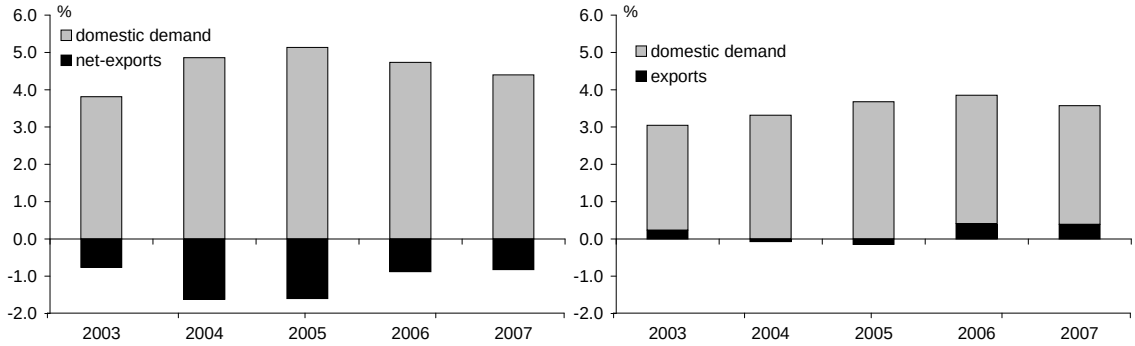


Figure 4.5 Contributions to GDP growth in Belgium, 2003-2007

Traditional method **Import-adjusted method**

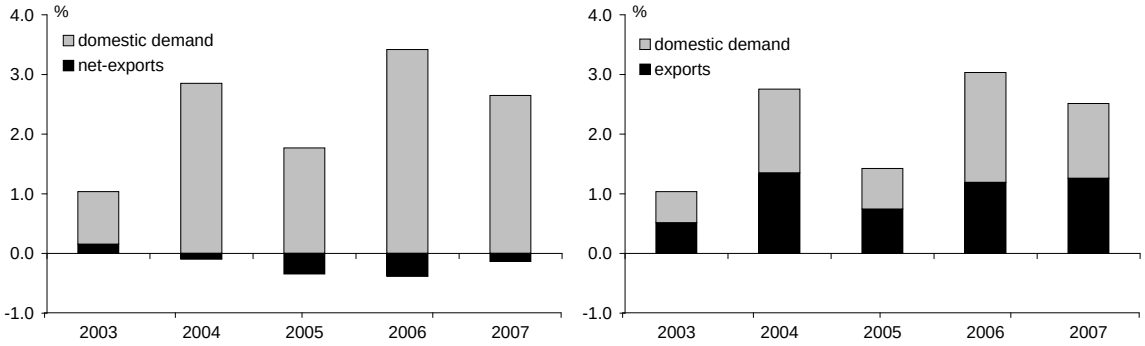


Figure 4.6 Contributions to GDP growth in the Netherlands, 2003-2007

Traditional method **Import-adjusted method**

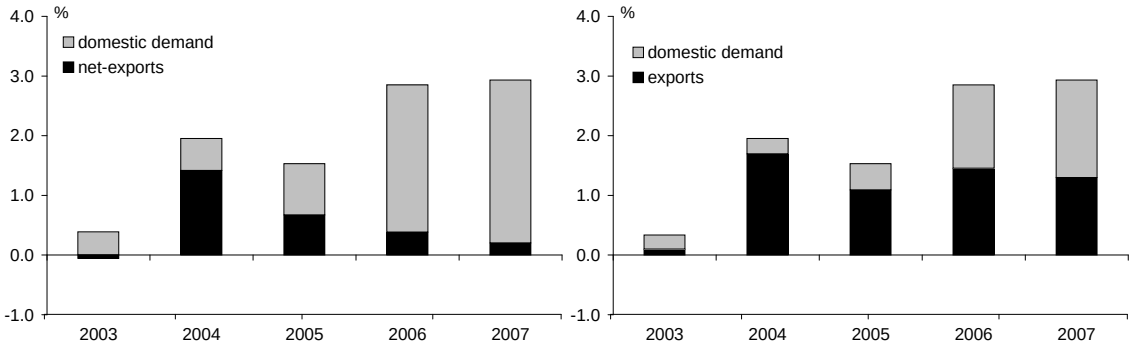
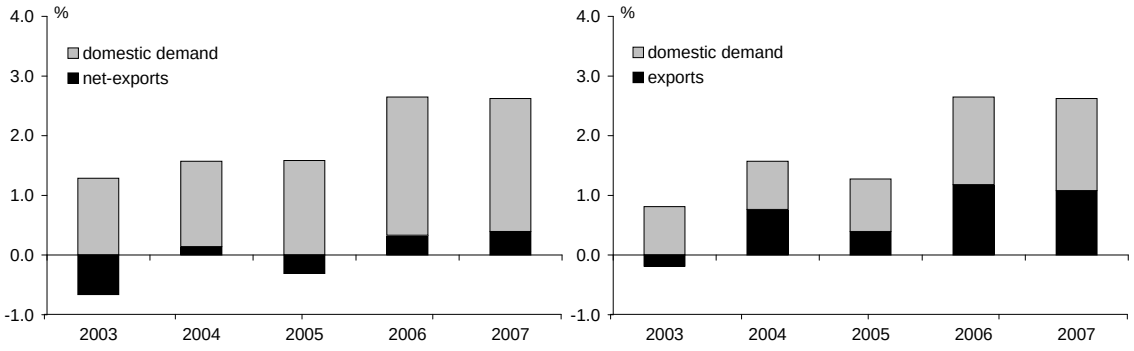


