CPB Memorandum

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How to determine the contributions of domestic demand and exports to economic growth?

Dutch versus international method

There are two methods in use to determine the contributions of expenditure categories to economic growth. In the conventional 'international method', total imports are deducted from exports, whereas in what is known as the 'Dutch method', final and intermediary imports are allocated to all expenditure categories. Although the Dutch method is a little more complex than the international method, it has the considerable advantage that the contributions of the expenditure categories to GDP growth can be better compared, producing a better understanding of the composition of GDP growth. This memorandum discloses the Dutch method and illustrates the differences in perception which the two methods produced for the years 1999 to 2004. The findings are that the international method underestimates the importance of exports for GDP growth and overestimates the importance of domestic expenditure categories, like private consumption and investments.

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1 Introduction[1]

When considering economic development, there is an increasing tendency to look at the composition of economic growth. Is growth export driven or is domestic consumption the main contributor to GDP growth? Did public sector expenditure have an economically beneficial effect or did it have the very opposite effect? To be able to answer that type of questions, we need to analyse the contributions of the various expenditure categories to economic growth. There are two popular methods of doing this, namely the method used by the Centraal Planbureau (CPB) and the Dutch Central Bank (DNB),[2] for simplicity's sake referred to below as the 'Dutch method', and the method used in other countries and by such international organisations as the OECD, the European Commission (EC) and the ECB. The outcomes of the two methods frequently produce very different answers to the question what is driving 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 paragraph 2 of this memorandum, the differences between the two methods are unveiled. Paragraph 3 then deals more in-depth with the Dutch method. Lastly, paragraph 4 discusses the results for the period 1999-2004, accompanied by a comparison with the outcome of the conventional international method.

2 Difference in method

By definition, Gross Domestic Product (GDP) is equal to 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

[1] This article was previously published in Dutch in *Kwartaalschrift Economie,* see Kranendonk and Verbruggen (2005). The main difference with that article relates to the underlying National Accounts data. In July 2005, the National Accounts were revised by Statistics Netherlands. In this article we use these revised National Accounts data, which were not available for the previously published Dutch version of the article.

[2] Alders (1988) was the first to point out the relevance of the difference between the two methods. In its publications on short-term forecasts, the CPB has been using the Dutch method since the 1989 Central Economic Plan. DNB uses both methods. For a recent application of the Dutch method, see for instance DNB (2003, p.75) and of the international method DNB (2005, p.55). However, in this connection DNB refers to net and gross growth contributions, respectively.

g = government expenditures

e = exports

m = imports

In order to determine the contributions of the expenditure categories to GDP (or to growth in GDP) we should deduct imports from the expenditure categories. The manner in which this is done constitutes the crucial difference between the international and the Dutch method. The OECD and the EC subtract the (negative) contribution of imports exclusively from the contribution of exports. In that event, the contribution of household consumption to GDP growth is equal to $(C/Y)_{-1} * \overset{\circ}{c}$, where a little circle above a variable indicates a per cent change. The contributions of the other domestic expenditure categories can be determined by analogy. In that case, the contribution from abroad is determined as $(E/Y)_{-1} * \overset{\circ}{e} - (M/Y)_{-1} * \overset{\circ}{m}$.

The benefits of this approach are its simplicity and that it is clear at first sight what has been the (net) contribution of foreign trade to economic growth. The main drawback, however, is that no correct view can be given of the actual contributions of the expenditure categories to GDP growth. After all, imports are used for domestic expenditures as well. That not only happens via imports of final goods and services, but also via the import of intermediary goods and services to businesses that sell products domestically.[3] By taking this into account, as is done in the Dutch method, the comparability of contributions to the separate expenditure categories making up economic growth is improved, while a better insight is provided into the background or composition of the economic development. The way the contributions to GDP growth are determined in the Dutch method is discussed in the next paragraph.

