Inventories and the business cycle

Analysing Dutch Inventories

Nahom Ghebrihiwet

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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.

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Inventories and the business cycle

Analysing Dutch inventories

Nahom Ghebrihiwet[1]

Abstract: Inventories play a crucial role in explaining turning points of the business cycle. This study analyses inventories in the Netherlands and comes to a number of novel conclusions. It is found that turning points of manufacturing and wholesale inventory changes occur at the same time. This indicates that Dutch inventory adjustments are influenced by the same factors. Hence, Dutch inventories are not adjusted autonomously but these adjustments are related to the business cycle. Furthermore, inventory movements in the Netherlands are procyclical and lag the business cycle. However, the Inventory to Sales Ratio (ISR) is countercyclical and consistently leads the business cycle, making it an interesting business cycle indicator.

Keywords: Inventories, Wholesale, Industry, Manufacturing, Inventory to Sales Ratio (ISR).

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[1] Floris van Ruth made the cycles in chapter 4. Roberto Wekker adjusted for seasonal effects in chapter 6. Symon Algera, Leendert Hoven, Henk Koele, Arjan van Loon and Carlo Driesen also contributed in different ways to this article.

1. Introduction

Inventories play a crucial role in explaining business cycle turning points. Inventories contributed 0.7 percentage point to a 4 percent contraction of economic activity in 2009 (European Commission, 2010). In light of this, demand for inventory data has been growing since the financial crisis hit in late 2008. This study discusses wholesale and manufacturing inventories in the Netherlands and relates them to the business cycle. The analysis is based on data from 2005 till 2010.

First, the method applied to develop the inventory statistics will be explained. Afterwards, the results will be analysed by comparing them to relevant indicators:

- Wholesale and manufacturing inventory changes (percentage change compared to the same period in the previous year) will be compared with one another. An important finding is that turning points of both inventory changes occur at the same time. This means inventories do not change autonomously but changes are related to the business cycle.
- Inventory changes are also compared with changes in national income. Based on turning points, inventory changes are procyclical and lag changes in national income.
- By controlling for short- and long-term trends, inventory cycles have been developed. These cycles are compared to the Business Cycle Tracer (BCT) Indicator. The BCT is a tool to determine the state and the course of the Dutch economy. It contains a selection of key macro-economic indicators. The combined positions of these indicators show in which phase of the business cycle the economy is situated. (see, Ruth, van & Wekker; 2005). It is found that the inventory cycles are highly correlated with the BCT Indicator.
- Sales and inventories are related, since sales and inventories combined should equal production. Hence, undeflated inventory changes will be compared with sales changes. It is shown that sales and inventories are strongly linked; both variables follow each other closely. In wholesale this relation is stronger than in manufacturing. However, the inventory-sales relation is not constant over time. In times of economic turbulence

inventory changes lag changes in sales. This can be explained by unexpected sales movements leading to lagged responses in inventories.

- Since sales and inventories are highly linked, the Inventory to Sales Ratio (ISR) will also be analysed. The ISR is equal to inventories divided by sales. It shows the development of inventories relative to the developments of sales. The ISR will be compared to the BCT Indicator. It is found that the ISR consistently leads the BCT Indicator. This means the ISR can be an interesting business cycle indicator.

In the last chapter conclusions from the comparison of the results are presented.

2. Methodology

The results are based on empirical panel data analyses. The datasets used contain wholesale and manufacturing inventory positions from 2005 till 2010. A company's inventory position is only included in the analyses if the inventory position of the previous period is also given. This means for every time period, inventories in period T and period T-1 form a new panel. The growth rate from T-1 to T now allows for comparison over time.

For every section within the wholesale and manufacturing industries, the growth rate between two periods has been defined has:

$$G^{h}_{t,t-1} = \frac{\sum V^{t}_{i}}{\sum V^{t-1}_{i}}$$

With; $G^{h}_{t,t-1} =$ the growth rate of section h between t and t-1 for t=1,..,s;

$V^{t}_{i} =$ the inventory value of company i in time period t. (see, Hoven, L.; 2009)

The index over longer periods of time results from a period-to-period index chain:

$$I_{t}^{h} = G^{h}_{t,t-1} * I^{h}_{t-1}$$

With; $I_{t}^{h} =$ the index of section h in time period t (the fourth quarter of 2004 is set at 100 %).

In order to control seasonal effects, inventory changes have been calculated. The inventory change is the growth rate of the inventory value-index with respect to the same period in the previous year. Furthermore, the inventory value-indices (undeflated indices) are divided by price indices in order to have inventory volume-indices (deflated indices). For the deflated index chains inventory changes have also been calculated.