Figure 4.7 Contributions to GDP growth in euro area, 2003-2007

Traditional method **Import-adjusted method**



The results are hardly surprising for the euro area, taking into account the results of the separate countries. The contribution of exports to GDP growth is much larger in the import-adjusted method. In 2005, the traditional method produces a negative contribution of exports, while according to the import-adjusted method the contribution of exports is still positive. All in all, both methods shine a different light on the economic situation.

5 Conclusions and evaluation of the methodology

An analysis of contributions to economic growth can use two different methods, which in most cases give divergent outcomes. The traditional method, in which imports are exclusively allocated to exports, underestimates the importance of exports and overestimates the importance of domestic demand. The explanation is that final- and intermediary goods and services are imported not only for exports, but also for domestic expenditures. This paper presents a methodology that provides a better decomposition of the sources of economic growth.

The methodology presented here is applicable for all countries that have at least one Input-Output table for some base year available. Because most import quotes increase gradually and fluctuate from year to year, it is preferable to have Input-Output tables for a number of years. Comparison of Input-Output tables from different years can provide greater insight into the volatility of the import intensities. The rapid increase of re-exports in some countries, in particular, may provide an important explanation for the rising import quotes.[10]

The quality of the decomposition of GDP growth depends especially on the availability of detailed information on the imports. In the two-step approach, a constant import quote is assumed initially, and the sum of the estimated total of imports will, in general, not be equal to the 'real' import growth. More accurate estimates for final- and intermediate imports reduce the residuals to be divided in the second step of the method.

Only with detailed Input-Output tables in constant prices is it possible to obtain an exact decomposition. In all other situations, the methodology gives an approximation. Thus, the decomposition can change when new Input-Output tables become available. Changing figures are, however, an aspect of economic reality. Data on economic growth alter when new National Accounts are published, and even after a long period of time revisions can take place.

While the methodology presented in this paper provides insight into the developments behind the economic growth, it cannot give a complete analysis, and thus aims to provide a quantitative description about the importance of domestic demand and exports. Since this methodology cannot explain why the contributions increase or decrease, the information of the presented decomposition of the GDP growth should always be completed with other analyses in order to tell the whole 'story'.

[10] See Mellens, Noordman and Verbruggen (2007).

Appendix A Derivation of the CPS matrix

The Cumulated Production Structure (CPS) matrix aims to provide a direct link between primary inputs and final demand. The matrix indicates how much of each primary input category is needed, both directly and indirectly (through the use of intermediaries), to produce each category of final output.[11] To derive this matrix, consider the following Input-Output table:

	(n)	(f)	(1)
(n)	A	F	z
(p)	P	W	×
(1)	z’	y’	

where

A	=	n × n matrix of domestically produced intermediary demand
F	=	n × f matrix of domestically produced final demand
z	=	n × 1 vector of domestically produced total demand
P	=	p × n matrix of primary inputs used by domestic firms
W	=	p × f matrix of primary inputs that are the same time final demand
x	=	p × 1 vector of total primary inputs
y	=	f × 1 vector of total final demand
n	=	number of industries
f	=	number of categories of final demand
p	=	number of primary input of categories

It should be noted that the existence of the matrix W is not standard in the international input-output literature. In Dutch Input-Output tables, the matrix contains primary costs that are simultaneously final demand components, such as the imports of final products, indirect taxes and subsidies on final products. In Input-Output tables for most other countries these components are incorporated in the matrices P and F. For those Input-Output tables, the proper CPS matrix can be derived by setting W=0 in the remainder of this appendix.

