Monitoring conditions for consumption, exports and fixed capital formation; the radar concept

Floris van Ruth

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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
2008–2009	= 2008 to 2009 inclusive
2008/2009	= average of 2008 up to and including 2009
2008/'09	= crop year, financial year, school year etc. beginning in 2008 and ending in 2009
2006/'07–2008/'09	= crop year, financial year, etc. 2006/'07 to 2008/'09 inclusive

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

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Monitoring conditions for consumption, exports and fixed capital formation; the radar concept

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Summary: The radar concept is a visual tool for monitoring and analysing conditions for the development of key economic indicators. The emphasis is on business cycle related developments. The aim is to place realisations for selected short-term indicators into context and to show what relevant developments are influencing them. The tool consists of a diagram showing together the development of six carefully selected indicators, and characterising these as above or below average. The indicators represent important driving factors for the key economic variables targeted. The overall picture of the radar tool shows whether general conditions are favourable or unfavourable for the development of these key indicators. In this study, radar tools for analysing the development of household consumption, exports and fixed capital formation are presented. The radar concept allows for a easily interpreted, robust characterisation of economic conditions, while also presenting cross-relationships between key economic indicators. Quantitative tests show conditions to be very significant in explaining the development of exports, consumption and fixed capital formation.

Keywords: short-term economic indicators, business cycle analysis, data visualisations, time series models

1. Introduction

Short-term economic developments can often be confusing. Some indicators go up, others go down, or maybe go down a little less than last month etc. The huge number of economic statistics on offer does not help either. Context and structuring are essential to make sense of economic statistics and what they mean for current economic conditions. The Statistics Netherlands radar concept was developed with these aims in mind. It takes the form of an interactive visualisation, presenting the data not in a table, but via a graphic web application. The radar concept thus makes statistical information better accessible in two ways; by structuring the data and by presenting the data in an easier to interpret format.

The radars presented in this paper monitor conditions for exports, consumption and fixed capital formation, reflecting the main components of the demand side of the economy. Monitoring conditions means illuminating developments in driving factors for consumption, exports and fixed capital formation growth. Realisations of these key macro-economic quantities are placed into context by showing how certain fundamentals are developing, showing which factors are driving developments and indicating whether current realisations are sustainable. Each driving factor is represented by one or more indicators. The concept has the useful additional characteristic of showcasing cross-relationships between economic indicators, thus communicating information on structures in the economy. It of course also shows via the selected indicators what can be the driving factors for certain key macro-economic developments.

But probably the most useful property of the radar concept is the selection and structuring of the huge supply of short-term economic indicators. The radar-diagram shows, in a coherent fashion, how each indicator is developing. This allows for an analysis of the individual indicators, but also presents an overall picture of general conditions for the key variable concerned. The main differences between the radar concept and other types of economic indicator sets are the focus on driving factors and the tight coherence required with the central indicator. The visual presentation in a diagram with dynamic and interactive options also allows for easy and quick interpretation. The aim of the radar concept is explicitly not to predict or model the development of the key indicators. It is a tool for background analysis, focussed on current developments. The idea is to structure the analysis of short-term economic developments, and make these as objective as possible.

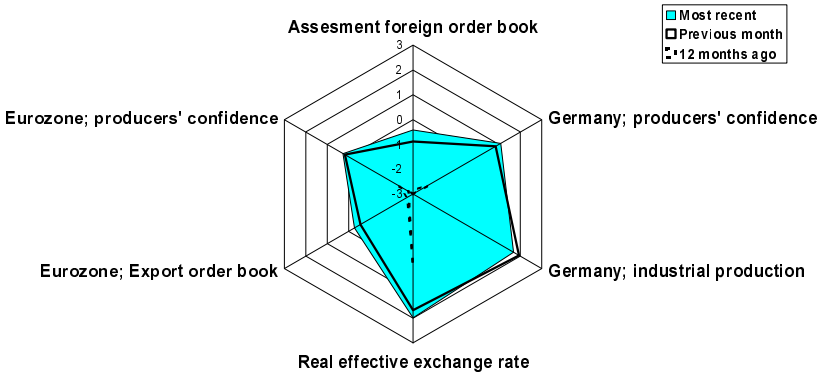
Crucial to the functioning of this analysis tool is of course the selection of the indicators. A careful development strategy was followed, which is fully described in earlier papers [Van Ruth (2008a, 2008b, 2008c)]. A short description can be found in section 3. This paper provides an update, presenting the radars as Statistics Netherlands is actually publishing or planning to publish. The main difference is that the radars consist of 6 indicators, in stead of 8 or 9 as was the case in the original studies. This change was adopted mainly out of visual considerations, i.e. it is easier to read a six-indicator diagram than an eight-indicator one. Therefore, this paper will present a summary of the relevant results only for the final selected indicators and indicator sets.

The paper starts with a general description of the radar concept, including a presentation of the three different radars. In the next section a short, general description of the methodology used in the development of the radars is given, together with a description of the method used in the actual production. The next three sections contain a more detailed description of each radar, consisting of a presentation of the properties of the individual indicators, and an analysis of how well the conditions derived from the radars reflect development of the three target indicators. The final section does this somewhat more rigorously by using model based approaches to test whether the conditions derived from the radars are significant in explaining and predicting the development of exports, consumption and fixed capital formation.

2. The radar concept

In this section, the radars themselves will be presented and the concept will be further explained. The first radar to be published by Statistics Netherlands was the Exports radar (see http://www.cbs.nl/en-GB/menu/themas/dossiers/conjunctuur/cijfers/kerncijfers/exportradar.htm). In the diagram, the indicators are shown individually, but they are presented as a whole. Thus the overall picture reflects general conditions for exports, whilst the disaggregated presentation allows the user to see how much each aspect/indicator contributes, or not, to the overall situation. As a rule, the indicators are entered in the form of year-on-year growth rates, with the exception of sentiment indicators which are entered as levels. All indicators are standardised, which means that a value of 0 means average development, a positive value means above average development and a negative one below average development. The focus is thus very clearly on the dynamics. An improvement in conditions does not indicate that growth is probable, but that an *increase* in the growth *rate* is probable. The radar tool only really becomes useful if it is possible to compare today's position with past ones, as shown in graph 2.1. One can than see whether conditions have become more or less favourable for Dutch exports. As graph 2.1 shows, in June 2010 conditions did improve dramatically compared to June 2009.

Graph 2.1; The Export Radar of June 2010

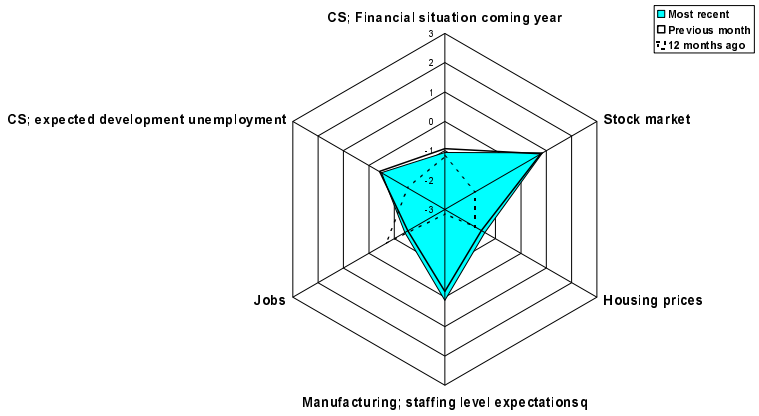


Four of the six indicators in the export radar reflect developments in the major markets for Dutch exports; Germany and the other countries in the Eurozone. For Germany, developments in production and confidence in the manufacturing industry proved to be especially relevant. This is logical, as a large part of Dutch exports

consist of inputs for the German industry. The same goes for the Eurozone as a whole, where the export order book and producers' confidence in the manufacturing industry are strong drivers for Dutch exports growth. The producers' confidence indicator reflects more current developments, while the export order book has a forward-looking character. Next to these four important other indicators are the development in the real effective exchange rate and in the assessment of the foreign order book of the manufacturing. These can be interpreted as broadly reflecting developments in competitiveness of Dutch exports.

The indicator set reflecting conditions for household consumption in the Netherlands is somewhat more complex, see graph 2.2. This is due to the fact that consumption development is determined both by the willingness to consume and how much people have to spend. The first factor is connected to job security and income expectations, whilst the second aspect is determined by the number of people working and wage developments.

Graph 2.2; The Consumption Radar of June 2010

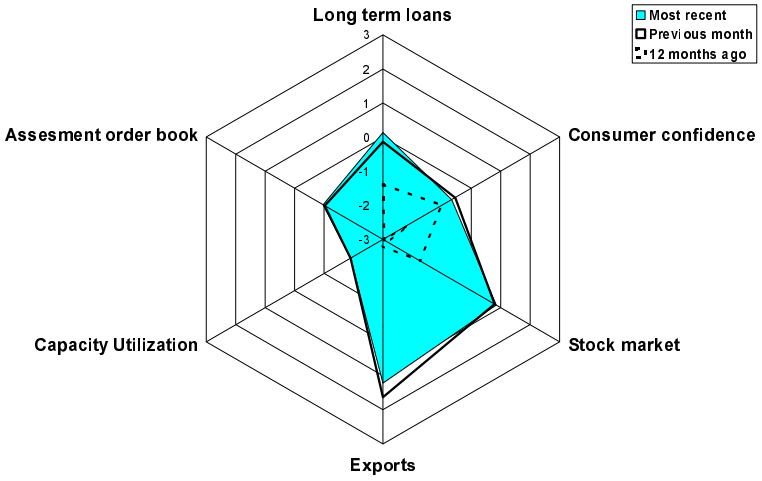


Jobs are a key factor, both actual jobs, employers' staffing level expectations and consumers' expectations of developments on the labour market. The expected financial situation, development of house prices and the stock market reflect (expected) income and wealth effects on consumption growth. So with only six indicators, the Consumption radar is able to give a quite diverse but also complete picture of factors influencing consumption development. A lot of relevant information in one diagram. And again, conditions have improved since June 2009, though not as much as for exports. In June 2010, most indicators were still exhibiting below average development.