3. Results

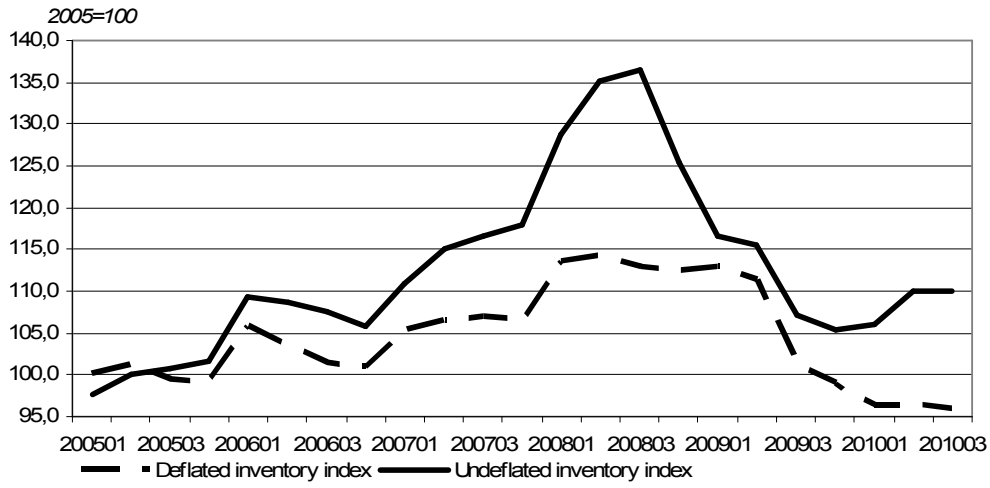
3.1 Index chains

In order to have inventory volumes, the undeflated inventory indices have been deflated (divided by price indices). Figures one and two compare the deflated and undeflated inventory index chains of the manufacturing and wholesale industry respectively. This is done in order to see if there is a significant difference between inventory values and inventory volumes. The difference between the lines indicates the price effect. If the difference between the lines stays constant, then prices are constant. An increasing difference means increasing prices and a decreasing difference means decreasing prices.

Manufacturing

The following figure shows the undeflated and deflated index chains for manufacturing inventories.

Figure 1: Undeflated and deflated manufacturing inventory index chains



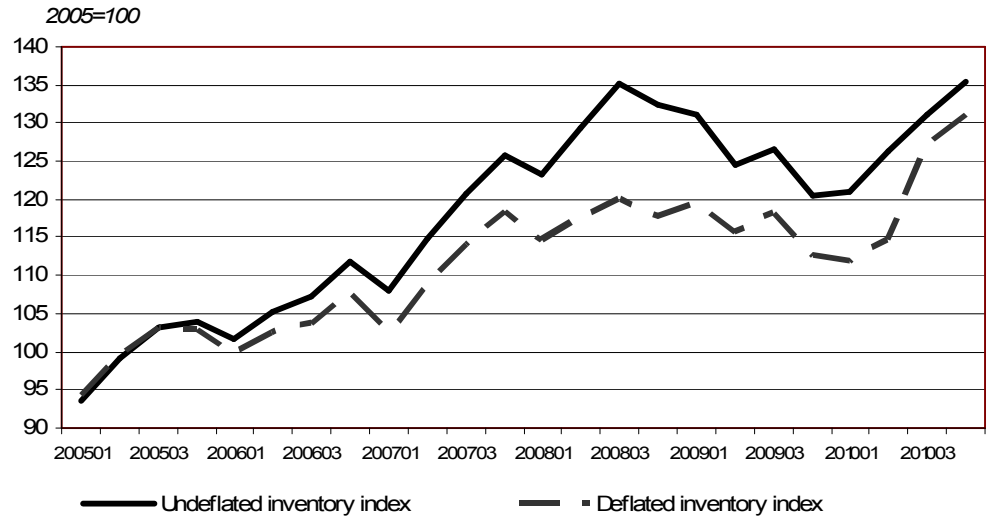
From 2005 till the third quarter of 2008 the undeflated inventory index chain increases sharply. The deflated index chain increases only until the first quarter of 2008 and shows a less strong increase. As a result the difference between manufacturing value and volume inventory index chains increases in this period. This is an indication of rising producer prices.

From 2008Q3 till 2009Q4 the inventory value index chain decreases sharply and an increase follows in 2010. The volume index chain stays almost constant between 2008Q1 till 2009Q2 and decreases sharply afterwards. This resulted in a declining difference between the two lines between 2008Q3 and 2009Q2, indicating declining producer prices, in this period. This is a result of declining demand, during the recent economic crisis. Between 2009Q3 and 2010Q3 the difference between the lines increases again, indicating increasing producer prices.

Wholesale

The same analyses will now be done for the wholesale industry. The following figure shows the undeflated and deflated wholesale index chains.

Figure 2: Undeflated and deflated wholesale inventory index chains



Both lines increase from 2005 till the third quarter of 2008. Then the undeflated inventory index chain starts to decrease sharply. The decrease holds on till the fourth quarter of 2009. The deflated inventory index chain shows only a small decrease in this period. In 2010 both lines increase again.