Define the matrices A^* and P^* by dividing the column entries of A and P by the corresponding entry in z’. A^* is the matrix of intermediary input coefficients, and P^* is the matrix of primary input coefficients. The entries A_i^{*j} and P_i^{*j} indicate the amounts of intermediary input of industry i and of primary input of category i needed to produce one unit of gross output of industry j. Define the n × f matrix $X (I - A^*)^{-1} F$. Each column in X is the vector of total demand (by industry) generated by the corresponding column vector of final demand in F.

[11] The derivation of the CPS matrix is based on Klein (1983).

Form the p × f matrix CPS' as follows:

$$CPS' = P^{*} \cdot X$$
$$= P^{*} (I - A^{*})^{-1} \cdot F$$

Each entry CPS'_{ij} represents the total or cumulated amount of primary input of category i needed to produce the j^{th} column vector of final demand in F. Recall that W_{ij} is the amount of primary input of category i that is at the same time a component of final demand of category j. $CPS'_{ij} + W_{ij}$ is therefore the total amount of primary input of category i needed to produce the total final demand of category j. We thus define the CPS matrix as follows:

$$PS = CPS' + W$$
$$= P^{*} (I - A^{*})^{-1} \cdot F + W$$

The column totals of this CPS matrix are the total value of the primary inputs needed, both directly and through intermediaries, to produce the corresponding category's final demand. Since total cost must equal total production, these column totals must equal the entries of vector y'. The row totals are the total amounts of primary inputs used, and thus form the column vector ×.

The full CPS matrix is then depicted as follows:

	(f)	(1)
(p)	CPS	×
(1)	y'	

Dividing the CPS matrix by its column totals yields the standardized CPS, whose columns consist of the cumulative cost shares of the primary input categories for each final-demand category.

Appendix B Import intensities

This appendix discusses the import intensities for some European countries. First, it is shown that marginal import intensities are higher than average import intensities for Germany. The appendix then presents tables with import intensities for six European countries and the euro area.

Subsection 3.2 noted that import intensities fluctuate from year to year, with a tendency to rise. This appendix first illustrates the phenomenon of increasing import intensity, applying Input-Output tables for Germany for the years 1995 and 2000. During this period, the total average import intensity increased from 17% on average to 23%. Table B.1 presents the 'marginal' CPS matrix for Germany, which is calculated as the CPS matrix in 2000, minus the CPS matrix in 1995.

Table B.1 Marginal Cumulative Production Structure matrix for Germany, 2000 minus 1995

	Private consumption	Government consumption	Investments	Exports	Total
	billions of euros				
GDP (1)	115	25	– 6	123	257
Imports (2)	68	10	47	126	251
- Final	26	1	33	51	111
- Intermediate	42	9	14	75	140
Total demand (3)	182	35	41	249	508
	%				
Marginal import intensity 2 as a % of 3 (4)	37	29	115	51	49

This table illustrates that around 50% of the increase of domestic demand and of exports was imported. This marginal import quote is much higher than the average import intensity in the years 1995 and 2000. The import intensity of exports increased very rapidly, thanks to a growth of 50% of the final imports for exports (also called 're-exports'). The marginal import intensity of investments in the period 1995-2000 is even higher than 100%. This may have been caused by a diversified development of different type of investments: a strong increase for import-intensive investments, such as computers and machinery, and a decrease in investments originating from domestic production, such as buildings. The method implicitly assumes that the demand categories are homogenous.

In principle, marginal import intensities can be calculated only when CPS matrices for two or more years are available. As far as we know, only the Netherlands publishes yearly Input-Output tables. Other European countries have Input-Output tables for only two years (1995 and 2000). For some countries, an Input-Output table is available for only one year, and this is

sometimes even very old (1995). However, it is possible to construct for these countries a CPS matrix for a second year. Using available totals for the inputs (rows) and the demand (columns), we apply a spreader procedure. The CPS matrix of the base year and the totals for a second year together allowed us to construct a complete CPS matrix. From these matrices the marginal intensities can be estimated. In principle, this spreader procedure could be applied to construct CPS matrices for every year— in current prices, in prices of the previous year or in prices of some base year.