Conditions for fixed capital formation are analysed by considering how attractive it is to invest in new fixed capital, the availability of finance and the need to invest. The need to invest is reflected in the rate of capacity utilization in the manufacturing industry. It also reflects attractiveness of investment; a high capacity utilization indicates a high probability of a good return on investment. The assessment of the

order book, consumer confidence and exports are also connected to the attractiveness of new investment. Consumer confidence, which reflects consumption growth, and export growth represent the development of demand for goods and services. Higher demand growth means that new investment is more likely to quickly yield good returns. The availability of long term loans and stock market developments represent the financial side. Investment has to be financed either by debt or by retained earnings. There are no good short-term data on private sector profits, but stock market developments should have a strong link with earnings growth.

Graph 2.3; The Fixed capital formation Radar of June 2010



The Radar for Fixed Capital formation of June 2010 is a good example of how the tool can be useful. As for the other June radars, conditions have improved markedly since June 2009. But the improvement has been rather unevenly distributed. Especially the stock market and exports have improved strongly, but for example capacity utilization and consumer confidence much less so. This indicates that the improvement of conditions is not broadly supported, which means that it can be expected that the improvement in the rate of fixed capital formation will be limited. The radar also shows that external developments are much more supportive than domestic ones. This is an example of how this tool can be used to perform a relative subtle analysis in a structured and objective manner.

3. Methodology

Development

After choosing a key economic phenomenon or indicator to be monitored, the first step in the development process was to identify the fundamental driving factors. These are underlying fundamentals which help *explain* why the target indicator is developing in a certain way. Identifying these driving factors is partly based on economic theory, partly on experience and empirical results. During the remainder of the development process, it is essential to keep an eye on whether these driving factors are still be represented by the indicators selected.

The development stage can be largely characterised as a selection or pruning process. After the driving factors had been identified, a gross list of potential indicators representing one of the factors was composed. The target indicators were in the form of relative year-on-year (volume) growth rates, and therefore the candidate indicators had to be transformed to be compatible with that. After that, the cross-correlation spectrum of each candidate indicator and the target indicator was computed. Indicators with low correlations were eliminated, and also those exhibiting long lags compared to the development of the target indicator. Some clarification probably is in order here. The aim is to find "related" indicators which can explain developments in the target indicator. They therefore need to have a strong link with the target indicator. The explanatory power was subjected to a number of statistical tests. A high correlation is the first. The explanatory indicator also cannot lag the target indicator, but high correlation indicators with a relatively small lag were retained at this stage. This was done because explanatory power is defined here using a variant of Granger causality.

In the next stage of the development process the candidate indicators were entered one by one in an ARMA model for the target indicator. It was tested whether the indicators were significant, and whether their presence improved the out-of-sample forecast performance compared to the benchmark univariate ARMA model. This does not mean that the indicators were selected for their predictive powers, or that the radar concept is a forecasting tool, as will become apparent further on in this paper. The forecasting exercise was just a method for testing the explanatory power of the candidate indicators. Indicators which were not significant, or possessed coefficients with the wrong sign, were eliminated. This resulted in a further pared down set of potential indicators.

In the final phase of the development process, the emphasis moves from testing individual indicators to testing potential sets of indicators. There were two criteria on which the potential indicator sets were scored; the coherence of the set of a whole with the target indicator and whether all driving factors previously identified were

adequately represented by the indicators in the set. The coherence with the target indicators was tested by computing the correlation of the target indicator with both the simple average of the indicators in the set and with the first principal component of the indicator set. Performing factor analysis also allows one to analyse the internal structure of the indicator set, whether there are indicators present which exhibited very different behaviour from the other members of the set. This was potentially undesirable, as all indicators are supposed to be linked to the development of the target indicator. A set with a higher correlation was of course preferred, and the aim was that the indicator set as a whole was more or less coincident with the target indicator. The final selection criterion was that smooth indicators which are available timely and at a monthly frequency were to be preferred. These yield a more stable and current picture. Based on these ground, the final indicator sets were selected. So the final stage of the selection was performed using a mix of quantitative and qualitative criteria.

Production

Monthly production of the radar tool is rather straightforward. The individual indicators are transformed to the required form, usually relative year-on-year growth rates, though sentiment indicators are entered as levels. Seasonal correction is performed if necessary. Next, all indicators are normalised:

$$X_t^N = \frac{X_t - \mu_t^x}{\sigma_t^x}$$

X^N_t = normalised X_t

X_t = realisation of indicator X at time t

μ^X_t = mean up to time t of indicator X

σ^X_t = standard deviation up to time t of indicator X

The indicators are normalised to ensure that all indicators have the same amplitude in the diagram. Also, this means that the zero line now acts as dividing line between below and above average development. For X_t the mean and standard deviation are computed using only the realisations of X up to time t. Thus, later realisations do not influence the characterisation of X at time t, and the historical record in the radar tool remains fixed. All radar indicators are entered without weights or coefficients, and as they become available at time t, without any correction for leads or lags. This is by design, as the radar tool is meant for background analysis. It is explicitly not the aim to model or predict the target indicator.

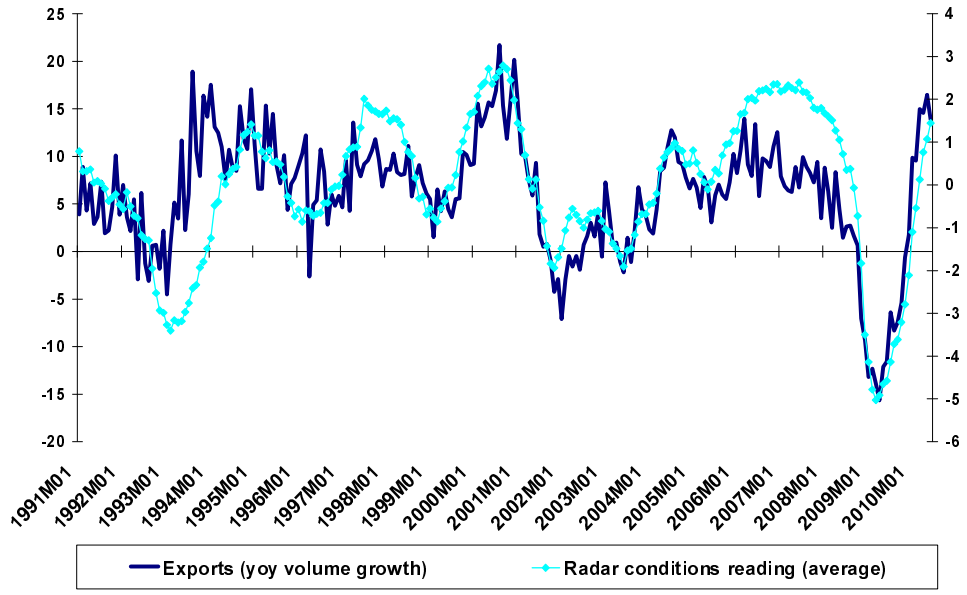
4. Detailed description and properties of the radars

In this section, the construction and performance of the exports, consumption and fixed capital formation radars will be described in some more detail. As the aim of the radar concept is to monitor how conditions evolve for the corresponding target indicator, the reading of the radar should on average reflect the development of this target indicator. A perfect fit is not required or even desirable, as the link between conditions and actual development need not be direct or absolute. In fact, conditions should evolve more smoothly and slowly than actual realisations. It is stressed again that the radars are not meant to be leading or predictive, they are analysis tools. The characterisation of indicators as leading or lagging and by their forecasting performance is used as a way to establish causation. To assess the overall performance of a radar, it is necessary to find a way to derive the reading of the radar at a certain point in time. Two methods are used here: taking the simple average of the normalised indicators and using factor analysis to derive the common component of the indicator set. It is posed here that, as all the disparate indicators are connected to the target indicator, the common component of the indicator set should be linked to the target indicator. The first principal component is taken to be that common component. In addition to this evaluation of the performance of the indicator sets, the outcomes of the tests performed to ascertain the link of the individual indicators will be reported. In the original research [Van Ruth (2006a, b, c)] a more elaborate description can be found, including the results for the potential indicators dropped during the selection process. Here, only the results for the six indicators selected for each radar will be reported.

4.1 The export radar

The correspondence between the readings of the export-radar and the development of exports, as represented by the year-on-year growth rate in the volume of exported goods, is extremely good. This goes both for the short term and over somewhat longer periods. The alternating periods of high and low export growth are matched quite well by periods of favourable and unfavourable conditions, see graph 4.1. Correlation between the two series is 0.707 at lag 0 and 0.726 at +1 month for the radar. Thus, overall the development of conditions indicated by the radar is on average coincident with export development. If one considers the overall resemblance and the good match between the turning points in both series, the correlation might even seem somewhat low. But this is mainly due to the conditions series developing more smoothly that actual exports growth, as expected and desired.

Graph 4.1; Export radar readings compared to growth rate of volume of exported goods. Export radar characterised by simple average of normalised indicators.



The results from the factor analysis show that the common component of the export radar indicator set is strong. The percentage of variance explained by the first principal component is at 68% quite high.

Table 4.1; Results of factor analysis by principal component analysis of export radar indicator set. Factor loadings on first principal component, percentage of variance explained by 1st principal component: 68%.

