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Abstract

In this paper, forecasting models for Swedish business investment growth which make use of data from Sweden's most important business survey – the *Economic Tendency Survey* – are evaluated. We conduct an out-of-sample forecast exercise using nine years of quarterly real-time data. Our results suggest that the survey data have informational value that can be used to improve forecasts. Perhaps not surprisingly, the time series with the highest predictive power for business investment growth tend to be based on data for the investment goods industry. Forecasts based on a simple arithmetic mean of individual model forecasts do well in the evaluation and should accordingly be useful when forecasting Swedish business investment in practice.

JEL Classification: E22, E27

Keywords: Out-of-sample forecasts, Real-time data

Summary in Swedish

I denna studie utvärderas prognosmodeller för tillväxten i näringslivets investeringar i Sverige. Modellerna baseras på data från Konjunkturbarometern som är Sveriges viktigaste enkätundersökning som genomförs i syfte att underlätta konjunkturanalys. Resultaten från en prognosövning baserad på nio års realtidsdata tyder på att data från Konjunkturbarometern kan användas för att förbättra prognoser. Kanske föga förvånande är tidsserier som baseras på data från investeringsvaruindustrin de som har högst prognosförmåga. Prognoser som baseras på det aritmetiska medelvärdet av enskilda prognoser står sig väl i prognosutvärderingen och borde följaktligen vara användbara när näringslivets investeringar i Sverige skall prognostiseras i praktiken.

Contents

1. Introduction

Non-residential business investment is an important variable for business cycle analysis seeing that it constitutes approximately 12 percent of Swedish GDP. International evidence, however, suggests that business investment is fairly difficult to forecast.[1] One way to potentially improve forecasts of business investment is to use survey data. The predictive power of survey data for the real economy has been investigated in a number of studies, both within and out-of-sample; see, for example, Carroll *et al.* (1994), Ludvigson (2004), Dreger and Schumacher (2005), Hansson *et al.* (2005), Kwan and Cotsomitis (2006) and Siliverstovs (2013).[2] The underlying idea in such studies is generally that the survey data should work as a leading indicator for the real variable being forecasted.

The purpose of this paper is to investigate whether short-term forecasts of Swedish business investment can be improved by using survey data provided in the National Institute of Economic Research's *Economic Tendency Survey*.[3] Following Österholm (2014) – who established that data from the *Economic Tendency Survey* had predictive power for Swedish GDP growth – we assess the usefulness of a subset of the data in the survey by employing them in a simulated out-of-sample forecast exercise using nine years of quarterly real-time data. Results indicate that while the root mean square forecast error tends to be fairly large in general, there are improvements to be made from using the survey data.

The rest of this paper is organised as follows: The survey data are discussed in Section 2. In Section 3, the setup of the out-of-sample forecast exercise is discussed and the results are presented. Finally, Section 4 concludes.

2. The survey data

The survey data employed in this paper come from the National Institute of Economic Research's *Economic Tendency Survey*. This is the largest survey of its kind in Sweden and it is widely discussed and used by analysts and forecasters. More than 6000 companies are included in the survey – based on stratified sampling through Statistics Sweden's business register – and they are divided into four major categories: manufacturing industry, construction industry, retail trade and private service sector.[4] Each month representatives from upper management of the companies are asked questions

[1] See, for example, Oliner *et al*. (1997), Rapach and Wohar (2007) and Baghestani (2012).

[2] As an alternative approach, one could consider using financial data to forecast the real economy; see, for example, Estrella and Hardouvelis (1991) and Mody and Taylor (2003).

[3] In this paper, we focus on short-term forecasts since it is reasonable to believe that it is at short horizons that the survey data have predictive power. Forecasts of business investment at longer horizons are, needless to say, also of interest to many agents but this is left for future research.

[4] These four main categories are in turn divided into many sub-categories. For a general description of the survey, see http://www.konj.se/1670.html.

concerning the present situation and the outlook for the near future regarding, for example, output, new orders, employment and prices.[5] The survey is slightly more extensive once every quarter – namely the surveys conducted in January, April, July and October – and we rely on these quarterly survey data in this paper.

For each question, the responses are standardised so that the percentages of the response alternatives add up to 100. To facilitate presentation and analyses, the concept "net figures" is employed, where a net figure is the difference between the percentage of respondents reporting an increase and a decrease for a certain question. For example, if 45 percent of respondents state that there has been an increase in output volume over the past three months, 25 percent that there has been no change and 30 percent that there has been a decrease, the net figure is 45-30=15.