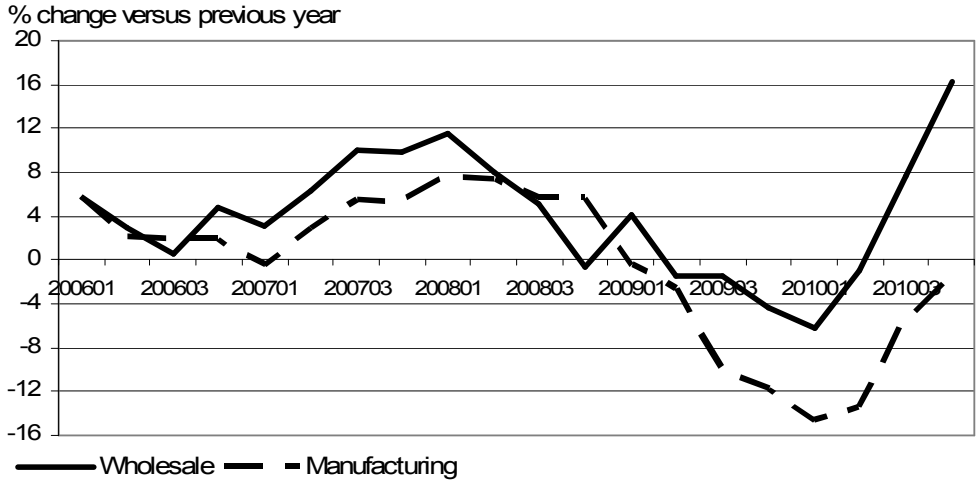
Between 2005Q3 and 2008Q3 the difference between the lines increases. This indicates an increase in producer prices in this period. As mentioned, the inventory value-index starts to decline from 2008Q3 onwards, while the volume-index stays almost constant until 2009Q3. Hence, the difference between the two lines becomes smaller, indicating declining prices between 2008Q3 and 2009Q3. This period again

coincides with the financial crisis which led to declining demand resulting in declining prices.

3.2 Inventory changes

The following figure shows the volume changes of wholesale and manufacturing inventories. This is the percentage change compared to the same period in the previous year.

Figure 3: Inventory volume changes



Overall, both lines show the same movements. From 2006 till 2009 both inventory changes increase, except for a small decrease of manufacturing inventory changes in 2007Q1 and of wholesale inventory changes in 2008Q4. The latter decrease looks like an outlier. Wholesale inventories change from an increase of 5.12 percent in 200Q3 to a decrease of 0.64 percent in 2008Q4 and they increase again in 2009Q1 with 4.11 percent. In the first quarter of 2009 first the manufacturing inventories start to decline with 0.5 percent, one quarter later wholesale inventories follow with a decline of 1.5 percent. Wholesale inventories start to increase again in the third quarter of 2010 while manufacturing inventories still decline in this period. The amplitude of manufacturing inventory changes is larger than the amplitude of wholesale inventory changes. This results from a sharper decline of manufacturing inventory changes in 2009 and 2010. This can be a result of the position within the supply chain of manufacturing and wholesale industries. The manufacturing industry is positioned further up the supply chain compared to the wholesale industry. This may mean that manufacturers are less able to anticipate demand shocks occurring further down the supply chain. This in its turn may result in larger amplitude of

inventory changes for manufacturing firms compared to wholesale firms (see Peels et al. (2009)).

The turning points of both lines occur at the same time. In 2008Q1 the increase in inventory changes starts to decrease. In 2010Q1 the decrease of inventory changes starts to go down. The fact that turning points of both wholesale and manufacturing inventory changes occur at the same time means that inventory changes are not autonomous but related to the business cycle.

3.3 Inventory volume changes and firms inventory contentment

The Business Sentiment Surveys for the manufacturing and wholesale industries give a first indication of the development of the inventory index in the near future. In these surveys, firms are invited to define their current inventories as too large (negative), normal or too small (positive) in relation to projected sales. These results are available two months before data on stocks of finished products.

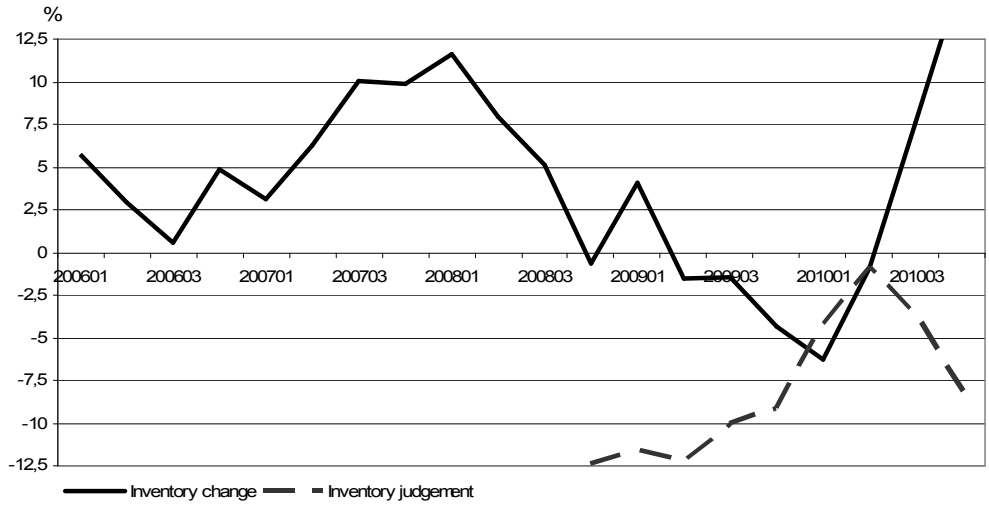
The following figure compares inventory contentment of manufacturing firms with manufacturing inventory changes. Inventory judgement is the percentage of firms judging their inventories as too small minus the percentage of firms judging their inventories as too big. Inventory judgement close to zero indicates satisfied firms.