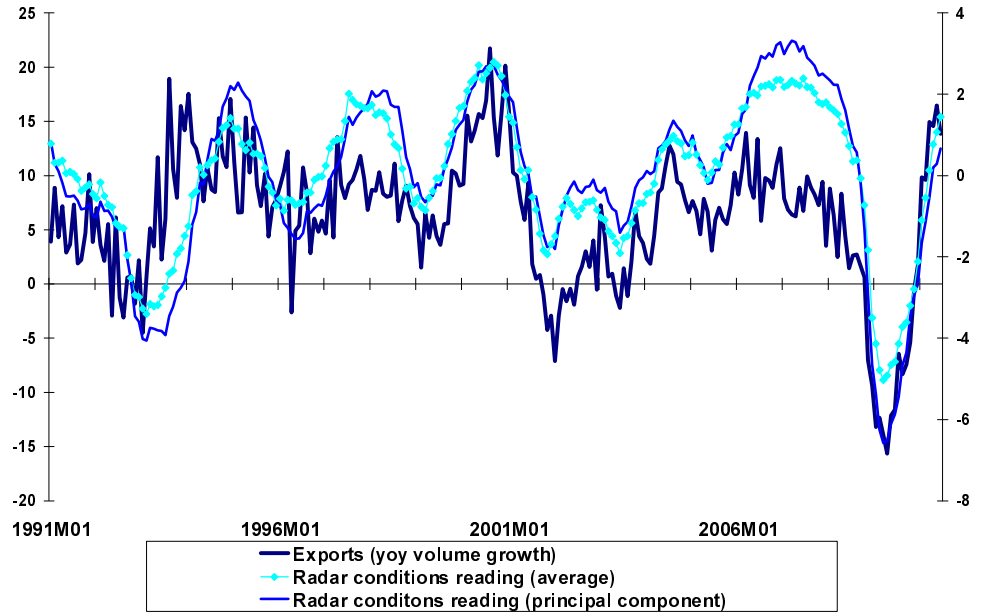
	Factor loading	*extraction*
Germany, Producers' confidence manufacturing	0.949	0.900
Germany, Production manufacturing industry	0.918	0.843
Euro zone, Export order book manufacturing	0.685	0.469
Euro zone, Producers' confidence manufacturing	0.952	0.907
Real effective exchange rate	-0.197	0.039
Assessment export order book	0.971	0.944

Most indicators have high factor loadings on the first principal component, indicating a strong link. The only exception is the real effective exchange rate, which has a rather low and negative loading. The negative sign is expected, it means that a rising real effective exchange rate is unfavourable for exports. The low factor loading means that it develops somewhat differently from the other indicators in the set, which all have high communality with the first principal component.

This divergent behaviour is actually not a problem, and it is worthwhile to pay some attention to why this is so. It is highly unlikely that all different dimensions of conditions will develop in the same way all the time. In fact, this is the reason why there is a need to identify underlying driving factors, and why the aim was to construct a diverse indicator set. Not all the factors and indicators have to be relevant all the time, at different moments different developments will determine the course of exports, consumption and fixed capital formation. Therefore, diverse behaviour of the indicators is desirable, as it minimises the risk that an important development is missed. Just as long as the radar remains overall representative for the target indicator.

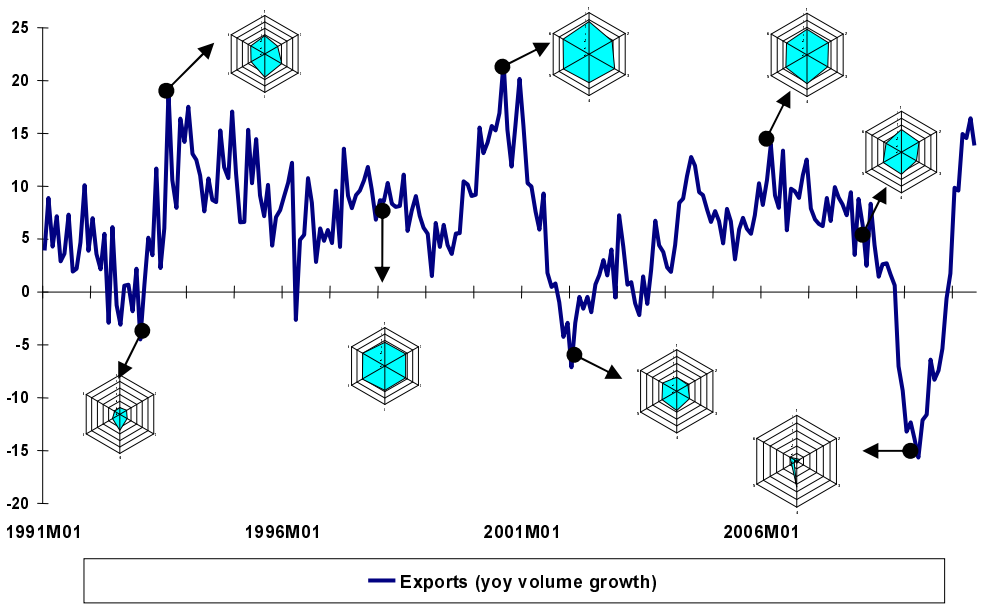
The first principal component of the export radar indicator set actually develops in quite a similar fashion to the simple average of the indicator set, see graph 4.2. Correlations are also quite comparable, 0.650 at lag 0 and maximum correlation of 0.680 at lag +2 for the radar.

Graph 4.2; Export radar readings compared to growth rate of volume of exported goods. Export radar characterised by both simple average and first principal component of normalised indicators.



To see how this would work in practice, graph 4.3 shows a number of selected export radar readings next to the development in time of exports growth. It shows how periods of low export growth are accompanied by export radar reading very near the centre of the diagram, indicating overall unfavourable conditions. As exports growth improves, so do the measured conditions as can be seen from the increasing area of the export radar diagram.

Graph 4.3; Actual readings of the Export radar compared to growth rate of the volume of exported goods at the corresponding points in time.



The identified driving factors of exports are rather straightforward:

- **Competitiveness**
- **Developments in major export markets**

The major export markets for Dutch exports are Germany with 24% of goods by value going there, whilst the Euro zone overall is good for 60% and the EU for 75% of total exports. It was found that the indicators for the Euro zone have a stronger link to Dutch export development than those of the EU as a whole. The link between the individual indicators of the export radar and export growth was tested using a number of quantitative criteria, the results of which are summarised in table 4.2.

Table 4.2; Outcomes of quantitative tests of the strength of the link between export growth (year-on-year growth rate of volume) and the individual indicators in the export radar.

	Germany, Producers' confidence manufacturing [#]	*Germany Production manufacturing industry* [§]	*Euro zone Export order book manufacturing* [#]	*Euro zone Producers' confidence manufacturing* [§]	*Real effective exchange rate* [§]	*Assessment export order book* [#]
ρ (lag 0)	0.323	0.881	0.394	0.398	-0.171	0.454
ρ max (lag)[‡]	0.400 (+1)	idem	0.439 (+3)	0.435 (+1)	-0.205 (-8)	0.455 (+1)
R^2 (ARMAX)	0.820	0.848	0.831	0.827	0.818	0.821
AIC	4.86	4.72	4.82	4.84	4.90	4.88
Forecast rmse	2.55	2.25	2.33	2.35	2.74	2.59
Coefficient (sig)	0.24 (0.0001)	0.69 (0.0000)	0.26 (0.0000)	0.384 (0.000)	-0.288 (0.0886)	0.11 (0.0089)
Lag in model[‡]	0	0	0	0	-9	0
Granger causality test[† †]	0.083	0.002	0.092	0.17	0.032	0.04
Series from	1991m1	1991m1	1991m1	1991m1	1991m1	1991m1

[#] = level (balance), [§] = relative year-on-year growth rate, [†] = indicator does not granger cause exports (12 lags), [‡] lags in months (+ means indicator is lagging, - means leading)

Benchmark model: exports = c ar(1) ar(3) ar(4) ma(1) ma(2) ma(12) ma(13)

R^2 = 0.815, AIC = 4.90, RMSE forecast = 2.81%-points

Q-stat 0.039 (12 lags), Jarque-Bera 2.509 (0.285), LM test 0.072 (3 lags)

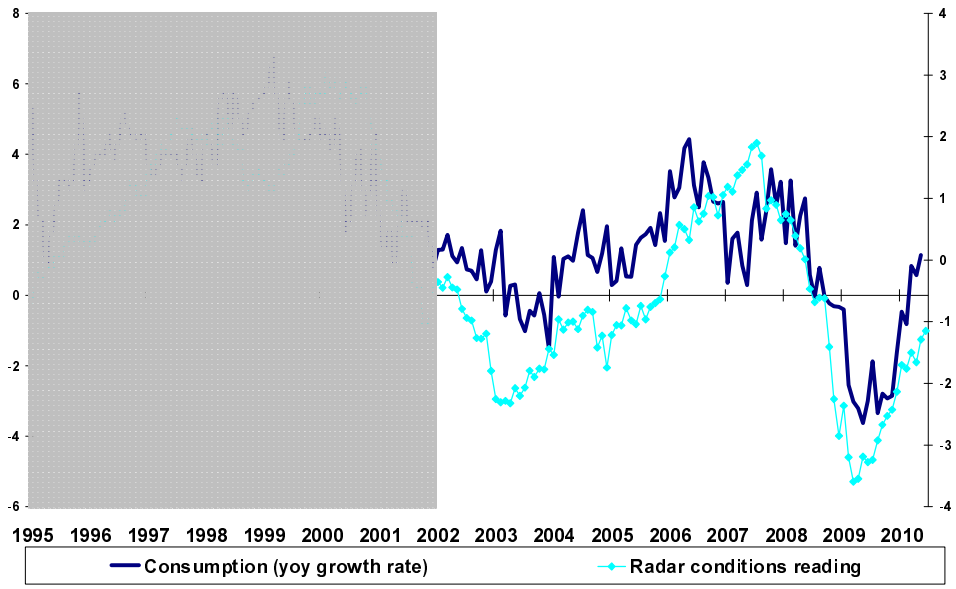
The eventual selection was based on assessing the performance on all criteria, including the link with the driving factors and the overall performance of different combinations of potential indicators. Most important for the individual tests were performance in the ARMAX model, i.e. correct sign of the coefficient, significance, enhancement of forecasting ability. Also, indicators should not be lagging too much according to the correlation spectrum, and not at all in the ARMAX-models.

