The monthly index of inventories of finished goods for the Dutch manufacturing industry

Marcel van Velzen and Leendert Hoven

Discussion paper (201101)

Statistics Netherlands

The Hague/Heerlen, 2011

Explanation of symbols

.	= data not available
*	= provisional figure
**	= revised provisional figure
x	= publication prohibited (confidential figure)
–	= nil or less than half of unit concerned
–	= (between two figures) inclusive
0 (0,0)	= less than half of unit concerned
blank	= not applicable
2010–2011	= 2010 to 2011 inclusive
2010/2011	= average of 2010 up to and including 2011
2010/'11	= crop year, financial year, school year etc. beginning in 2010 and ending in 2011
2008/'09–2010/'11	= crop year, financial year, etc. 2008/'09 to 2010/'11 inclusive

Due to rounding, some totals may not correspond with the sum of the separate figures.

Publisher
Statistics Netherlands
Henri Faasdreef 312
2492 JP The Hague

Prepress
Statistics Netherlands - Grafimedia

Cover
TelDesign, Rotterdam

Information
Telephone +31 88 570 70 70
Telefax +31 70 337 59 94
Via contact form: www.cbs.nl/information

Where to order
E-mail: verkoop@cbs.nl
Telefax +31 45 570 62 68

Internet
www.cbs.nl

ISSN: 1572-0314

60083201101 X-10

The monthly index of inventories of finished goods for the Dutch manufacturing industry

Marcel van Velzen and Leendert Hoven[1]

Summary:

At the end of 2009, Statistics Netherlands introduced the monthly volume index of inventories of finished goods for the Dutch manufacturing industry. This paper describes the method used in the compilation of the newly developed index and assesses the plausibility of the outcomes. The paper also addresses the potential use of the index in the compilation of production indices.

Keywords: inventories, volume-index, short-term indicator, manufacturing industry, turnover, production index.

1. Introduction

Inventories can be viewed as an important economic indicator that can be used in monitoring and evaluating the path of the economy. Their importance is for example illustrated by the fact that inventories adjustment accounted for nearly half the fall in Gross Domestic Product in the first quarter of 2009 in the USA as businesses reduced their stocks to bring them more in line with lower sales (OECD, 2009). Evidence in other countries also suggests that, in response to lower sales, substantial destocking took place around that time.

Increasing or decreasing inventories of finished goods are an indication of movements in economic trends, especially if related to changes in turnover or production. Increasing inventories can indicate an unexpected decrease in turnover but can also indicate that the level of production is too high. Decreasing inventories can be caused by an unexpected increase in demand or a level of production unable

[1] The authors would like to thank Floris van Ruth and Leon Stroeks for helpful comments and fruitful discussions.

to keep up with demand. However, changes in inventories can be the result of a lack of anticipation to a changing economic situation but equally well be the result of a correct anticipated reaction to an expected economic change. Because changes in inventories can be caused at the demand or the production side (or both), they can not be interpreted by themselves but only in conjunction with other economic variables.

Timely and frequent information on inventories is not only useful as a short-term indicator, but can also be used in the compilation of Quarterly National Accounts and (monthly) production indices. In compiling production indices, production is often approximated by turnover (output sold). To obtain a correct measure of the output of the production process, it would be necessary to correct turnover for changes in inventories. Until recently, Statistics Netherlands did not compile and publish high-frequent (monthly, quarterly) information on inventories, despite its obvious usefulness. In the Quarterly National Accounts, changes in inventories were (and still are) mainly derived by balancing production and expenditure components as a residual item.

The lack of short-term information on inventories prompted Statistics Netherlands to investigate the possibilities of addressing this data gap. As a first result, Statistics Netherlands introduced a monthly volume index of inventories of finished goods for the manufacturing industry at the end of 2009. At the moment, research is carried out with the aim of developing an index of inventories for the wholesale industries.

This paper describes the newly developed volume index of inventories of finished goods for the manufacturing industries. In chapter 2 of this paper, the method used in the compilation of the index is spelled out. In chapter 3, the plausibility of the index is assessed. Chapter 4 addresses the mathematical relation between the index of turnover, the production index and the index of inventories. Chapter 5 concludes.