Figure 4: Manufacturing, inventory volume changes and firm judgement of inventories

Between 2007Q2 and 2008Q4 manufacturing inventory increased compared to the same period a year before. This period coincides with a period in which inventory contentment decreased. Between 2009Q1 and 2010Q4 inventories decreased compared to the same period a year before. In this period manufacturing firms' opinions on their stocks had improved considerably.

The following figure compares inventory satisfaction of wholesale firms with wholesale inventory changes. Wholesale inventory satisfaction is only known for period 2008Q4-2010Q4.

Figure 5: Wholesale, inventory volume changes and firm judgement of inventories



Between 2009Q2 and 2010Q2 wholesale inventory changes decreased. This period coincides with a period in which inventory contentment increased. In 2010Q3 and 2010Q4 inventory changes increased. In this period wholesale firms' positive opinions on their stocks had decreased.

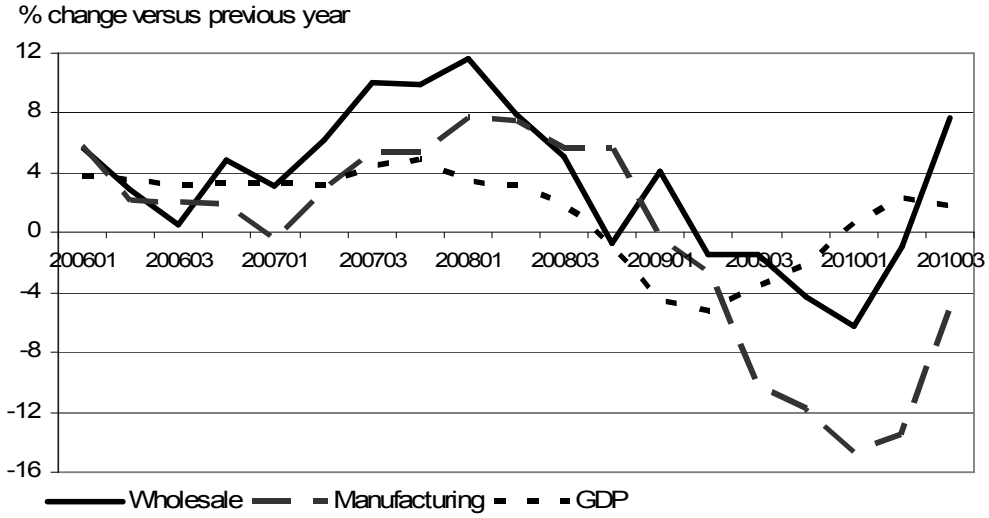
From the above it becomes clear that firms become more pleased with their inventories when the inventories decrease and they become less pleased with their inventories when inventories increase.

4. Inventories and the business cycle

4.1 Inventory and GDP volume changes

This part compares inventory changes with national income changes, in order to see how inventories are related to the economy. The comparison is shown in the following figure for time period 2006Q1-2010Q3.

Figure 6: Inventory and GDP volume changes



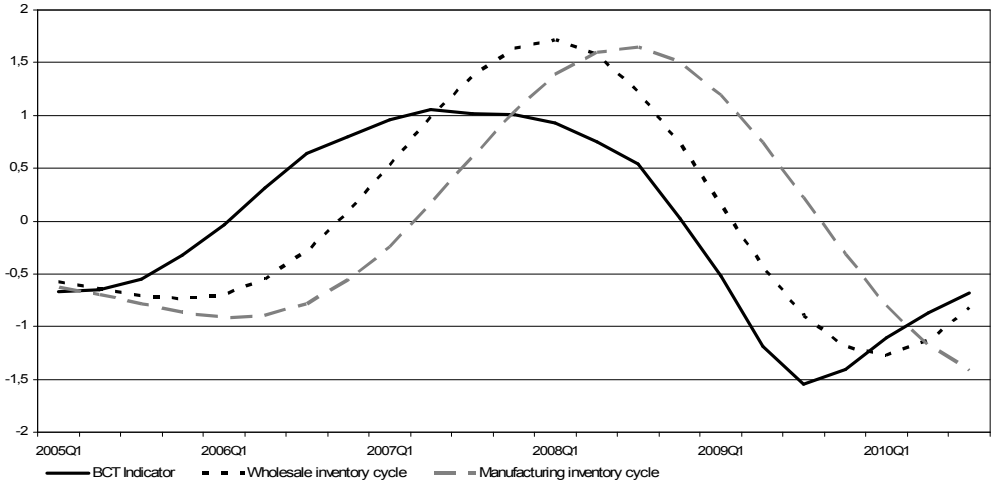
The first turning point in national income occurs in the fourth quarter of 2007. The turning point of inventories follows in the same direction in the first quarter of 2008. The second turning point of national income occurs in the second quarter of 2009. Again inventories follow in the same direction with a turning point in the first quarter of 2010. This means inventory changes are procyclical and lag national income changes. Furthermore, as can be seen from the figure, the amplitude of inventory changes is much stronger than the amplitude of national income changes. This can mean that firms react to short term fluctuations by means of inventory adjustments ("production smoothing").