3 The Dutch method

In order to calculate the contributions of the various expenditure categories to economic growth using the Dutch method, total imports have to be attributed to all expenditure categories. This attribution is done by using ratios derived from what is known as a Cumulative Production Structure (CPS) matrix.[4] Per sales category, this matrix indicates the make-up of the output by gross value-added component, 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). Valuation at market prices is assumed for this purpose, so that the sum of the gross value-added per expenditure category is

[3] This drawback is mentioned by the ECB (2005, pp. 54) as well.

[4] The GPS matrix derivation is based on Klein (1983) and Eering cum suis (1988). See Appendix A.

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.

In matrix algebra, the CPS matrix formula looks as follows:[5]

$$(2) \qquad CPS = P * (I - A)^{-1} * F + W$$

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 (like final imports, indirect taxes and subsidies on final sales, in value terms)

Table 1 contains a condensed CPS matrix of the Dutch economy for the year 2004. The columns show the various expenditure or output categories and the rows show the input categories. The selected classification of the input and output categories is based on SAFFIER, the CPB model for short-term and medium-term analyses.[6] It goes without saying that alternative classifications can be selected if preferred.

At the top right of the table is the GDP amounting to 488.6 billion euro in 2004. The domestic shares in table 1 indicate for every output category what percentage of the domestically produced goods and services – in other words: of the total sales less the final imports – consists of value-added. The complement is the percentage of the (cumulative) imports of intermediary goods and services. On average, the share of domestic origin is 77%. For consumption and for the investment in houses the shares are higher, partly owing to the indirect taxes levied on them. By definition, the public sector's earnings amount to 100%. The percentage of domestically produced exports of manufactured goods is lower on average (61%). Owing to the - by definition - high final import component of re-exports, domestically produced re-exports (12.7 billion euro in 2004) only constitute a small part of total re-exports.[7] Of this small part, made up mostly of trade and transport margins, gross added value accounts for 81%. For the export of energy, we make a distinction between natural gas, with its high added-value

[5] See also CPB (1992), section 2 and Appendix I.
[6] SAFFIER is an integrated version of CPB's short-term model SAFE , see CPB (2003a), and CPB's medium-term model JADE, see CPB (2003b). A CPB Document that describes the SAFFIER model is forthcoming.
[7] Please note that by far the largest component of final imports consists of re-export products.

component (86%), and oil products, which have the lowest domestic share due to the high share of imported crude (21%).

Based on table 1, the difference between the international and the Dutch method can be easily illustrated. In the international method, total imports (292.6 billion euro) are deducted from total exports (329.0 billion euro), resulting in a net export GDP contribution of 36.4 billion euro. In the Dutch method, imports are split into a final and an intermediary component, which are then attributed to all the different expenditure categories.

By subtracting these imports from total demand, the contributions to GDP can be calculated for every output category. Of total GDP in 2004 (488.6 billion euro) 171.3 billion euro, that is 35%, can be attributed to private consumption. The contributions to GDP of government consumption, investments and exports are respectively 22%, 12% and 31%. The GDP contributions in values (in billion euro's) are presented on the top row, while the shares (in % of total GDP) are presented on the bottom row.

Table 3.1 Cumulated Production Structure (CPS) Matrix for the Dutch economy, 2004, billion euro's

	Private consumption	Government consumption			Investment			Exports					Total
		wage sum	benefits in kind	other	residential buildings	other fixed assets	govern-ment	domestically produced non-energy goods[a]	re-exports	natural gas	oil-products	services	
Gross Domestic Poduct (GDP)	171.3	49.0	35.5	21.8	24.6	25.0	10.6	76.8	10.3	5.4	3.4	54.9	488.6
Final imports	33.5					19.2			96.5				149.1
Intermediary imports	34.4		4.7	7.4	5.1	7.1	3.0	48.4	2.4	0.9	13.1	16.9	143.5
Total demand	239.2	49.0	40.3	29.2	29.7	51.3	13.6	125.2	109.2	6.3	16.5	71.8	781.3
Domestically produces output	205.7	49.0	40.3	29.2	29.7	32.1	13.6	125.2	12.7	6.3	16.5	71.8	632.1
Domestic share (level, in %)[b]	83	100	88	75	83	78	78	61	81	86	21	76	77
GDP contribution (level, in %)[c]	35	10	7	4	5	5	2	16	2	1	1	11	100

[a] Including inventories.