Two indicators were dropped from the original export radar indicator set. As mentioned before, this was done because a diagram consisting of six indicators is easier to read. It was also found that these dropped indicators did not add much information. Dropped were: manufacturing production in the Euro zone, which contains much the same information as producers' confidence in manufacturing. Also dropped was the difference in HICP development between the Netherlands and Germany. This develops quite similarly to the real exchange rate.

4.2 The consumption radar

The consumption radar has on average a very high correlation with consumption growth, 0.829 at lag 0, maximum correlation of 0.836 at lag +1. Thus conditions for consumption development as measured by the consumption radar seem to be quite relevant. Again, as desired, radar conditions develop more smoothly than actual consumption growth, see graph 4.4. The match with consumption growth is not absolute, see for example the period 2006-2007 when a dip in consumption growth is not reflected in more unfavourable conditions. Again, this is not a problem as conditions are meant to give a somewhat more long-term picture, and the relatively favourable assessment of conditions in that period is vindicated by the speedy pick up in consumption growth in 2007.

Graph 4.4; Consumption radar readings compared to growth rate of volume of household consumption. Consumption radar characterised by simple average of normalised indicators, shaded area indicates period for which the indicator set is incomplete.



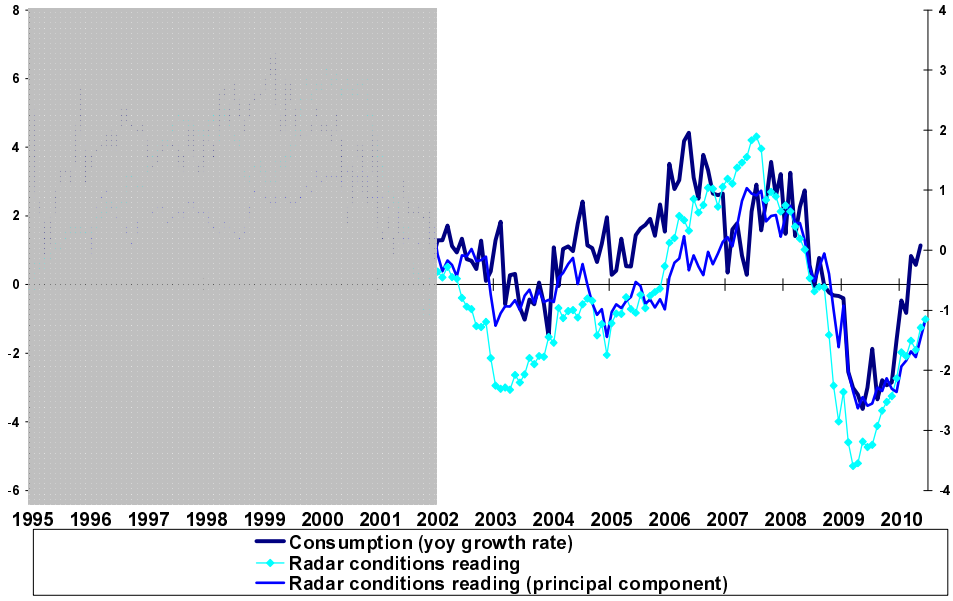
The results of the factor analysis indicate that consumption development is a more complex phenomenon than export growth. The percentage of variation explained by the first principal component is lower at 52%, indicating weaker communality.

Table 4.3; Results of factor analysis by principal component analysis of consumption radar indicator set. Factor loadings on first principal component, percentage of variance explained by 1st principal component: 52%.

	Factor loading	*extraction*
Jobs	0.790	0.624
Stock market	0.287	0.082
Cs financial situation coming year	0.551	0.303
Cs unemployment expectations	-0.925	0.856
Manufacturing staffing level expectations	0.926	0.857
House prices	0.653	0.426

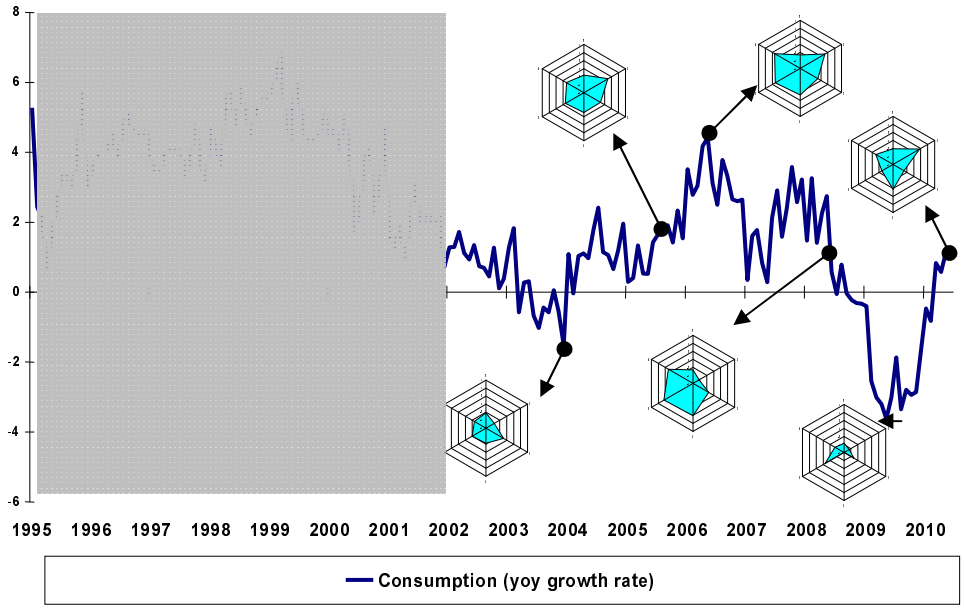
This means that the different indicators of the consumption radar set have less in common, due to the fact that they represent a wider range of economic phenomena. This is also reflected in the factor loadings, which are somewhat lower on average than for the export radar indicator set. For example the low factor loading of stock market developments indicates that by far not all stock market developments are relevant for consumption development, as one would expect. These results support the interpretation that consumption is influenced by very diverse factors. This means that not all indicators will be relevant all the time. Selecting just the indicators with the highest average correlations and significance will result in an indicator set which is too limited and which will probably at certain times miss important developments. Visually, the first principal component of the consumption radar indicator set seems to reflect conditions for consumption better than the simple average of the indicator set, see graph 4.5. Correlation is lower though, at 0.758 at lag 0 and maximum correlation of 0.761 at a lead of 1 month.

Graph 4.5; Consumption radar readings compared to growth rate of volume of household consumption. Consumption radar characterised by both simple average and first principal component of normalised indicators.



Graph 4.6 shows how the consumption radar would reflect consumption conditions over time.

Graph 4.6; Actual readings of the Consumption radar readings compared to growth rate of volume of household consumption at the corresponding points in time.



Identifying the driving factors of consumption is rather complex. Economic theories centre on the life-cycle hypothesis and consumption smoothing: these point to the influence of (expected) income developments, which are also reflected in labour market developments. More recent research indicates the influence of wealth effects, reflected by asset price developments. Apart from these influences, there is a simple volume effect: the more people have jobs, the higher the aggregate income available for consumption. Summarising, the driving factors identified here are:

- **Job market developments**
- **income (expectations)**
- **wealth**

In general, the link of the selected indicators with consumption growth, as characterised by correlations and significance in ARMAX models, is quite strong. See table 4.4.

Table 4.4; Outcomes of quantitative tests of the strength of the link between household consumption growth (year-on-year growth rate of volume) and the individual indicators in the consumption radar.