In this paper, we use a subset of the data which is judged to be the most relevant. More specifically, we employ data for the manufacturing industry, the investment goods industry, the construction industry and the total business sector.

3. Empirical findings

3.1 The out-of-sample forecast exercise

Our out-of-sample forecast exercise is conducted using quarterly real-time data of seasonally adjusted business investment which have been retrieved from the historical data banks of the National Institute of Economic Research.[6] The series with net figures from the *Economic Tendency Survey* are not adjusted in any way; the most recent vintage is accordingly equivalent to real-time data.[7] Concerning the forecast horizon, we focus on a short-term forecast. Specifically, we forecast quarter t business investment growth when standing part way through quarter t.[8] The measure of forecast precision that we rely upon for evaluation of the forecasts is the root mean square forecast error (RMSFE).

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[5] The questionnaires employed in the survey – which show exactly how the question underlying each variable employed in the empirical analysis in this paper is phrased – can be found at http://www.konj.se/1666.html.

[6] Specifically, we employ data on non-residential business investment excluding ships and aircraft.

[7] For discussions concerning the importance of using real-time data, see, for example, Croushore and Stark (2001), Orphanides and van Norden (2002) and Döpke (2004).

[8] This can be seen as conducting a nowcast; however, since the national accounts are released with a delay of approximately two months, it could also be seen as having a forecast horizon of roughly one quarter.

A large number of models is employed in the out-of-sample forecast exercise. Our benchmark model is an AR(1) model,

$$g_t = \delta + \rho g_{t-1} + v_t, \tag{1}$$

where g_t is quarterly business investment growth and v_t is an error term; AR models are a commonly used benchmark in the macroeconomic forecasting literature given their simplicity and flexibility.[9] As it turns out though, investment growth is very weakly serially correlated – a fact which is visually confirmed in Figure 1 – and judging by the autocorrelation and partial autocorrelation functions, a model with only an MA(3) term appears to be reasonable.[10] We accordingly also include two more simple models for comparison, namely a model with only a constant

$$g_t = \kappa + \chi_t, \tag{2}$$

where χ_t is an error term, and a model with a constant and an MA(3) term,

$$g_t = \mu + \psi_t + \lambda \psi_{t-3}, \tag{3}$$

where ψ_t is an error term. Finally, we estimate 77 models which make use of survey data. These are given by

$$g_t = \alpha_j + \beta_j S_{j,t} + \varepsilon_{j,t} + \theta_j \varepsilon_{j,t-3}, \tag{4}$$

where $\varepsilon_{j,t}$ is the error term for model *j* and $S_{j,t}$ is a variable based on the survey data, $j = 1,\ldots,77$; see Table A1 in the appendix for a complete list.

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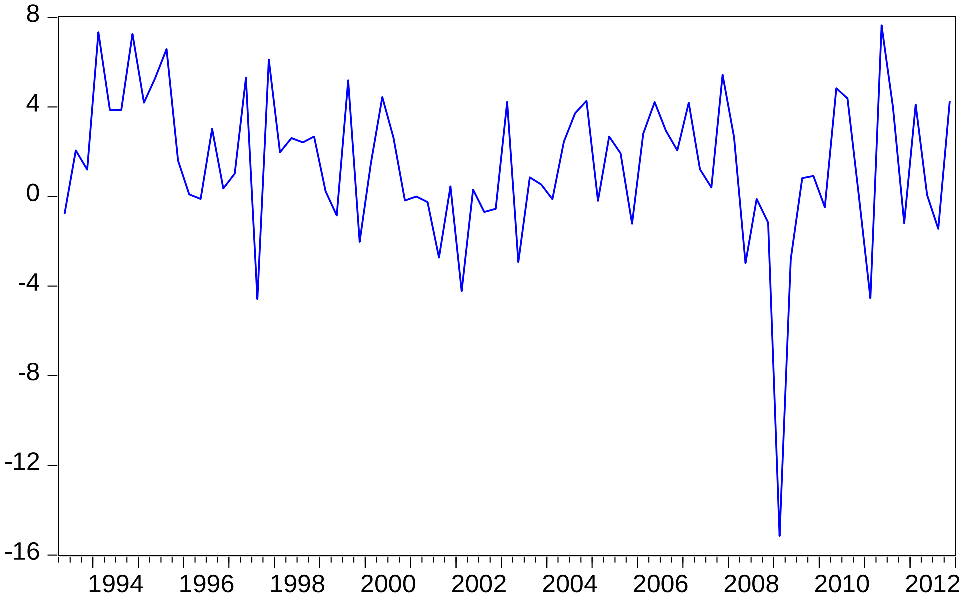
[9] See, for example, Pesaran *et al*. (2009).