4.2 Inventory cycles and the Business cycle tracer (BCT) indicator

By means of the Christiano-Fitzgerald band pass filter (3-10 years) the short- and long-term trends in the inventory data are eliminated. This has resulted in inventory cycles. The following figure compares the inventory cycles with the Business Cycle Tracer (BCT) Indicator. The BCT shows the state and the

course of the Dutch economy based on macro-economic indicators. The BCT Indicator is calculated as the unweighted average of the fifteen indicators in the Business Cycle Tracer. It is a summary indicator that enables users to interpret the Tracer quickly and to determine whether a turning point is imminent (see, Ruth, van & Wekker; 2005).

Figure 7: Inventory cycles and the BCT Indicator



The inventory cycles move in the same direction as the BCT indicator. The line indicating the BCT indicator also consistently leads both inventory cycles. The first turning point of the BCT indicator in 2007Q is followed by a turning point of the wholesale inventory cycle in 2008Q1 and of the manufacturing inventory cycle in 2008Q3. The second turning point of the BCT indicator in 2009Q3 is followed by a turning point of the wholesale inventory cycle in 2010Q1 and of the manufacturing cycle in or after 2010Q3. Hence, wholesale and manufacturing Inventories lag the business cycle and manufacturing inventories lag wholesale inventories.

The cycles are related in the following way:

- The wholesale and manufacturing inventory cycles have a correlation of 0.96.
- The wholesale inventory cycle has a correlation of 0.91 with the BCT Indicator, with a lag of one quarter. Based on turning points the inventory cycle lags the BCT Indicator with four quarters.

- The industry inventory cycle has a correlation of 0.84 with the BCT Indicator, with a lag of three quarters. Based on turning points the industry inventory cycle lags the BCT Indicator with more than a year.

Tabel 2: Cycle correlations

Correlation cycles	Manufacturing inventory	Wholesale inventory
BCT Indicator	0,835	0,912
Wholesale inventory	0,963	1

This means the inventory cycles are highly and positively correlated with the BCT Indicator. Hence, both inventory cycles move in the same direction as the BCT Indicator (they move procyclical). Further, both inventory cycles lag the BCT Indicator. This means that economic prosperity is followed by increasing inventories in later periods and economic stagnation is followed by decreasing inventories in later periods.

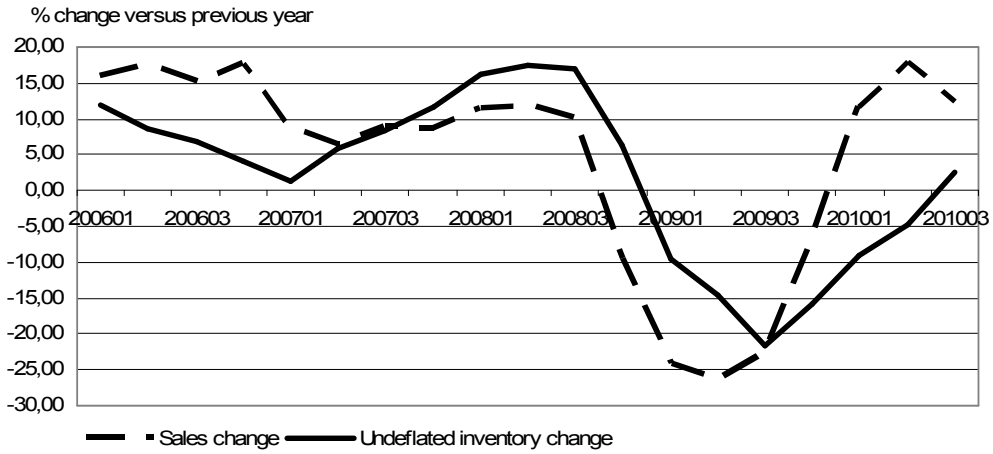
5. Inventory and Sales

This part analyses the relationship between inventories and sales. The part of production that is not sold will become inventory. This means that a close relationship between sales and inventories is expected. Hence, inventory and sales changes (change compared to the same period in the previous year) will be compared with one another. This is done in order to see if the data confirms a close relationship between inventories and sales. Furthermore, this is done in order to see how inventories and sales are related. Do they move simultaneously or does one lag the other?

Manufacturing

The following figure compares manufacturing sales and inventory changes.

Figure 8: Manufacturing, undeflated inventory change and sales change



Between 2006 and the third quarter of 2008 both sales and inventory changes increased compared to the same period in the previous year. In 2008Q3 there is a turning point, increases of both inventory and sales changes moved downward. In 2008Q4 the change in sales started to decrease compared to the same period in the previous year. Then, in 2009Q2 the turning point in sales changes is going upwards. The decrease in sales changes continued for a year, until the fourth quarter of 2009. In 2010 it increased again.