	Jobs[§]	*Stock market*[§]	*Cs financial situation coming year*[#]	*Cs unemployment expectations*[#]	*Manufacturing staffing level expectations*[#]	*House prices*[§] *s*
ρ (lag 0)	0.489	0.420	0.599	-0.663	0.708	0.769
ρ max (lag)[‡]	0.762 (+6)	0.633 (-9)	0.614 (-2)	-0.679 (+1)	0.714 (+1)	0.826 (+4)
R^2 (ARMAX)	0.859	0.834	0.829	0.834	0.915	0.917
AIC	2.15	2.57	2.61	2.57	2.02	2.02
Forecast rmse	n.a.	0.72	0.77	0.73	0.76	0.75
Coefficient (sig)	0.40 (0.126)	0.01 (0.0184)	0.029 (0.0193)	-0.006 (0.0131)	0.026 (0.0073)	0.185 (0.0023)
Lag in model[‡]	-3	-2	-11	-4	-3	0
Granger causality test[†] [†]	0.008	0.035	0.056	0.115	0.061	0.005
Series from	2002m1	1990m1	1990m1	1990m1	1990m1	1996m1

[#] = level (balance), [§] = relative year-on-year growth rate, [†] = indicator does not granger cause exports (12 lags), [‡] lags in months (+ means indicator is lagging, - means leading)

Benchmark model: exports = c ar(1) ar(2) ar(3) ma(12)

R^2 = 0.829, AIC = 2.60, RMSE forecast = 0.74%-points

Q-stat 0.001 (12 lags), Jarque-Bera 847 (0.0000), LM test 0.878 (3 lags)

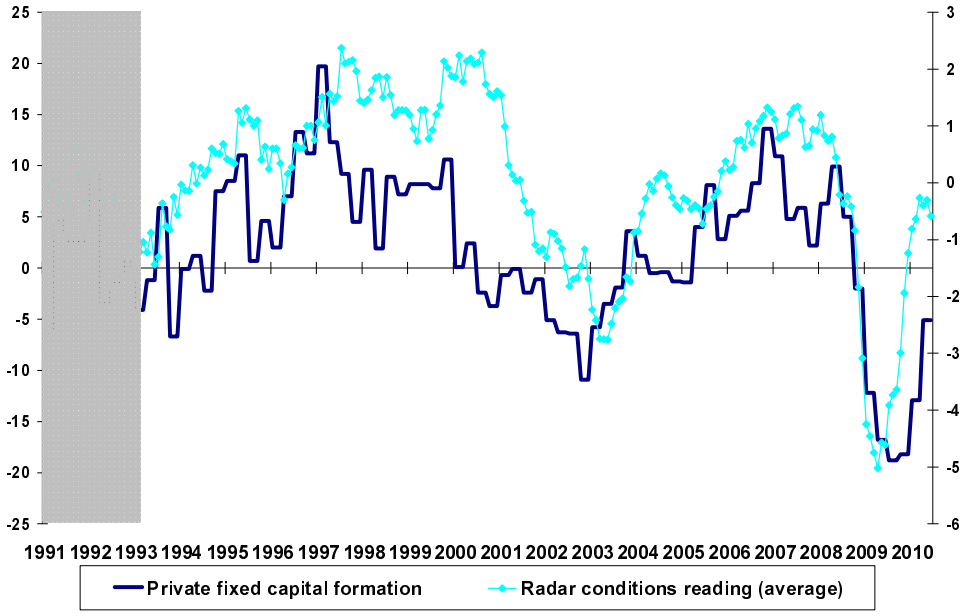
In some cases, especially for the sentiment indicators, forecast performance is somewhat disappointing. In the original research [Van Ruth (2009a)], it was found that the year-on-year change in sentiment indicators usually had a longer lead and better forecasting properties than the level of this type of indicator. But for reasons of simplicity and uniformity, it was chosen to enter all sentiment indicators in the radar tools as they are usually published, i.e. in the form of levels (balances).

Three indicators were dropped from the original consumption radar. Consumer confidence, as the consumption radar indicator set already contains two, more informative, indicators from the consumer sentiment survey. Producers' confidence in the manufacturing industry, because the indicator set also contains staffing level expectations from the manufacturing industry survey. And the rate of inflation, as it does not really supply information on the driving factors identified here.

4.3 The fixed capital formation radar

The radar tool for private fixed capital formation development was relatively difficult to construct. The problem was not in finding relevant indicators, but in constructing an indictor set which was on average coincident with fixed capital formation, as can be seen in graph 4.7. On average, development of conditions as derived from the radar are coincident with fixed capital formation growth, maximum correlation is 0.698 at lag 0. But radar conditions seem to lag actual capital formation development in the first half of the sample, and to lead somewhat at the end. Overall though, the development of conditions derived here seems to credibly reflect what's going on with fixed capital formation, the main goal of the tool. There is no iron connection presumed here between conditions and actual developments. Just as long as the tool yields relevant and interesting insights into the influences working on fixed capital formation.

Graph 4.7; Fixed capital formation radar readings compared to growth rate of volume of private fixed capital formation. Fixed capital formation radar characterised by simple average of normalised indicators, shaded area indicates period for which the indicator set is incomplete.



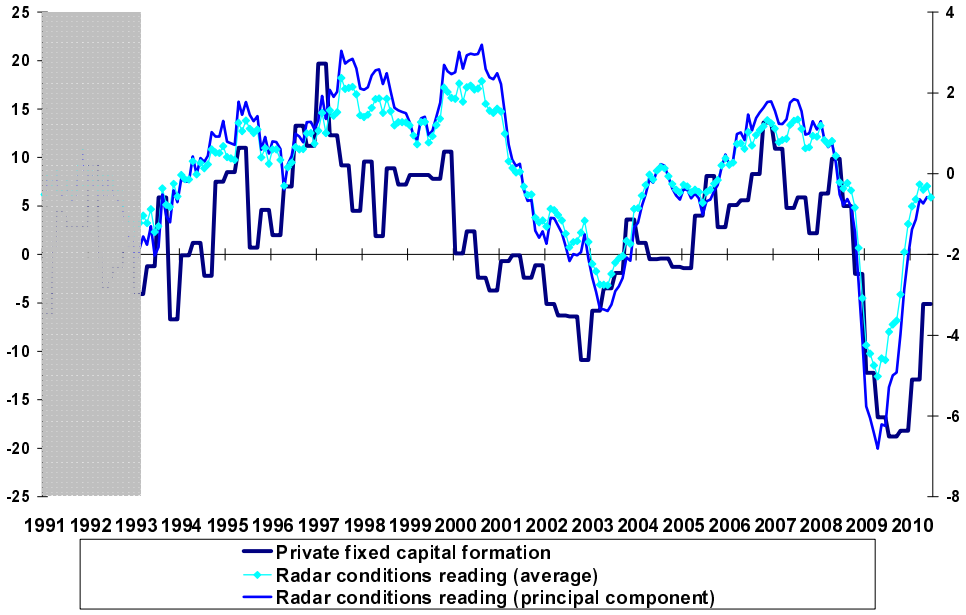
The outcome of the factor analysis is largely similar as before (table 4.5). The first principal component explains at 57% the majority of the variance in the indicator set. The indicators have high to very high factor loading, suggesting that these rather disparate variables do possess a strong common component. The first principal

component has an average correlation with fixed capital formation development of 0.630 at lag 0, and maximum correlation of 0.660 at a lead of 1 quarter. The development of the first principal component is virtually identical to that of the simple average, see graph 4.8.

Table 4.5; Results of factor analysis by principal component analysis of fixed capital formation radar indicator set. Factor loadings on first principal component, percentage of variance explained by 1st principal component: 57%.

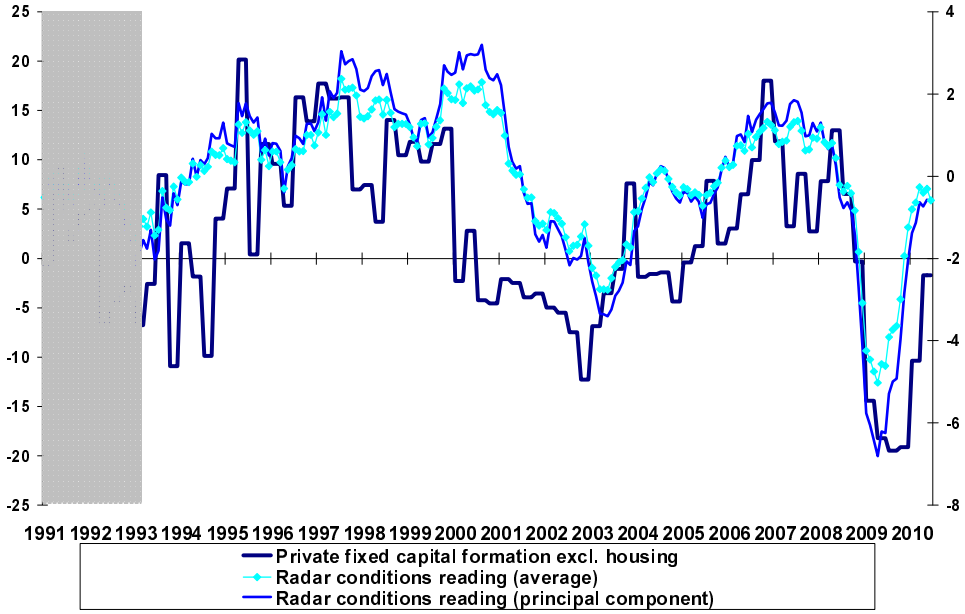
	Factor loading	*extraction*
Stock market	0.663	0.839
Consumer confidence	0.827	0.686
Capacity utilization	0.777	0.729
Manufacturing; assessment of order book	0.905	0.863
Exports	0.791	0.781
Long term loans	0.476	0.639

Graph 4.8; Fixed capital formation radar readings compared to growth rate of volume of private fixed capital formation. Fixed capital formation radar characterised by both simple average and first principal component of normalised indicators.