[b] GDP contribution of output category i in percentage of total demand of category i.

[c] GDP contribution of output category i in percentage of total GDP.

When the CPS matrix for 2004 (table 1) and the domestic origin ratios derived from it (table 2) were calculated, use was made of the most recent Input-Output (IO) table for the Dutch economy available at that time. It takes six months for these IO-tables to become available, so that the outcome is based on the IO-table for 2004. This begs the question which ratios are used when the Dutch method is applied to past and future years. Several options are possible.

Table 3.2 Parameters to determine expenditure categories' contributions to GDP growth

Expenditure categories	% domestic share (α_i)	% in dividing residual ($ß_i$)
Private consumption, excluding final imports	83	35
Government consumption		
of which: wage sum	100	0
benefits in kind	88	7
other government consumption	75	5
Investment in residential buildings	83	5
Investment in other fixed assets, excluding final imports	78	5
Investment of government	78	2
Stock building	40	5
Exports		
of which: domestically produced non-energy goods	61	21
re-exports, excluding final imports	81	2
natural gas	86	1
oil products	21	1
services	76	11

The simplest method, which the CPB currently applies, assumes that the ratios based on the most recent IO-tables also apply to the past and the near future. Earlier research suggested that in general these ratios are fairly stable over time.[8] For most years, the error being committed by using fixed ratios is accordingly limited.

This simple approach does not have to be followed in respect of the past, since for former years, too, the CBS has published IO-tables at constant prices. This means that CPS matrices can be calculated at constant prices, thus enabling the GDP volume growth to be precisely attributed to the relevant sales categories. However, as from 1970 onwards, owing to various revisions, the CBS does not have a set of ongoing IO-tables available with uniform definitions and allocations. The production of an exact analysis of the contributions to GDP growth for the past 35 years is, therefore, an extremely labour-intensive exercise which, moreover, empirically provides relatively little added-value compared to calculations based on constant ratios.

[8] See Kranendonk (1998). Only for stock building the ratios concerned are not very stable, because both the level of stock building and the import origin can switch from positive to negative. That is why stockbuilding, rather than being assigned a separate column in the GPS matrix, is combined with the export of domestically produced manufactures.

Alternative methods are also conceivable for forecasting purposes. In periods with relatively large price differences between imported products and products that are produced domestically, import penetration can (temporarily) increase or decrease. Its effect could be approximated using estimated price elasticities. In addition, a high capacity utilisation or a low capacity utilisation could affect the intensity of imports.[9] Owing to the manner in which the CPB uses the Dutch method, notably as a supplement to the forecasts made by means of the SAFFIER macro-model, this is superfluous, however. After all, the economic links referred to are part of the macro-model used, in which explicit account is taken of import penetration and the effects of utilisation ratios in the behavioural model equations for the final and intermediary import components. It should, however, be noted in this context that by so doing, the intermediary imports only take account of the average effect of import penetration and utilisation rate, and that these effects are not allocated to the different expenditure categories.

The deliberate choice of a simple calculation method has the drawback that the ratios in table 1 are not appropriate. Due to the effects of relative prices or otherwise, the marginal ratios could differ in individual years from the average ratios. That would result in an attribution problem, since the sum of the contributions of the distinctive expenditure categories no longer tallies with the total GDP volume growth.[10] The residual is then 'divided' pro rata across the expenditure categories, the weights being broadly equal to the GDP shares.

The parameters the CPB currently uses are shown in table 2. This table indicates the distinctive expenditure categories, which domestic origin ratios are used, and how the residual, if any, is divided in order to arrive at the correct GDP growth.