Macroeconomic time series were used to construct CPS matrices in constant prices for the years 2000 and 2005, applying the spreader procedure.[12] The euro area is approximated by the first six countries mentioned in the table, which represent more than 80% of domestic demand and almost 90% of GDP in the euro area. The figures include intra-euro area trade.[13]

Table B.2 Average import intensity, 2005

	Private consumption	Government consumption	Investments	Exports	Total demand
Belgium	32	10	48	62	45
France	18	8	26	45	23
Germany	22	9	33	42	28
Italy	19	8	31	26	20
Netherlands	27	12	41	60	42
Spain	16	8	23	65	27
Euro area	20	9	31	47	28

Subtracting the CPS matrices of 2005 and 2000 gives the marginal import intensity (α's in formula (3)) and marginal import shares (β's in formula (4)). The results can be found in table B.3. For most countries, the marginal import intensities are higher than the average import intensities in 2005.

Table B.3 Marginal import intensity, 2000-2005 (in prices of 2000)

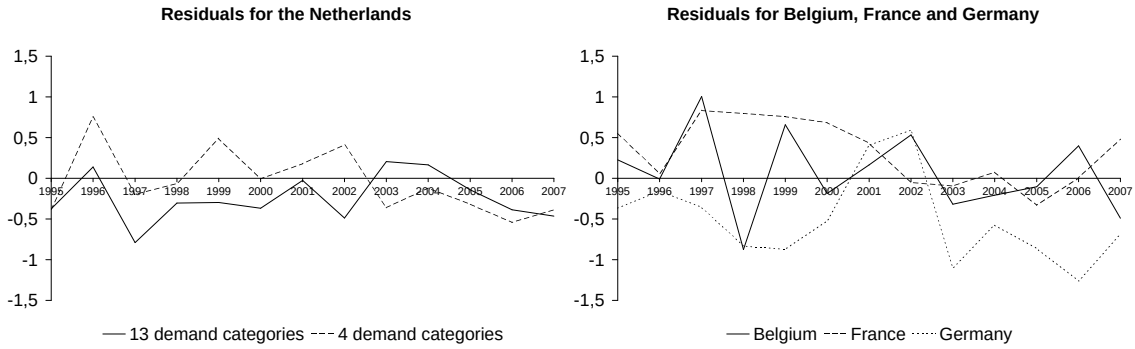
	Private consumption	Government consumption	Investments	Exports	Total demand
Belgium	49	14	60	69	58
France	31	16	63	74	41
Germany	≥100	50	12	49	68
Italy	22	9	32	15	20
Netherlands	64	19	≤0	69	65
Spain	26	14	30	≥100	38
Euro area	39	16	95	62	49

[12] The advantage of using matrices in constant prices is that price developments have no influence on the calculation of the real marginal import intensities.

[13] Calculating a CPS matrix excluding intra-trade is not a trivial task, because of the lack of time series for exports and imports of the euro area. The split of the intermediate and final imports, which together are some 50% of total imports, for intra and extra euro area should be based on some arbitrary assumptions.

For some countries, the results in table B.3 are remarkable. Germany experienced a strong growth of imports during the period 2000-2005. Application of the spreader procedure lead to the additional imports partly contributing to private consumption and government consumption, which showed almost no real growth in this period. This procedure lead in some cases to estimated marginal import intensities for domestic demand that were rather high— sometimes even above 100%. We replaced the percentages above the 100%, as well as the negative percentages, to obtain more reasonable figures.[14]

Figure B.1 Residual of first step



Applying the import intensities from formula (6) provided initial approximations of the contributions to GDP growth. These do not add up to the GDP growth, because the import quotes fluctuate from year to year. Figure B.1 illustrates the magnitude of the resulting residuals for some countries. The left-hand graph presents two methods for the Netherlands. In the more detailed approach (with thirteen different demand categories, and using also information on final imports), the mean absolute residual is only 0.2%-point of GDP.[15] Applying the more global approach (discussed in this paper) with only four demand categories, the mean absolute residual is 0.4%-point of GDP. The right-hand graph presents the residuals for some European countries.

The CPS matrices also allow us to derive import shares, which sum up to 100% over the demand categories (see table B.4). We only increased the weight of the exports for Germany to 70%, more in line with the strong increase of the re-exports. The weights for private consumption and investment were reduced to sum up to 100%. These shares are used in our methodology to divide, in the second step of the calculation of the contributions, a residual from the first step. These are the β's in formula (7).

[14] We also decreased percentages above 30% for government consumption and increased percentages under 20% for investments.

[15] See Kranendonk and Verbruggen (2005).

Table B.4 Import shares, 2005

	Private consumption	Government consumption	Investments	Exports	Total demand
Belgium	20	3	13	64	100
France	34	6	17	43	100
Germany [a]	33 (16)	4	16 (10)	47 (70)	100
Italy	43	6	25	26	100
Netherlands	19	4	11	66	100
Spain	27	4	18	51	100
Euro area	31	5	17	48	100

[a] Figures between brackets are imposed, see text.