[10] The autocorrelation and partial autocorrelation functions are not reported but are available upon request.

Figure 1. Business investment growth.



Note: Percentage change from previous quarter in seasonally adjusted non-residential business investment (excluding ships and aircraft). Vintage of data published in November 2012.

The first out-of-sample forecast is generated using data on investment from 1993Q2 until 2003Q4;[11] this means that the earliest point in time at which it could have been made is late February/early March 2004. The forecast generated from this estimation is for the growth of business investment in 2004Q1. The sample is then extended one period, the models re-estimated and new forecasts generated, this time for 2004Q2. The last forecast uses data on business investment until 2012Q2 and the forecast is accordingly made for investment growth for 2012Q3. This means that a total of 35 out-of-sample forecasts can be evaluated for each of the 80 models.[12]

As is well-known from the forecasting literature, an arithmetic mean of available forecasts often performs well – see, for example, Clemen (1989) and Stock and Watson (2003) – and we accordingly also evaluate the forecast which at each point in time is generated as the arithmetic mean of the forecasts from every model excluding our benchmark model (that is, the AR(1) model).

3.2 Results

Results are given in Table A1 in the appendix and it can initially be noted that the AR(1) model has the second highest RMSFE of all models; only the model relying on the survey data based on question 106

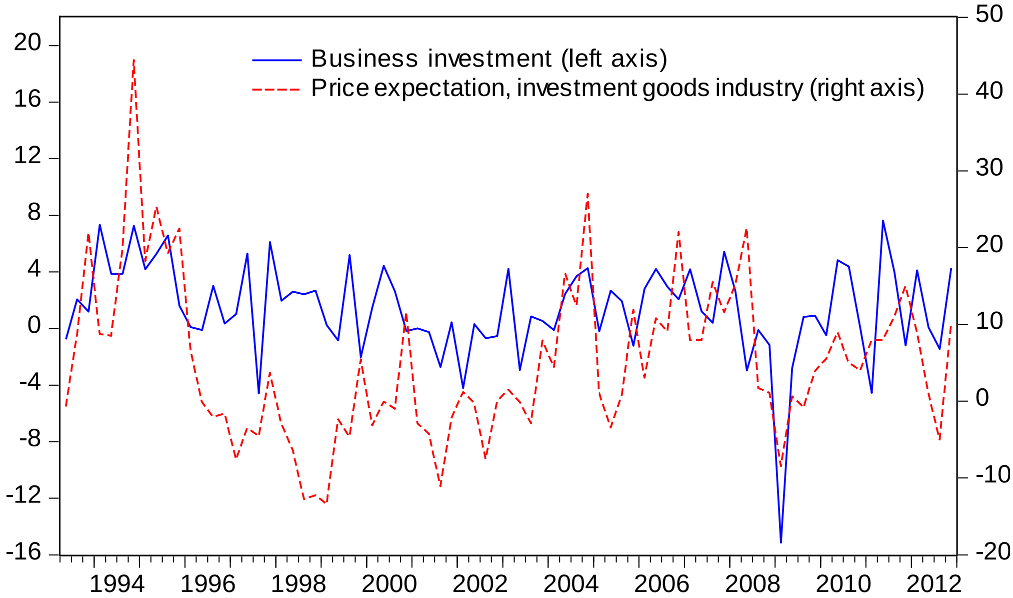
[11] Some models are estimated on a shorter sample – which starts in 1996Q2 – since some of the survey data series are not available from 1993.

[12] The 80 models are: the benchmark AR(1) model in equation (1), the two simple models in equations (2) and (3), and the 77 models based on survey data described by equation (4).

for the manufacturing industry performs worse. Of the other two models that do not make use of survey data, we note that the model with only a constant has an RMSFE that is only marginally lower than the AR(1) model whereas the model with an MA(3) term has an RMSFE that is 0.27 percentage points lower than the AR(1) model.