2. Methodology

2.1 Information collected and sample design

Information on inventories is collected monthly from a sample of businesses in the manufacturing industry. Businesses or industry sectors with no or negligible inventories are excluded from the survey. Cut-off sampling is used to select the businesses concerned: all businesses with 50 or more employees are included. Smaller businesses are totally excluded.

The information collected consists of the balance sheet value of finished products at the end of the month. Products in intermediate stages of completion, manufactured for third parties, are also part of inventories.

Credibility checks are applied to aid validation of the data. The failed validation checks are examined and expert knowledge is used to determine whether the contributor needs to be re-contacted to query the data.[2]

2.2 Index Compilation

It is common practice and according to international recommendations to compile a volume-index using a Laspeyres formula of the general form:

$$I_t = \frac{\sum_{i=1}^{n} p_{i,0} q_{i,t}}{\sum_{i=1}^{n} p_{i,0} q_{i,0}} \qquad (1)$$

where

I_t = the volume index for the month under review t relative to a base period 0.

$p_{i,0}$ = the price of product i in the base period 0.

$q_{i,0}$ = the quantity of product i in the base period 0.

$q_{i,t}$ = = the quantity of product i in the month under review t.

Also in the case of the volume index of inventories the above formula is used as a starting point. Formula (1) can also be written as:

[2] The data until 2010 have been selected for inclusion into the index of inventory by automatic filtering of raw data with plausible filter criteria. No businesses were contacted to validate implausible data values. This is one of the reasons that publication at a lower aggregated level has been postponed.

$$I_t = \sum_{i=1}^{n} w_{i,0} \frac{q_{i,t}}{q_{i,0}}, \tag{2}$$

where

$w_{i,0} = \dfrac{p_{i,0} q_{i,0}}{\sum_{i=1}^{n} p_{i,0} q_{i,0}}$ denotes the share of product *i* in the base period value of output.

It is straightforward to show that the index I_t can also be written as a weighted average over volume indices of subaggregates:

$$I_t = \sum_{i=1}^{m} w_0(B_i) I_t(B_i), \tag{3}$$

where $w_0(B_i)$ denotes the value share of the subaggregate B_i and $I_t(B_i)$ the volume index of the subaggregate B_i. The subaggregates in turn can be composed of weighted averages of lower subaggregates according to formula (3).

Usually the volume index is not calculated according to formula (2) because the necessary information on the quantity of goods is not available. In the inquiry only the value (price times quantity) of the goods in stock is stated. The volume index is then obtained by deflating the value index through the application of an appropriate price index.

By dividing the value index

$$\frac{\sum_{i=1}^{n} p_{i,t} q_{i,t}}{\sum_{i=1}^{n} p_{i,0} q_{i,0}} \tag{4}$$

by a Paasche price index

$$\frac{\sum_{i=1}^{n} p_{i,t} q_{i,t}}{\sum_{i=1}^{n} p_{i,0} q_{i,t}} \tag{5}$$

the Laspeyres volume index (Eq. 1) can also be obtained:

$$I_t = \frac{\frac{\sum_{i=1}^{n} p_{i,t} q_{i,t}}{\sum_{i=1}^{n} p_{i,0} q_{i,0}}}{\frac{\sum_{i=1}^{n} p_{i,t} q_{i,t}}{\sum_{i=1}^{n} p_{i,0} q_{i,t}}} = \frac{\sum_{i=1}^{n} p_{i,0} q_{i,t}}{\sum_{i=1}^{n} p_{i,0} q_{i,0}} \qquad (6)$$

However, the Paasche price index is usually not available at the most detailed level. For the Paasche price index detailed information about price and quantity would be necessary for every month. Therefore, below a certain aggregation level one makes use of the available Laspeyres price indices $\frac{\sum_{i=1}^{n} p_{i,t} q_{i,0}}{\sum_{i=1}^{n} p_{i,0} q_{i,0}}$, as an approximation of the Paasche price index. Because in the case of inventories price information about the goods in stock is also unknown, the producer price index (PPI) is used as an approximation.