The formulas used to determine the contributions of the individual expenditure categories to GDP growth are as follows:

(3) $$contr_i^{\,p} = \alpha_i \; demand_i$$

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

[9] This is what is known as the 'home pressure of demand'-effect; when domestic utilisation capacity is high, foreign suppliers will be approached more readily, which will result in extra imports.

[10] In the period 1990-2004, the residual left to be divided had been approximately nil on average, and in absolute terms, except for one year, it had been 0.5 percentage point or less.

where:

$demand_i$ = volume change (Δ) of domestically produced demand category i, in billion euro's

$contr_i^p$ = 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 = domestic share of expenditure category i

β_i = share of expenditure category i in dividing the residual

y = volume change (Δ) of GDP, in billion euro's

Y = Gross Domestic Product (GDP), in billion euro's

4 Results

This paragraph shows what results the aforementioned Dutch method produces, and what the differences are with the international method. Figure 1 reflects the allocation of GDP growth in the years 1999-2004 according to both methods. Only the domestic and foreign contributions are shown. The differences are significant. When the international method is used, the impression is created, for instance, that in 1999 and 2001 the contribution to GDP growth from abroad was negative, whereas according to the Dutch method, exports contributed positively to economic growth. For the year 2000, too, the picture that emerges regarding the background of GDP growth is substantially different. According to the international method, the domestic contribution was considerably higher in those years than the contribution from abroad, whereas according to the Dutch method the opposite is true.

Figure 4.1 Contributions to GDP growth according to the Dutch method and the international method, 1999-2004

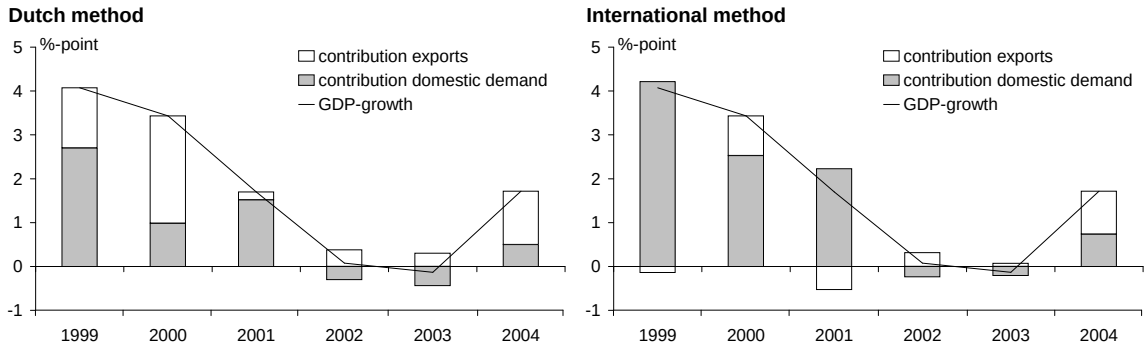
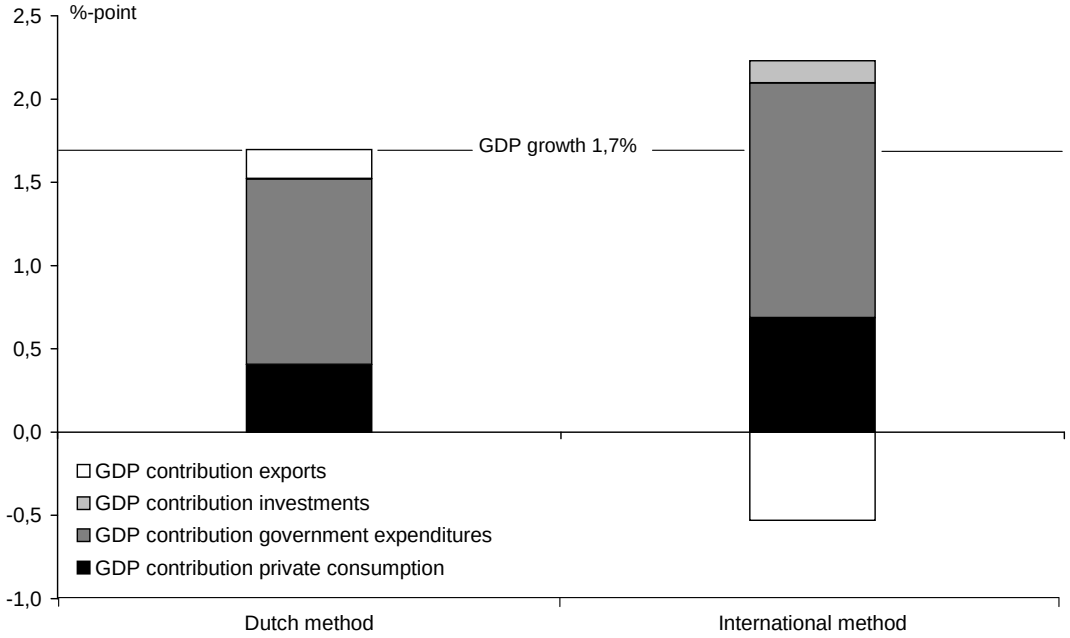