The change in inventories started to decrease from the first quarter of 2009. There is an upwards going turning point at 2009Q3, one quarter later than the turning point in sales changes. The decrease in inventory changes continued until the second quarter of 2010.

Inventory and sales changes follow each other in the same direction and the first turning point of sales and inventory changes occurs at the same time (in 2008Q3). During the period of economic turbulence, in 2009, the turning point of inventory changes lags the turning point of sales changes. This means that the relationship between sales and inventories is not constant but depends on economic circumstances.

Wholesale

The following figure compares sales and inventory changes for the wholesale industry.

Figure 9: Wholesale, undeflated inventory change and sales change

Between 2006 and the third quarter of 2008 both lines follow each other closely. Increases of both inventory and sales changes are almost equal in this period. Then in 2008Q3 both increases start to decline, representing the first turning point in this time period. In the fourth quarter of 2008 the change in sales decreased compared to the same period in the previous year. The change in sales continued to decrease for a

year, until the fourth quarter of 2009. The change in inventory started to decrease in the second quarter of 2009 and continued to decrease until the first quarter of 2010.

Again a close relationship between sales and inventories is confirmed. Between 2006 and the end of 2008, this relationship seems to be stronger in wholesale than in manufacturing. This difference can be a result of the position wholesale and manufacturing firms take within the supply chain. Further up the supply chain (manufacturing) firms might be less capable or willing to let their inventories follow sales changes as closely as firms downstream the supply chain (wholesale), because demand variations are larger further up the supply chain. This is the so called Bullwhip effect (see e.g. Lee, Padmanabhan, and Whang (1997)).

This figure also shows us that in times of economic turbulence (2008-2010) inventory and sales changes follow each other less closely. This again implies that the relationship between sales and inventories is not constant but subject to circumstances. It seems that changes in sales came as a surprise in this period of economic turbulence, resulting in inventory changes lagging changes in sales. This can mean that companies adjust their inventories based on sales expectations. In times of economic downturn sales go down and as a result firms decrease their inventories, expecting a further decline in sales. In periods of economic recovery sales increase and as a reaction firms increase their inventories expecting a further increase in sales.

Since sales and inventories are strongly related, the ratio of inventories to sales will be analysed in the next chapter.

6. Inventory to Sales Ratio (ISR)

The Inventory to Sales Ratio (ISR) is calculated by dividing inventories by sales. It shows the development of inventories relative to the development of sales. This is calculated for the manufacturing and wholesale industries in the Netherlands. First, inventory and sales index chains are adjusted for seasonal effects. Because the yearly inventory and sales levels are known it is possible to go from index chains to level chains. This is done by setting sales and inventories in 2005 (= time period t) at 100 percent. Every quarter the index is multiplied with the level in 2005 and the result is divided by 100. This leads to inventory and sales time series.

$$I^{L}_{t+1} = (I^{x}_{t+1} * I^{L}_{t}) / 100$$

With; I^{L}_{t+1} = the inventory level in time period t+1.

I^{X}_{t+1} = the inventory index in time period t+1.

$$S^{L}_{t+1} = (S^{x}_{t+1} * S^{L}_{t}) / 100$$

With; S^{L}_{t+1} = the inventory level in time period t+1.

S^{X}_{t+1} = the sales index in time period t+1.

By dividing the inventory level by the sales level in the same period, the ISR is calculated:

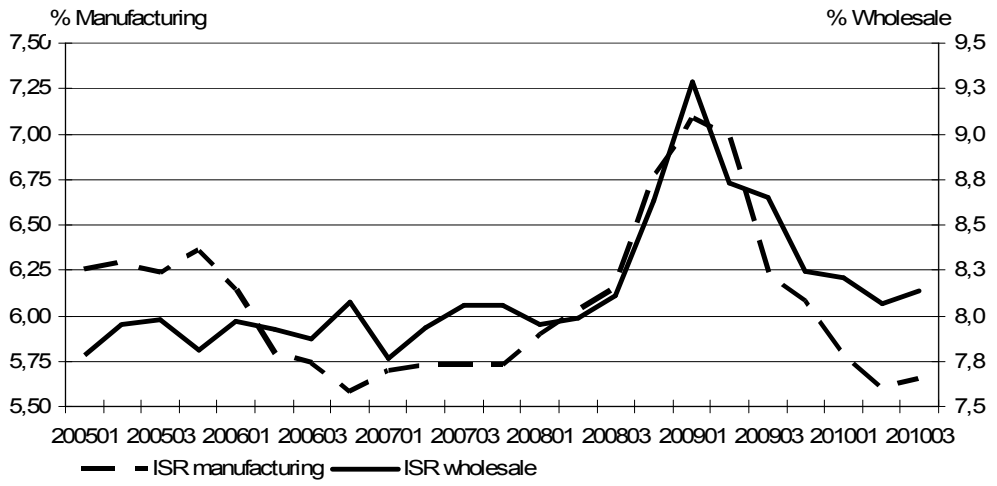
$$ISR_t = \frac{I^{L}_{t}}{S^{L}_{t}}$$

With; ISR_t = the inventory to sales ratio in time period t.