In practice, for each 2-digit SIC industry class, a value index of inventories is compiled as a chain index of month-to-month value indices. Each month-to-month value index is based on matched samples, that is, only businesses that have responded in both consecutive periods. Volume indices at the 2-digit level are then compiled by dividing the value indices by the corresponding producer price indices. Thus, it is implicitly assumed that, at the 2-digit level, the composition of inventories equals the composition of production.

The volume indices are then scaled to a value 2005=100. Thus the year 2005 is taken here as the base year, the year in which the average index value is set to 100 percent. The volume indices are then aggregated to obtain the volume index for the total industry (according to formula 3), with weighting coefficients (w_0) given by the value share of the aggregate in the base year. Finally, once every 5 year the base year is revised (2005=100, 2010=100, etc.).

3. Evaluating the plausibility of the index of inventories

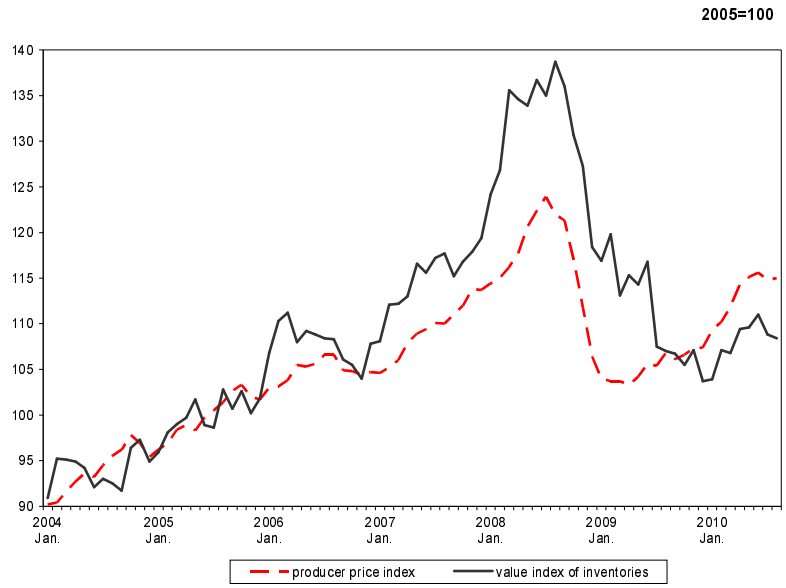
In this chapter, we try to get some idea about the accuracy of the newly developed index. Accuracy refers to the proximity of an estimate to the unknown true value, so it is probably better to speak of plausibility instead of accuracy.

One of the problems encountered in developing a volume index of inventories is that the basic data, that are collected monthly, do not contain any information on the accounting treatment of inventories employed by the respondent businesses. In practice, different systems are in use by which companies value their inventories. Historical cost is used in many accounting systems. This means that inventories will be declared as a mixture of quantities, valued at different historical prices. As the detailed composition of inventories is unknown[3], it is problematic to convert the different goods in the inventories to the same price base. The preferred price base would be equal to current market prices, in order to get inventories on the same price base as turnover. This would, for example, facilitate the use of the information on inventories in the compilation of production indices based on turnover.

As was explained earlier, producer price indices are used to convert the value indices of inventories at the 2-digit SIC level to the same price base, in the absence of price information on inventories. Some justification of this choice may be found in figure 1, which compares the value index of inventories for the manufacturing industry with the corresponding producer price index. Figure 1 shows that there is a strong relation between both indices.

[3] Because of the existing drive to reduce the administrative burden on the private sector, it is not really an option to extend the survey with additional questions on the accounting method and exact composition of inventories.