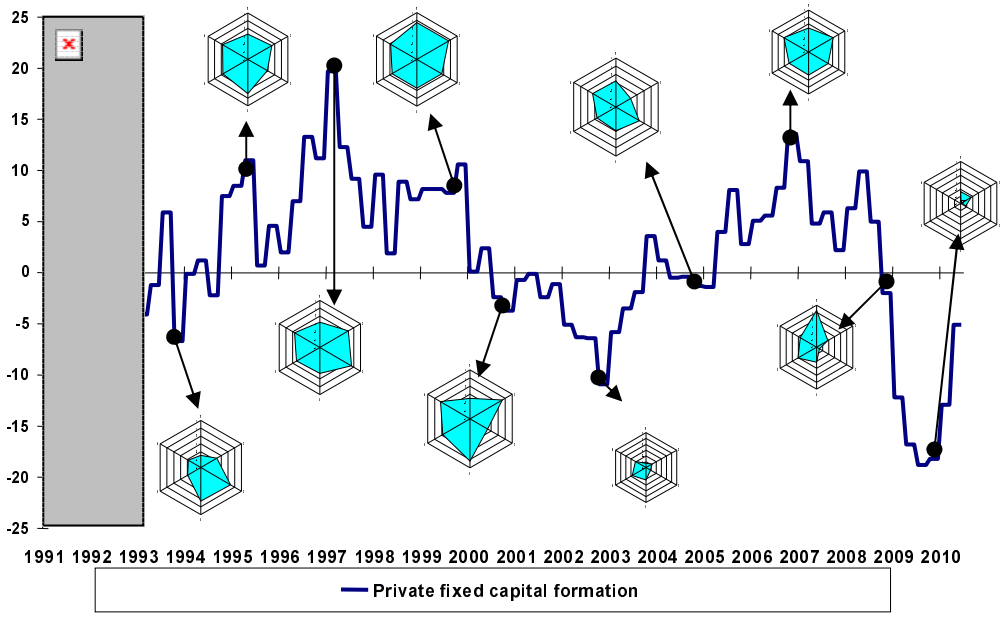
An interesting observation is that, at least visually, the coherence between conditions readings and private fixed capital formation is improved when investment in housing is excluded from fixed capital formation, see graph 4.9.

Graph 4.9; Fixed capital formation radar readings compared to growth rate of volume of private fixed capital formation excluding investment in housing. Fixed capital formation radar characterised by both simple average and first principal component of normalised indicators.



This greater similarity is easy to explain, as the concept as represented by the driving factors and potential indicators tested, was mostly targeted at investment meant to increase production capacity. The housing cycle is somewhat separate from that. Graph 4.10 shows again how the radar tool would perform in practice.

Graph 4.10; Actual readings of the fixed capital formation radar readings compared to growth rate of volume of private fixed capital formation at the corresponding points in time.



Private fixed capital formation is probably the most complex phenomenon of the three key macro-economic indicators targeted in this study. Fixed capital formation is largely discretionary, in contrast to consumption which is much more need-driven. There are also timing issues, i.e. it can take some time for investment projects to start and they can take long to finish. Apart from these complicating factors, the range of direct influences is also relatively broad:

- **Return on investment/capital**
- **Replacement needs**
- **Capacity utilization**
- **Availability/cost of funding**

This wide range of potential influences translates into a rather diverse set of indicators for the fixed capital formation radar. But all these have relatively high correlation with fixed capital formation development, see table 4.6. Even more important, all are significant in the ARMAX models, and some yield marked improvements in forecasting performance. Five out of six indicators are leading in an impulse response sense, i.e. are leading in the ARMAX models. The strong relationship with stock market developments is especially noteworthy.

Table 4.6; Outcomes of quantitative tests of the strength of the link between private fixed capital formation growth (year-on-year growth rate of volume) and the individual indicators in the fixed capital formation radar.

	Stock market[§]	*Capacity utilization (rate)*	*Manufacturing assessment order book*[#]	*Consumer confidence*[#]	*exports*[§]	*Long term loans*[§] *s*
ρ (lag 0)	0.412	0.614	0.685	0.495	0.440	0.457
ρ max (lag)[‡]	0.641 (-4)	idem	idem	0.543 (+3)	0.547 (-2)	0.517 (+1)
R^2 (ARMAX)	0.796	0.728	0.758	0.744	0.787	0.758
AIC	5.52	5.78	5.65	5.72	5.56	5.74
Forecast rmse	3.92	5.16	4.14	4.76	4.13	5.09
Coefficient (sig)	0.16 (0.0003)	0.54 (0.0343)	0.384 (0.0005)	0.141 (0.0674)	0.392 (0.0039)	0.60 (0.0097)
Lag in model[‡]	-4	-2	-1	-2	0	-1
Granger causality test[†] [†]	0.0005	0.3299	0.0202	0.1198	0.1720	0.0467
Series from	1992m1	1990m1	1990m1	1990m1	1991m1	1990m1

[#] = level (balance), [§] = relative year-on-year growth rate, [†] = indicator does not granger cause exports (4 lags), [‡] lags in **quarters** (+ means indicator is lagging, - means leading)

Benchmark model: fixed capital formation = c ar(1) ar(2) ar(3) ar(4) ma(1) ma(2) ma(4)

R^2 = 0.754, AIC = 5.63, RMSE forecast = 4.81%-points

Q-stat 0.004 (8 lags), Jarque-Bera 1.00 (0.606), LM test 0.223 (1 lag)

Two variables were omitted from the eight present the original fixed capital formation radar. The first is the yield on one year government bonds, which gave additional information on the development of the cost of capital. Also dropped was producers' confidence manufacturing Germany, which is related to the demand for Dutch products and therefore to the return on capital. This is already well covered by the inclusion of the development of exports.

5. Modelling and forecasting with the radars

Two different model based approaches were used to further quantify and test the relationship between the derived conditions and the target indicators. The first approach is a standard single-equation model as used before: the ARMAX where the conditions indicator is entered in the same benchmark ARMA-models as used before to test the individual indicators. The second type of model used is a two-equation VAR, where the target indicator is combined with the conditions indicator. The conditions indicator is computed as the simple average of the indicators of the respective radar diagrams. In the ARMAX model, it is tested whether conditions are significant in explaining the development of the target indicators, and whether conditions have predictive power. As mentioned earlier, the aim of the radar-concept is not to predict the development of the target indicator. But significance and predictive power are ways to test whether conditions as computed here really have influence on the development of the target indicators. In addition to these two properties, in the VAR a block exogeneity test and impulse-response analysis are performed. The block exogeneity test is a way to test which way the influence runs between the indicators in the VAR. It can be both ways, or only from one indicator to the other. In that case, the second indicator will have no influence on the first indicator, which is therefore exogenous. Impulse-response shows how the indicators respond to a standardized change in either of the indicators of the VAR.

Export conditions are very significant in explaining the development of exports, see table 5.1 for the results of the ARMAX model. Not only were conditions significant, bur forecast performance improved markedly compared to the benchmark ARMA model. This indicates that conditions as derived from the radar have considerable short-term predictive power for exports development. A very interesting observation is that forecast errors for the composite conditions indicator are smaller than when using individual indicators (compare with table 4.2).

Table 5.1; Results of ARMAX model yoy-volume growth exports with conditions from export radar. Benchmark model: AR 1, 2, 3, 4 MA 1, 2, 4. R^2=0.815, AIC 4.90, forecast rmse = 2.81%-points

Exports	*Lag in model*	*Coefficient (sig.)*	*R^2*	*AIC*	*Forecast[$] rmse lag 0*	*Forecast[$] rmse lag - 1*	*Forecast[$] rmse lag - 2*
Conditions	-1	2.5 (0.0000)	0.829	4.82	2.08%-point	2.29%-point	2.42%-point

[$]lag (in months) conditions indicator in ARMAX model in rolling regression forecast simulation

The outcomes of the VAR-model are broadly similar. Conditions are significant, though according to the R^2, AIC and forecast rmse, the VAR model performs slightly worse than the ARMAX model. The long lag length of 13 months is somewhat remarkable.

Table 5.2; Results VAR exports and export conditions. Lag determined by lag length criteria tests.

Exports	*Lag VAR*	*R^2 exports equation*	*R^2 conditions equation*	*AIC exports equation*	*AIC conditions equation*	*AIC VAR*	*Forecast rmse VAR*
VAR	13	0.827	0.983	5.04	0.07	5.07	2.11%-points

According to the block exogeneity test of the VAR, the direction of influence is one way: from conditions to exports. Export development is not significant in explaining conditions development, which is logical as it seems unlikely that Dutch export development will influence economic conditions in Germany and the Euro zone. These results are confirmed by the outcomes of the impulse response analysis (graph 5.1), which show relatively little influence of export growth on the development of export conditions