Appendix C Contributions to GDP growth[16]

Table C.1 Contribution to GDP growth

	Private consumption		Government consumption		Investments		Exports		GDP
	Import-adjusted method	Traditional method	Import-adjusted method	Traditional method	Import-adjusted method	Traditional method	Import-adjusted method	Traditional method	
	%								
Belgium									
2003	0.2	0.5	0.4	0.5	– 0.1	– 0.1	0.5	0.2	1.0
2004	0.4	0.8	0.4	0.5	0.6	1.6	1.3	– 0.1	2.8
2005	0.3	0.6	– 0.1	– 0.1	0.5	1.3	0.7	– 0.3	1.4
2006	0.7	1.3	0.3	0.3	0.8	1.8	1.2	– 0.4	3.0
2007	0.5	1.1	0.4	0.5	0.4	1.1	1.3	– 0.1	2.5
France									
2003	0.8	1.2	0.4	0.5	0.1	0.2	– 0.1	– 0.7	1.1
2004	1.0	1.4	0.4	0.5	0.3	0.8	0.3	– 0.7	2.0
2005	0.7	1.2	0.2	0.2	0.2	0.7	0.1	– 0.9	1.2
2006	1.0	1.5	0.4	0.4	0.2	0.5	0.5	– 0.3	2.1
2007	1.1	1.3	0.4	0.4	0.2	0.4	0.5	0.1	2.2
Germany									
2003	– 0.2	0.0	0.0	0.1	0.3	0.7	– 0.3	– 0.9	– 0.2
2004	– 0.2	– 0.2	– 0.2	– 0.2	– 0.1	– 0.4	1.3	1.2	0.8
2005	0.0	0.2	0.1	0.1	0.2	0.6	0.9	0.5	1.1
2006	0.2	0.5	0.2	0.3	0.6	1.8	1.9	1.1	3.0
2007	0.3	0.5	0.2	0.2	0.7	1.8	1.8	1.1	2.9
Italy									
2003	0.5	0.6	0.4	0.4	– 0.2	– 0.3	– 0.5	– 0.5	0.1
2004	0.2	0.4	0.3	0.3	0.1	0.3	0.5	0.0	1.0
2005	0.2	0.4	0.3	0.3	– 0.1	0.0	– 0.1	– 0.4	0.2
2006	0.6	0.9	– 0.1	– 0.1	0.3	0.5	1.1	0.6	1.9
2007	0.6	0.9	0.1	0.2	0.4	0.7	0.9	0.4	2.0
Netherlands									
2003	– 0.1	– 0.1	0.5	0.7	– 0.2	– 0.2	0.1	– 0.1	0.3
2004	0.1	0.3	0.0	0.0	0.2	0.2	1.7	1.4	2.0
2005	0.1	0.3	0.0	0.1	0.3	0.4	1.1	0.7	1.5
2006	0.3	1.0	0.3	0.3	0.9	1.1	1.5	0.4	2.9
2007	0.3	1.1	0.3	0.4	1.0	1.3	1.3	0.2	2.9

[16] Figures for the Netherlands in this appendix are based on the discussed methodology and not on the more detailed approach CPB uses for the calculation of the contribution in the official CPB publications.

Table C.1 Contribution to GDP growth (continued)

	Private consumption		Government consumption		Investments		Exports		GDP
	Import-adjusted method	Traditional method	Import-adjusted method	Traditional method	Import-adjusted method	Traditional method	Import-adjusted method	Traditional method	
	%								
Spain									
2003	1.2	1.6	0.7	0.8	0.9	1.4	0.2	– 0.8	3.0
2004	1.6	2.4	0.9	1.1	0.8	1.3	– 0.1	– 1.6	3.2
2005	1.7	2.4	0.7	0.9	1.2	1.8	– 0.1	– 1.6	3.5
2006	1.5	2.1	0.7	0.8	1.2	1.8	0.4	– 0.9	3.9
2007	1.5	2.1	0.9	1.0	0.8	1.3	0.4	– 0.8	3.6
Euro area									
2003	0.3	0.6	0.3	0.4	0.2	0.3	– 0.2	– 0.7	0.6
2004	0.4	0.7	0.2	0.2	0.2	0.5	0.8	0.1	1.6
2005	0.4	0.7	0.2	0.3	0.3	0.6	0.4	– 0.3	1.3
2006	0.7	1.1	0.3	0.3	0.5	0.9	1.2	0.3	2.6
2007	0.7	1.0	0.3	0.4	0.5	0.9	1.1	0.4	2.6

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