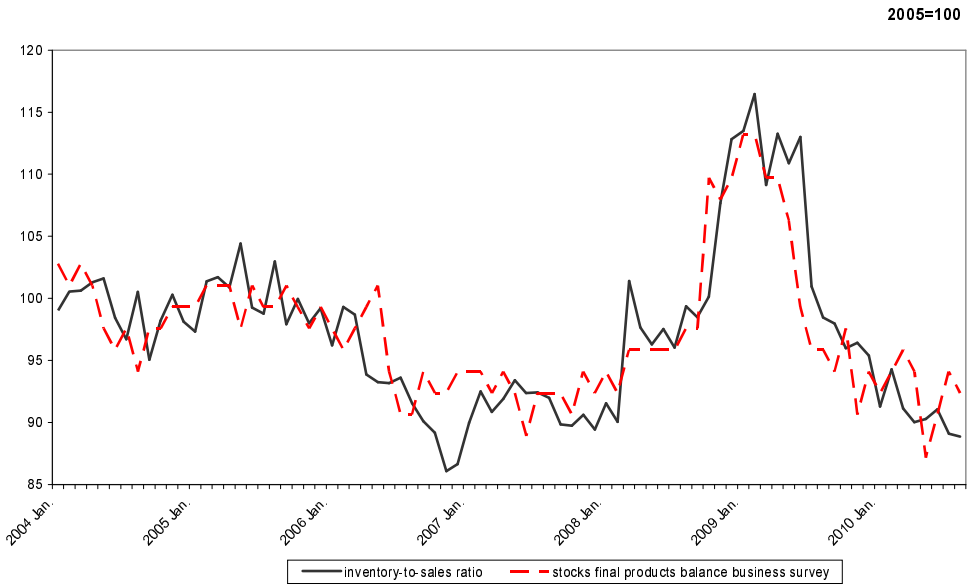
Figure 1. The value index of inventories of finished goods for the Dutch manufacturing industry compared with the Producer Price Index.



Evidence of the plausibility of the inventories index can be obtained by comparing the index with results from the Dutch business survey for the manufacturing industry. In the business survey, manufacturing companies are asked, amongst others, to assess the level of inventories, in view of the anticipated sales. The possible answers are too large, sufficient or too small.

The outcome of this can be compared with the so-called inventory-to-sales ratio. The inventory-to-sales ratio is obtained by dividing the value index of inventories by the index of turnover. A declining inventory-to-sales ratio is usually good news for the economy, since it means that sales are increasing faster than inventories. Businesses respond to meet the increase in sales by speeding up their production rates. A rising inventory-to-sales ratio means that inventories are rising faster than sales and that businesses are becoming overstocked. They respond by cutting production rates. It does not need much imagination to assume that businesses, when judging the level of inventories as too large, sufficient or small, take a close look at their inventory-to-sales ratio. Therefore, one may expect a significant correlation between the two indicators. Figure 2 compares the inventory-to-sales ratio with the stocks final products balance from the business survey, which is compiled as the weighted percentage of manufacturers reporting the stocks final products are too large minus the percentage reporting these stocks are too small. Figure 2 shows that there is indeed a strong correlation. This supports the plausibility of the index of inventories.

Figure 2. The inventory-to-sales ratio compared with the (scaled) stocks final products balance from the business survey.



Additional evidence of the plausibility of the inventories index can be obtained by comparing the outcomes with the outcomes in other countries. Below, the Dutch inventory-to-sales ratio is compared with the ratio for the United States.

In the United States, the inventory-to-sales ratio has been compiled from 1992 onwards by the US Bureau of the Census. Contrary to the Dutch ratio, which is compiled by dividing the inventories index by the index of sales, the US inventory-to-sales ratio is determined directly from the level of inventories and the level of sales. The US ratio shows the relationship of the end-of-month value of inventories to the monthly sales, and can be looked at as an indication of the number of months of inventory that are on hand in relation to the sales for a month.