6.1 ISR wholesale and manufacturing

The following figure compares the wholesale and manufacturing ISR's. The left y-axis shows manufacturing inventories as a percentage of manufacturing sales. The right y-axis shows this for wholesale.

Figure 10: Wholesale and manufacturing ISR's



From the above figure it becomes clear that inventories relative to sales are higher in wholesale than in manufacturing. For all years the wholesale ISR exceeds (by about 2%) the manufacturing ISR. Further, the manufacturing ISR seems to be more cyclical. Between 2005 and 2007 the wholesale ISR is on average almost constant, while the manufacturing ISR decreases in this period. The wholesale ISR is almost constant because wholesale inventories and sales follow each other closely in this period (see figure 7). The fact that the manufacturing ISR decreases in this period, means that in the manufacturing industry inventories relative to sales decreases.

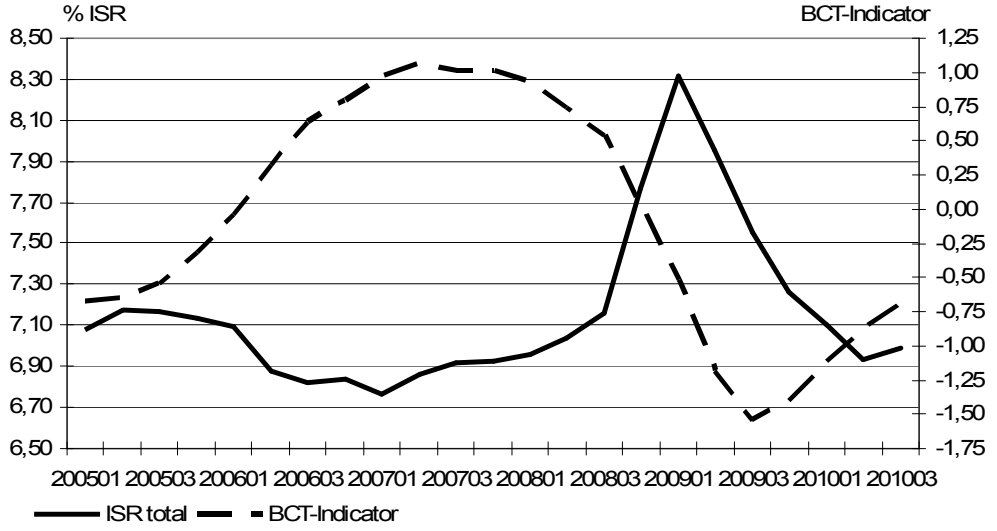
Between 2007 and 2009 both the wholesale and the manufacturing ISR increase with respectively 1.5 percent and 1.4 percent. The fact that in this period there is a larger decrease in sales than in inventories can explain this. This results in an increasing ratio of inventories to sales. Between 2009 and 2010Q2 both the wholesale and manufacturing ISR decrease with respectively 1.2 percent and 1.5 percent. This can be explained by a larger increase in sales than in inventories and by the fact that the sales increase occurs sooner than the increase in inventories (see figure 7). This leads to a decrease of the inventory to sales ratio.

An in-depth article on the Dutch manufacturing ISR by van Ruth and van Velzen is forthcoming (Ruth, van & Velzen, van; Forthcoming)).

6.2 ISR and the BCT Indicator

The following figure compares the total ISR with the BCT Indicator. The total ISR is, wholesale and manufacturing inventories combined divided by wholesale and manufacturing sales combined.

Figure 10: Total ISR and the BCT-indicator

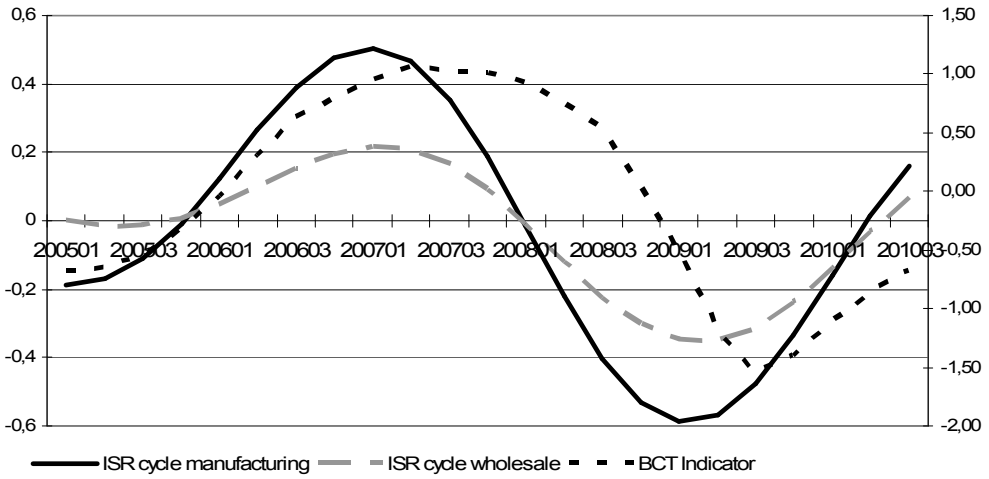


Between 2005 and 2007Q1 the total ISR decreases. The BCT-Indicator increases in this period. From 2007Q1 onwards the ISR increases. This increase continues for two years until 2009Q1. It then decreases until 2010Q2. The BCT-Indicator decreases from 2007Q2 onwards and continues to decrease until 2009Q3. It then increases again until 2010Q3.