Table 5.2; Block exogeneity test for VAR of export growth and export conditions

VAR Granger Causality/Block Exogeneity Wald Tests

Included observations: 221

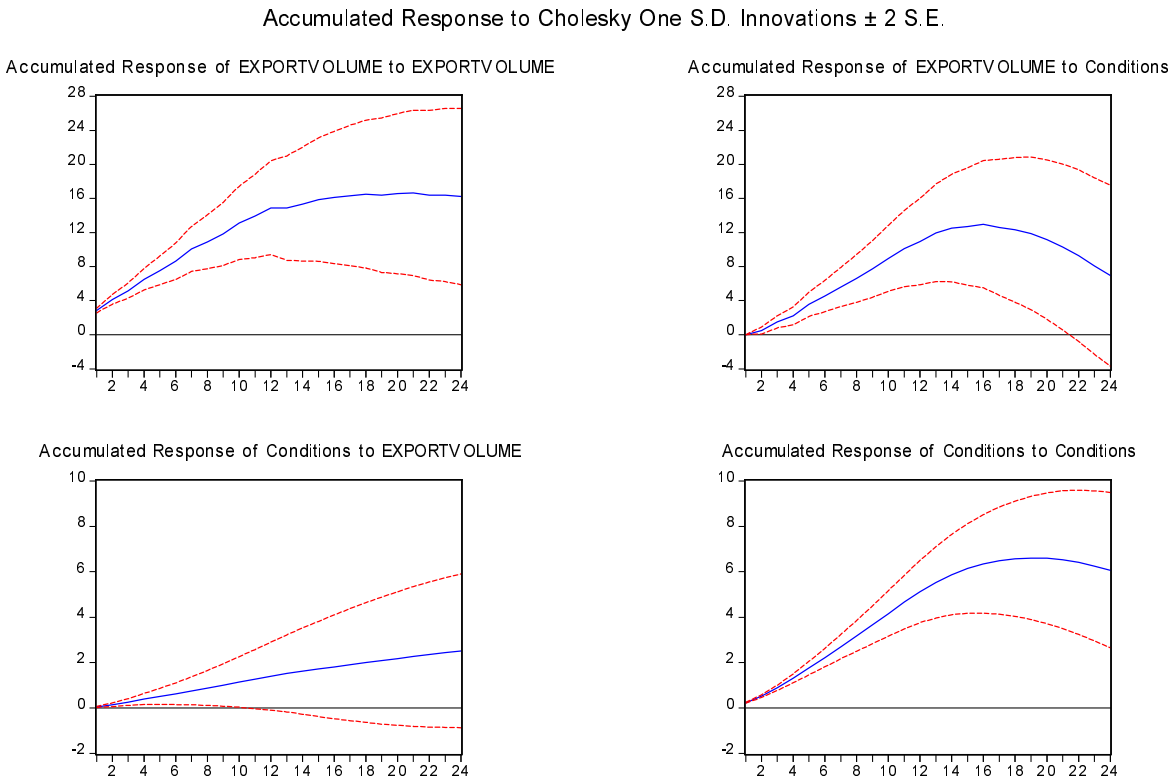
Dependent variable: EXPORT

Excluded	Chi-sq	df	Prob.
conditions	46.98701	13	0.0000
All	46.98701	13	0.0000

Dependent variable: conditions

Excluded	Chi-sq	df	Prob.
EXPORT	17.87472	13	0.1623
All	17.87472	13	0.1623

Graph 5.1; Impulse response analysis of VAR of export growth and export conditions. Cumulative response over 24 months to 1 standard deviation shock.



For household consumption, conditions are also of significant influence, see table 5.3 for the results of the ARMAX model. Forecast performance improved only slightly compared to the benchmark model. In this case, the best individual indicators are slightly better at forecasting consumption growth than the conditions indicator, see table 4.4. But the good statistics of the ARMAX models show that conditions are very significant in explaining household consumption development.

Table 5.3; Results of ARMAX model yoy-volume growth household consumption with conditions from consumption radar. Benchmark model: AR 1, 2, 3 MA 12. R^2=0.829, AIC 2.60, forecast rmse = 0.74%-points

Consumption	*Lag in model*	*Coefficient (sig.)*	*R^2*	*AIC*	*Forecast[$] rmse lag 0*	*Forecast[$] rmse lag -1*	*Forecast[$] rmse lag -2*
Conditions	-2	0.67 (0.0003)	0.876	2.04	0.76%-point	0.74%-point	0.70%-point

[$]lag (in months) conditions indicator in ARMAX model in rolling regression forecast simulation

The VAR also confirms the relevance of conditions for the development of consumption, see table 5.4. Lag length is relatively short, and R^2, AIC and forecast rmse are somewhat worse than for the ARMAX model. The block exogeneity test (table 5.5) shows that in this case the influence runs one way as well: conditions are significant in explaining consumption growth, but are not themselves influenced by consumption development.

Table 5.4; Results VAR household consumption and consumption conditions. Lag determined by lag length criteria tests.

Consumption	*Lag VAR*	*R^2 consumption equation*	*R^2 conditions equation*	*AIC consumption equation*	*AIC conditions equation*	*AIC VAR*	*Forecast rmse VAR*
VAR	1	0.756	0.950	2.62	0.47	3.08	0.77%-points

Table 5.5; Block exogeneity test for VAR of consumption growth and consumption conditions

VAR Granger Causality/Block Exogeneity Wald Tests

Included observations: 100

Dependent variable: Consumption

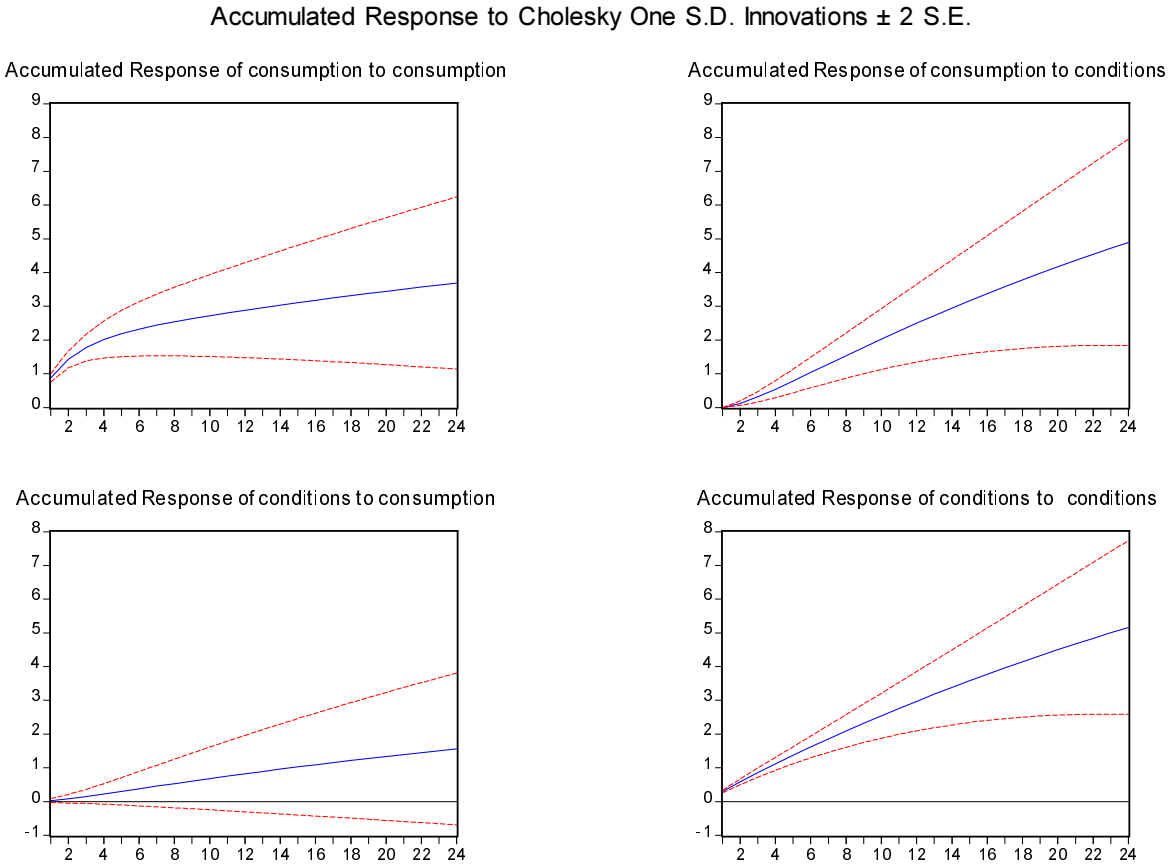
Excluded	Chi-sq	df	Prob.
Conditions	14.64880	1	0.0001
All	14.64880	1	0.0001

Dependent variable: Conditions

Excluded	Chi-sq	df	Prob.
Consumption	1.162771	1	0.2809
All	1.162771	1	0.2809

The impulse response analysis shows this as well, see graph 5.2: consumption reacts strongly to a change in conditions, much stronger than to a change in consumption growth itself. On the other hand, conditions hardly respond to a change in consumption.

Graph 5.2; Impulse response analysis of VAR of household consumption growth and consumption conditions. Cumulative response over 24 months to 1 standard deviation shock.



The situation for fixed capital formation is somewhat more complex. Earlier it was shown that conditions as reflected in the fixed capital formation radar are probably more relevant for fixed capital formation excluding investment in buildings such as houses and offices. Therefore, the modelling exercises were performed both for total private fixed capital formation development and for private fixed capital formation excluding investment in buildings. As the results from the benchmark ARMA models show (table 5.6), fixed capital formation excluding building investment is more difficult to model than total fixed capital formation. This is not a surprise, as the former aggregate is more volatile. On the other hand, improvement after inclusion of the conditions indicator is far greater for the growth of fixed capital formation excluding building investment, both in terms of R^2 increase, and decrease of forecast error. Conditions are significant in explaining both aggregates, but are clearly more relevant for fixed capital formation excluding building investment. Nevertheless, the forecasting performance of the composite conditions indicator for total private fixed capital formation growth is clearly superior to those of the individual indicators.

Table 5.6; Results of ARMAX model yoy-volume growth in fixed capital formation, with and without investment in buildings, with conditions from fixed capital formation radar. Benchmark model with building investment: AR 1, 2, 3,4 MA 1, 2, 4. R^2=0.754, AIC 5.63, forecast rmse = 4.81%-points. Benchmark model excluding building investment: AR 1, 2, 4 MA 1, 2, 4. R^2=0.664, AIC 6.29, forecast rmse = 6.24%-points.

Fixed capital formation	*Lag in model*	*Coefficient (sig.)*	*R^2*	*AIC*	*Forecast[$] rmse lag 0*	*Forecast rmse lag -1*	*Forecast rmse lag -1*
Conditions vs total	0	2.80 (0.0003)	0.724	5.78	3.96%-points	3.99%-points	3.74%-points
Conditions vs excl. building investment	0	3.77 (0.0003)	0.776	5.91	4.79%-point	7.61%-point	5.14%-point

[$]lag (in quarters) conditions indicator in ARMAX model in rolling regression forecast simulation

The VAR models show that the influence of conditions on fixed capital formation development is a relatively long term process, over 6 quarters. The VAR models do not outperform the ARMA models, see table 5.7. Block exogeneity tests (tables 5.8a and 5.8b) show that conditions influence both private fixed capital formation in total and excluding building investments. But while conditions are not influenced by the development of private fixed capital formation excluding building investment, they are influenced by the total. A possible explanation is that total private fixed capital formation is such a broad aggregate, which is still quite sensitive to economic conditions, that its development largely coincides with the general Dutch business cycle. And business cycle developments will have a strong influence on conditions for investment.