Figure 2 includes a more detailed split of the contributions of the domestic demand components for the year 2001, using both methods to calculate these contributions. Of the contribution of 0.7 percentage points of household consumption to GDP growth according to the international

method, 0.4 percentage point remains if account is taken of the final and intermediary imports required for consumer sales. Government consumption needs much less final and intermediary imports; according to the Dutch method, the contribution of government consumption is 1.1 percentage point, as against 1.4 percentage points according to the international method. The contribution of investments to GDP growth according to the international method (0.1 percentage point) shrinks to zero if the Dutch method is used. As mentioned earlier, by allocating a part of the imports to the domestic expenditure categories, exports in 2001 under the Dutch method result in a positive contribution, whereas according to the international method this contribution is negative.

Figure 4.2 Detailed contributions to GDP growth, 2001



5 Conclusion

To analyse the background or composition of economic growth there are currently two methods in use, which in most cases result in very different outcomes. The customary international method, in which imports are exclusively allocated to exports, results in an understatement of the importance of exports and an overstatement of the importance of domestic expenditure categories.[11] The reason for this is that, for domestic expenditures, too, final and intermediary goods and services are imported. This is why the CPB and DNB use what is known as the

[11] ECB (2005, pp. 55) also concludes that the net export measure gives an understated picture of the impulse from the external sector.

Dutch method, which allocates imports to all sales categories. In principle, this method is suitable for all countries for which an Input-Output table is available. Even if there is no such table, but data are available on the final import of goods and services, a more realistic view of the contributions of expenditure categories to economic growth can be obtained, merely by allocating these final imports of goods and services to the demand categories concerned.

Appendix A: Derivation of the CPS matrix

The purpose of the CPS matrix is to provide a direct link between primary inputs and final demand. More specifically, it is a matrix which indicates how much of each primary input category is needed, both directly and indirectly (through the use of intermediaries), to produce each of the categories of final output.[12]

To derive this CPS 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 categories of primary inputs

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, it contains primary costs which are at the same time 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.

[12] The derivation of the CPS matrix is based on Klein (1983) and Eering c.s. (1988).

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^* 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 tot produce one unit of gross output of industry j. Define the n × f matrix X as $(I - A^*)^{-1}$ F. Each column in X is the vector of total demand (by industry) generated by the corresponding column vector of final demand in F.

Form the p × f matrix CPS' by:

$$\begin{aligned} CPS' &= P^* . X \\ &= P^* (I - A^*)^{-1} . F \end{aligned}$$

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. Remember 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 therefore define the CPS matrix as:

$$\begin{aligned} CPS &= CPS' + W \\ &= P^* (I - A^*)^{-1} . F + W \end{aligned}$$

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 table is then depicted as follows:

	(f)	(1)
(p)	CPS	×
(1)	y'	

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

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