This means that when the BCT-Indicator increases the ISR decreases and when the BCT-Indicator decreases the ISR increases. Hence, the ISR moves anti-cyclical. Moreover, the ISR consistently leads the BCT-Indicator. The turning point in 2007Q1 of the ISR is followed by a turning point in 2007Q2 of the BCT-Indicator. The turning point in 2009Q1 of the ISR is followed by a turning point in the BCT-Indicator in 2009Q3. Hence, the total ISR leads the business cycle by 1-2 quarters.

Again through the Christiano-Fitzgerald band pass filter (3-10 years) the long and short term trends are eliminated. This resulted in manufacturing and wholesale ISR-cycles. The following figure compares the inverted cycles with the BCT Indicator.

Figure 12: Inverted wholesale and manufacturing ISR-cycles and the BCT Indicator



Since the ISR cycles are inverted, it is clear that they move countercyclical. Increases in the business cycle go along with decreasing ISR's and decreases in the business cycle go along with increasing ISR's. So, in times of economic prosperity, inventories relative to sales decrease and in times of economic stagnation, inventories relative to sales increase. Furthermore, the ISR cycles both lead the business cycle. The fact that they consistently lead the business cycle means the ISR cycle is an interesting business cycle indicator.

7. Conclusion

In this study, inventories in the Netherlands have been analysed. In particular this study looks at wholesale and manufacturing inventories. Inventories play a crucial role in explaining turning points of the business cycle. Contraction of economic activity in 2009, which was 4 percent, could for 0.7 percentage point be explained by inventory adjustments This has resulted in increasing demand for inventory statistics, since the financial crisis hit in late 2008. This study looks at how inventories in the Netherlands are related to the business cycle. This is done for time period 2005-2010Q3.

From the comparison of wholesale and manufacturing inventory changes (percentage change compared to the same period in the previous year) it becomes clear that turning points of both inventory changes occur at the same time. This means that the same factors influence inventory changes in these industries. Hence, inventory changes do not move autonomously but they are related to the business cycle.

Inventory changes are also compared with national income changes. It is shown that if national income changes increase, inventory changes also increase and if national income changes decrease, inventory changes decrease. This means inventories are procyclical. It is also shown that, based on turning points, inventory changes lag changes in national income. Furthermore, inventory changes have larger amplitude than national income changes. This can mean that firms react to short-term fluctuations by means of inventory adjustments. Based on the Christiano-Fitzgerald band pass filter (3-10 years) the short and long-term trends in the inventory data are eliminated, resulting in inventory cycles. These cycles are compared with the Business Cycle Tracer (BCT) Indicator. The BCT shows the state and the course of the Dutch economy based on macro-economic indicators. The inventory cycles are strongly correlated with the BCT Indicator. Again it is shown that inventories are procyclical and lag the business cycle.

Sales and inventories combined should equal production, so a close relationship between sales and inventories is to be expected. Indeed, comparing wholesale and manufacturing inventories with sales in these industries shows us that inventories

and sales follow each other closely. In wholesale they seem to follow each other more closely than in manufacturing. However, this close relationship is not constant over time. In times of economic turbulence it is shown that inventory changes lag changes in sales. This can be explained by unexpected changes in sales in these periods. This results in firms adjusting their inventories in later periods. This can mean that firms adjust their inventories based on sales changes. If sales increase they will increase their inventories and if sales decrease they will decrease their inventories.

This relationship between sales and inventories makes it interesting to look at the Inventory to Sales Ratio (ISR). The ISR is inventories divided by sales and shows the development of inventories relatively to the development of sales. It is shown that the wholesale ISR is less cyclical than the manufacturing ISR. In the period prior to the financial crisis the wholesale ISR is almost constant on average. This comes from the fact that in this period, inventories and sales follow each other more closely in wholesale than in manufacturing. Further, the wholesale ISR is higher for all periods than the manufacturing ISR. This means that inventories as a percentage of sales are higher in wholesale than in manufacturing.

Also for the ISR's the cycles have been developed in order to eliminate short- and long-term trends and have a look at the cyclical component of the data. Comparing the ISR-cycles to the BCT Indicator shows us that ISR-cycles are countercyclical and consistently lead the business cycle. So, while inventories themselves are procyclical and lag the business cycle, the ISR-cycles are countercyclical and lead the business cycle. This means that in times of economic prosperity inventories relative to sales decrease and in times of economic stagnation inventories relative to sales increase. The fact that the ISR-cycle consistently leads the business cycle makes it an interesting business cycle indicator.

8. Literature

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