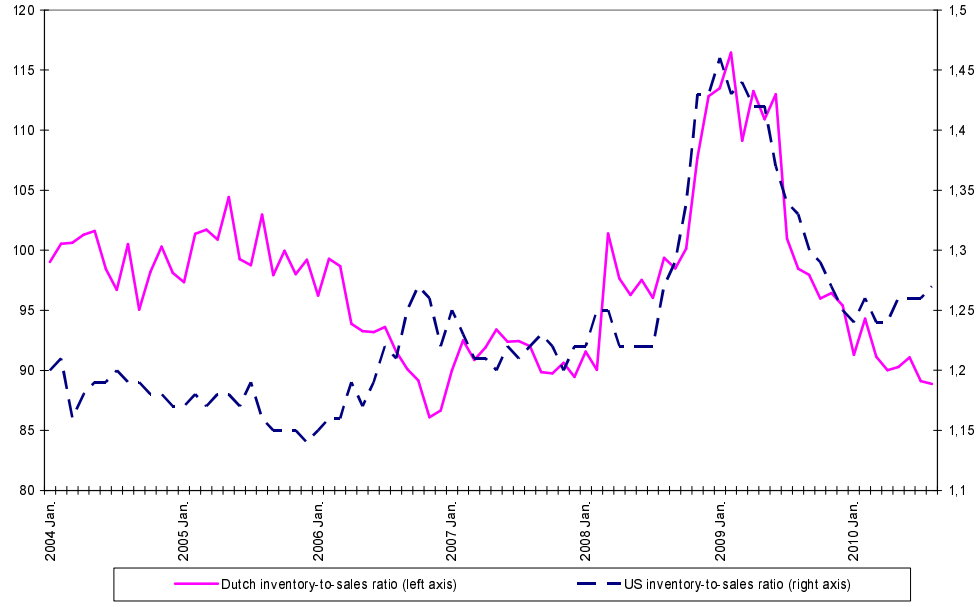
Figure 3 depicts the US inventory-to-sales ratio over a period of 18 years for the manufacturing industry. It shows that the ratio has decreased steadily over time, an indication of the improved control over inventories due to, among other things, developments in information technology. Figure 3 also shows that in the second half of 2008 there has been an unprecedented increase in the inventory-to-sales ratio.

Figure 3. The US manufacturing inventory-to-sales ratio from January 1992 to August 2010.

The US inventory-to-sales ratio pertains to the US economy while the Dutch inventory-to-sales ratio pertains to the Dutch economy, and so the two ratios are not equal. Figure 4 shows the US inventory-to-sales ratio together with the Dutch ratio. Although the ratios of the two countries are not equal, the sudden increase at the end of 2008 is visible in both.

It is quite remarkable that these two indices, compiled independently, have such a similar change over time during the economic slowdown in the latter half of 2008 and early 2009. The resemblance between the two ratios provides additional support to the plausibility of the newly developed index.

Figure 4. The US and Dutch manufacturing inventory-to-sales ratios from January 2004 to August 2010



4. Using information on inventories in compiling production indices

One of the potential uses of statistical information on inventories is correcting turnover in order to arrive at a measure of production. The most obvious way to do so, would be correction on the level of individual companies. As we have stated earlier, inventories are usually valued differently from turnover. Some may argue that, if possibilities to properly convert inventories valued at historical prices into actual market prices are lacking, this precludes their use in correcting turnover. Others may find that, even if the information is not perfect, it would be better to be about right than to be perfectly wrong.

This chapter focuses on the possibilities of using information on turnover and inventories at an aggregated level in the compilation of production indices. The following example will show that, in order to obtain the change in the index of production, is it imperative to combine the change in the index of turnover and the change in the index of inventories according to the correct mathematical relation. In the example in table 1, month-to-month production is decreasing while month-to-month turnover is increasing.

Table 1. Production and turnover in three consecutive months

	number of units produced/sold		
	March	April	May
Production	16	15	14
Turnover	10	11	12

Here production and turnover are measured as the number of units produced or sold, so prices play no role in this example. The month-to-month change of production and turnover in the month of May are:

Change in Production = (14/15-1)*100 = -6.7%

Change in turnover = (12/11-1)*100 = 9.1%

It is tempting to conclude that inventories must have significantly decreased as production has decreased and turnover has increased. As a general rule this is not correct. In Table 2 the figures for inventories and change in inventories have been added, starting with an inventory of 6 units in April.