The lowest RMSFE of all is found for the model which makes use of the survey data based on question 203 – that is, expectations concerning selling prices the next three months – in the investment goods industry. This is plotted together with business investment growth in Figure 2. The RMSFE is 0.42 percentage points lower than that of the AR(1) model which is a sizable improvement, even if the absolute level of the RMSFE still is high. As was pointed out initially though, business investment is generally considered difficult to forecast.

Figure 2. Business investment and price expectation in the investment goods industry.



Note: Business investment is measured as percentage change from previous quarter. Vintage of data published in November 2012. The price expectation is measured as the net figure.

Evaluating the forecast which is generated as the arithmetic mean of all other forecasts (except that of the AR(1) model), we find that this has an RMSFE that is 0.37 percentage points lower than the AR(1) model's. It is hence outperformed only by two of the models relying on data from single survey data series. Once again in empirical work, this simple strategy hence proves to be a good way to generate a forecast with a low RMSFE.

Having conducted this out-of-sample forecast exercise though, one could say that when making forecasts in the future, one only wants to employ a subset of the information used in the analysis in this paper. In particular, it is not unreasonable to focus on the series which appear to have the highest informational value for business investment growth – that is, the ones that were associated with the highest forecast precision in the out-of-sample forecast exercise. We therefore also evaluate a forecast generated as the arithmetic mean of the ten best models in the out-of-sample forecast exercise.[13] As can be seen from Table A1 in the appendix, this forecast has an RMSFE which is 0.5 percentage point lower than the AR(1) model. It hence has a lower RMSFE than all other alternatives discussed and it would seem reasonable to expect this forecast to perform well in practice.

4. Conclusions

In this paper, we have investigated the short-term forecasting performance of simple econometric models for Swedish business investment growth which rely on survey data. In line with previous literature in the field, we find that business investment growth is hard to forecast on an absolute scale. However, our results indicate that the survey data have informational value that can be used to improve the forecasts. The time series with the highest predictive power for business investment growth tend to be based on data for the investment goods industry. Forecasts based on a simple arithmetic mean – over all models or the best ten models – do well in the evaluation and should be useful when forecasting Swedish business investment in practice.

[13] Nine of these models are based on data for the investment goods industry and one on data for the manufacturing industry; see Table A1 in the appendix for details.

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Appendix

Table A1. Root mean square forecast errors.

		Equation (4): Manufacturing	Equation (4): Investment	Equation (4): Construction	Equation (4): Total
Equation 1: AR(1)	3.025	-	-	-	-
Equation 2: Constant	2.985	-	-	-	-
Equation 3: MA(3)	2.758	-	-	-	-
101	-	2.900	2.922	2.798	-
102	-	2.760	2.896	2.813	-
103	-	2.893	2.886	2.940	-
104	-	2.893	3.011	3.047	-
105	-	2.958	2.809	2.919	-
106	-	3.048	2.854	2.811	-
107	-	2.848	2.709	-	-
1073	-	-	-	2.842	-
108	-	3.004	2.760	-	-
109	-	2.762	2.813	-	-
110	-	2.888	3.004	-	-
112	-	2.967	2.652	-	-
113	-	2.892	2.754	-	-
114	-	2.990	2.743	-	-
115	-	2.773	2.671	-	-
116	-	2.838	2.693	-	-
117	-	2.745	2.715	-	-
118	-	2.784	2.777	-	-
119	-	2.853	2.793	-	-
120	-	3.005	2.875	-	-
121	-	2.664	2.856	-	-
122	-	2.809	2.692	-	-
125	-	2.741	2.766	-	-
201	-	2.948	2.818	2.815	-
202	-	2.979	2.970	2.873	-
203	-	2.924	2.609	2.801	-
204	-	2.748	2.713	2.769	-
205	-	2.997	2.867	2.813	-
206	-	2.838	2.830	-	-
207	-	2.899	2.672	-	-
Sales prices, present	-	-	-	-	2.935
Sales prices, expectation	-	-	-	-	2.839
Number of employees, present	-	-	-	-	2.789
Number of employees, expectation	-	-	-	-	2.811
Demand situation	-	-	-	-	2.705
Shortage of labour	-	-	-	-	2.863
Main factor currently limiting production: insufficient demand	-	-	-	-	3.019
Mean (all)	2.656	-	-	-	-
Mean (best ten)	2.525	-	-	-	-

Note: The numbers in the far left column refer to the number a specific quesiton has in the *Economic Tencency Survey*.

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