Table 5.7; Results VAR private fixed capital formation growth(total and excluding investment in buildings) and fixed capital formation conditions. Lag determined by lag length criteria tests.

Fixed capital formation	*Lag VAR[$]*	*R^2 f.c.f equation*	*R^2 conditions equation*	*AIC f.c.f equation*	*AIC conditions equation*	*AIC VAR*	*Forecast rmse VAR*
VAR total f.c.f.	6	0.737	0.922	5.85	1.36	7.09	3.96%-points
VAR f.c.f. excl. buildings	6	0.605	0.911	6.61	1.49	7. 09	5.63%-points

[$]lags in quarters

Table 5.8a; Block exogeneity test for VAR of total private fixed capital formation growth and fixed capital formation conditions

VAR Granger Causality/Block Exogeneity Wald Tests

Included observations: 76

Dependent variable: Fixed capital formation

Excluded	Chi-sq	df	Prob.
Conditions	15.66390	6	0.0157
All	15.66390	6	0.0157

Dependent variable: Conditions

Excluded	Chi-sq	df	Prob.
Fixed capital formation	20.49172	6	0.0023
All	20.49172	6	0.0023

Table 5.8b; Block exogeneity test for VAR of private fixed capital formation growth(excluding investment in buildings) and fixed capital formation conditions

VAR Granger Causality/Block Exogeneity Wald Tests

Included observations: 76

Dependent variable: Fixed capital formation excl. building investment

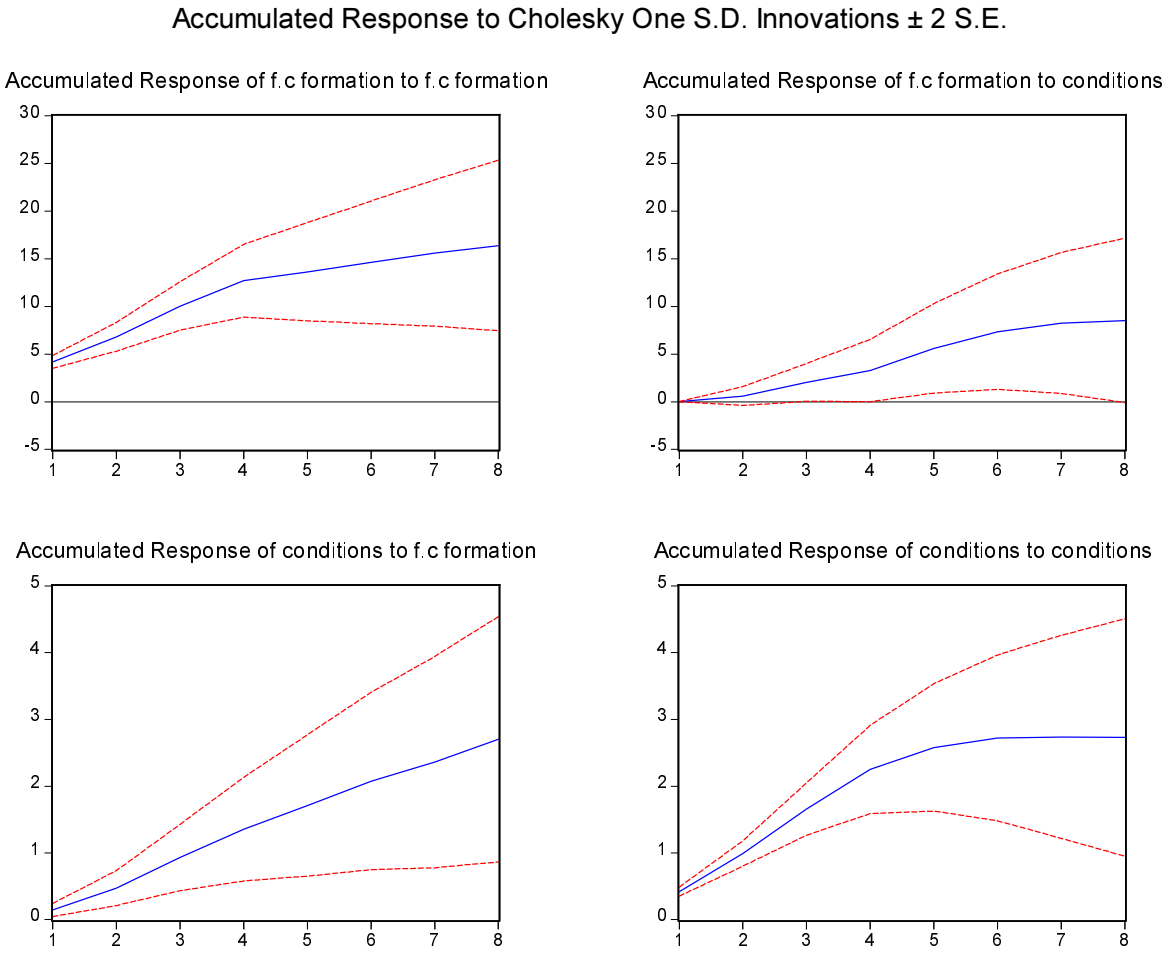
Excluded	Chi-sq	df	Prob.
Conditions	10.31943	6	0.1118
All	10.31943	6	0.1118

Dependent variable: Conditions

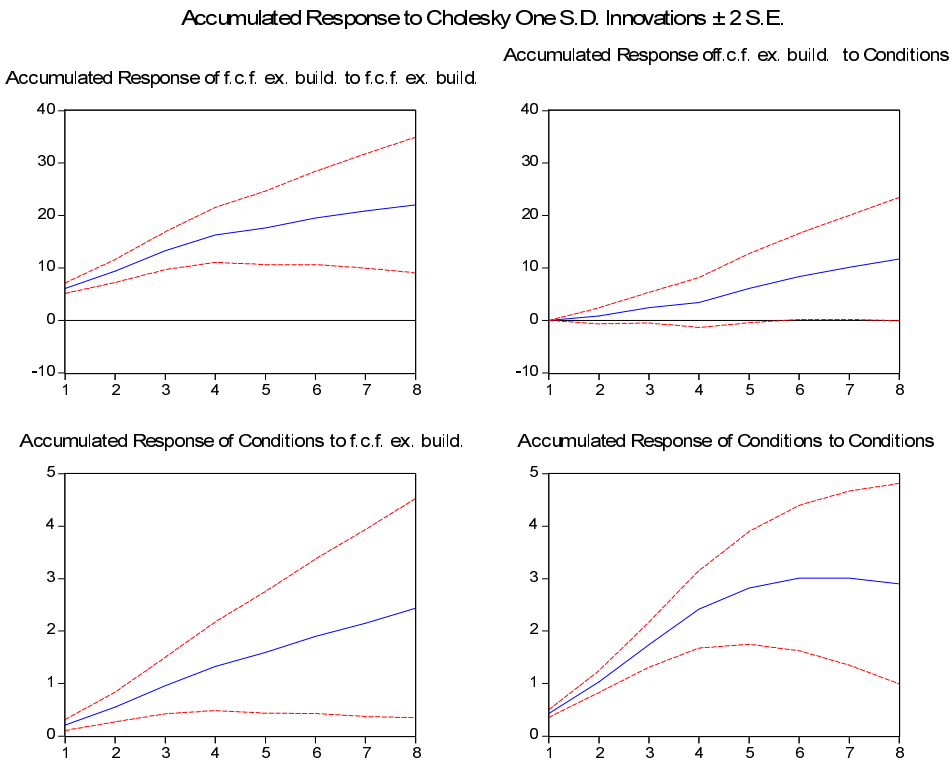
Excluded	Chi-sq	df	Prob.
Fixed capital formation excl. building investment	9.954603	6	0.1266
All	9.954603	6	0.1266

The impulse response analysis, graphs 5.3a and 5.3b, for both capital formation aggregates confirms the previous analysis. There is, compared to the other radars, a relatively strong reaction of conditions to changes in fixed capital formation development, more so for total fixed capital formation.

Graph 5.3a; Impulse response analysis of VAR of total private fixed capital formation growth and fixed capital formation conditions. Cumulative response over 24 months to 1 standard deviation shock.



Graph 5.3b; Impulse response analysis of VAR of private fixed capital formation growth (excluding investment in buildings) and fixed capital formation conditions. Cumulative response over 24 months to 1 standard deviation shock.



6. Discussion

This paper presented a visual tool for monitoring conditions for the short-term development of key economic indicators. Radar tools for analysing the development of consumption, exports and private fixed capital formation were described. By showing in unison the development of six carefully selected indicators, a rich analysis of the factors influencing the development of the targeted key economic indicator is made possible. The visual presentation and dynamic options allow for a fast and robust interpretation of the development of conditions. Analysis of the evolution of conditions as presented by the respective radar tools showed that these had a strong link with the actual development of the targeted key-indicators. The development and selection process was described. Results of quantitative analyses show that the individual radar indicators have strong links with the relevant key macro-economic indicators. According to the modelling and forecasting tests performed, conditions are significant in explaining and predicting the development of exports, consumption and fixed capital formation. Even more interesting, aggregate conditions are better at short-term predictions than individual indicators.

Literature

Van Ruth, Floris 2009a,"A conditions monitor for household consumption" Statistics Netherlands discussion paper 09006

Van Ruth, Floris 2009b "A conditions monitor for exports" Statistics Netherlands discussion paper 09007

Van Ruth, Floris 2009c "A conditions monitor for fixed capital formation" Statistics Netherlands discussion paper 09008