Table 2. Production, turnover and inventories in three consecutive months

	number of units		
	March	April	May
Inventories (6)	12	16	18
Change in Inventories	6	4	2
Production	16	15	14
Turnover	10	11	12

We see that inventories have increased all the time and changes in inventories have been positive. In the month of May the increase in inventories is

Change in inventories = (18/16-1)*100 = 12.5%

The reason that inventories are increasing, despite decreasing production and increasing sales, is that production is higher than turnover. If production and turnover are more in proximity to each other, this will be less likely to occur. However, in the case of short term economic effects, like month-to-month changes, this is not guaranteed.

More in general one could ask: what is the correct mathematical expression relating turnover and inventories to production. Production (P) relates to turnover (T) and inventories (V) via the formula

$$P_m = T_m + V_m - V_{m-1} \tag{7}$$

where *m* denotes the month for which production is being calculated. Note that production (P_m) denotes the total number of goods produced in the month *m* and turnover (T_m) denotes the total number of goods sold in the month *m*. Both are flow variables. Inventory (V_m), however, is a stock variable, denoting the volume of the inventories at the end of month *m*. In the formula, use has been made of the fact that the level of the inventories at the end of month m-1 is equal to the level at the beginning of the month m. The difference between stock and flow variables is that the number of produced or sold goods at the beginning of the month is still zero while inventories at the beginning of the month usually have a non zero value.

To obtain the production index, production in month *m* is divided by the level of production in the base period P_1

$$\frac{P_m}{P_1} = \frac{T_m + V_m - V_{m-1}}{P_1} \tag{8}$$

This can be rewritten as:

$$\frac{P_m}{P_1} = \frac{T_m + V_m - V_{m-1}}{P_1} = \frac{T_1}{P_1}\frac{T_m}{T_1} + \frac{V_1 - V_0}{P_1}\frac{V_m - V_{m-1}}{V_1 - V_0} \tag{9}$$

Now define the weights

$$w_1 = \frac{T_1}{P_1} \tag{10}$$

$$w_2 = \frac{V_1 - V_0}{P_1} \tag{11}$$

It is clear that the weights add up to one

$$w_1 + w_2 = 1 \tag{12}$$

It is important to note that the weights are independent of month *m* and are therefore constants. To avoid referring to production, the weights can also be written as

$$w_1 = \frac{T_1}{T_1 + V_1 - V_0} \tag{13}$$

$$w_2 = \frac{V_1 - V_0}{T_1 + V_1 - V_0} \tag{14}$$

The index of production (Eq. 8) can now be written as

$$\frac{P_m}{P_1} = w_1\frac{T_m}{T_1} + w_2\frac{V_m - V_{m-1}}{V_1 - V_0} \tag{15}$$

Now define the indices of production (I_P), turnover (I_T) and inventories (I_V)

$$I_{Pm} = \frac{P_m}{P_1} \tag{16}$$

$$I_{Om} = \frac{T_m}{T_1} \tag{17}$$

$$I_{Vm} = \frac{V_m}{V_0} \tag{18}$$

In practice these indices are obtained through chaining. For the production index, for example, the index is written in the following chained form:

$$I_{Pm} = I_{Pm-1} \frac{P_m}{P_{m-1}} \tag{19}$$

and starting value $I_{P1} = 1$. In theory Eq. 8 and 19 are equal, but using the chained form (Eq. 19), complications due to referring over extended periods of time, are avoided by referring only to month-to-month growth. Note that in the special case of inventories the starting value is given by $I_{Vo} = 1$.

Dividing, in Eq. 15, the numerator and the denominator of the last term on the right hand side by V_0, a formula composed only of weights and indices is obtained

$$I_{Pm} = w_1 I_{Tm} + w_2 \frac{I_{Vm} - I_{Vm-1}}{I_{V1} - 1} \tag{20}$$

This is the master equation, relating the index of production to the index of turnover and the indices of inventories. This formula shows that the change of the production index over time is strongly influenced by the initial condition of the index of inventories (I_{V1}). Note that the inventories must change from the zeroth month to the first month ($I_{V1} \neq 1$), otherwise Eq. 20 is not applicable in its present form. The formula also shows that the index of production cannot be determined or even estimated by simply adding the index of inventories and the index of turnover!

It is instructive to apply Eq. 20 to table 2, of the above example. For convenience the table has been depicted again below:

Table 2 (repeated). Production, turnover and inventories in three consecutive months

	number of units		
	March	April	May
Inventories (6)	12	16	18
Change in Inventories	6	4	2
Production	16	15	14
Turnover	10	11	12

The individual indices can be readily obtained from the table

$$I_{T1} = 1,\ I_{T2} = \frac{11}{10},\ I_{T3} = \frac{12}{10} = \frac{6}{5}$$

$$I_{V0} = 1,\ I_{V1} = \frac{12}{6} = 2,\ I_{V2} = \frac{16}{6} = \frac{8}{3},\ I_{V3} = \frac{18}{6} = 3$$

$$I_{P1} = 1,\ I_{P2} = \frac{15}{16},\ I_{P3} = \frac{14}{16} = \frac{7}{8}$$

Note that the index of inventories has a different base year than the other indices ($I_{V0} = 1$).

Eq. 20 tells us that the index of production can also be obtained from the index of turnover and the index of inventories. For the weights (Eq. 13 and 14) one finds

$$w_1 = \frac{T_1}{T_1 + V_1 - V_0} = \frac{10}{16} = \frac{5}{8}$$

$$w_2 = \frac{V_1 - V_0}{T_1 + V_1 - V_0} = \frac{12 - 6}{16} = \frac{3}{8}$$

The weights will not change over time. Eq. 20 now gives

$$I_{P2} = w_1 I_{T2} + w_2 \frac{I_{V2} - I_{V1}}{I_{V1} - 1} = \frac{5}{8} x \frac{11}{10} + \frac{3}{8} x \frac{(\frac{8}{3} - 2)}{2 - 1} = \frac{15}{16}$$

and

$$I_{P3} = w_1 I_{T3} + w_2 \frac{I_{V3} - I_{V2}}{I_{V1} - 1} = \frac{5}{8} x \frac{6}{5} + \frac{3}{8} x \frac{(3 - \frac{8}{3})}{2 - 1} = \frac{7}{8}$$

These values equal the values for the production indices determined directly from the production levels.

From these production indices the month-to-month mutation of production in the third period can be readily obtained

$$\Delta I_{P3} = \frac{I_{P3}}{I_{P2}} - 1 = \frac{7/8}{15/16} - 1 = -\frac{1}{15}$$

which is of course equal to the definition of mutation of production

$$\Delta I_{P3} \equiv \frac{P_3}{P_2} - 1 = \frac{14}{15} - 1 = -\frac{1}{15}$$

It is possible to obtain the index of production from Eq. 12 in practice. However, it is then necessary to determine the levels of inventories very accurately, in two consecutive months, in order to obtain reliable values for the weights and the first non trivial value for the index of inventories (I_{V1}).

5. Conclusion

Inventories are an important economic indicator. Timely and frequent information on inventories is not only useful as a short-term indicator, but is also important in the compilation of Quarterly National Accounts and (monthly) production indices. Statistics Netherlands introduced the monthly volume index of inventories of finished goods for the manufacturing industry in its publication programme at the end of 2009. This paper describes the method used in the compilation of the index of inventories and assesses the plausibility of the outcomes.

One of the problems encountered in compiling volume indices of inventories is, that the exact composition of inventories and their valuation is not known to us. Some methodological short cuts and approximations were therefore necessary. Nevertheless, we have shown that the resulting indices at the level of total manufacturing industry are sufficiently reliable to give useful information. Whether indices at a lower aggregation level will also be published, is still under consideration. Plans for the near future also consist of developing a short-term indicator of inventories for the wholesale industries.

References

OECD, 2009, Economic outlook 85, OECD, Paris.

U.S. Census Bureau, 2010, database, Manufacturing & Trade Inventories & Sales Inventories/Sales Ratio