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2004:14

Combining leading indicators and a flash estimate

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Inquiries Lars-Erik Öller, Statistics Sweden and Department of Statistics,
Stockholm University
e-mail: lars-erik.oller@scb.se

Tom Persson, Stockholm University

ISSN 1650-9447
Printed in Sweden
SCB-Tryck, Örebro 2004

Contents

Abstract

A Flash Estimator (*FE*), using monthly production data to obtain early estimates on quarterly figures of Manufacturing, is combined with *Leading Indicators (LI)*, both monthly and quarterly. The leading information is extracted from the Business Tendency Survey using Kalman Filters. The result is called a *Leading Flash Estimator (LFE)*. *LFE* proves to be more timely than a conventional *FE* and more accurate than the *LI*.

Keywords: Flash Estimate, Business Tendency Survey, Kalman Filter

1 Introduction

Monitoring the economy can be likened to a beam of light, moving forward in time. The focus is on the present, some of the beam predicts the future and some revises the past. In order to focus in on the ”now” statisticians all over the world are working on their production routines so as to make the data more timely, without too much of accuracy being lost in the process. In this paper we want to sharpen the picture at the frontier between the future and the past, i.e. between a forecast and a preliminary figure. It could be called a ”nowcast”. Here we suggest combining monthly ”proxy” data and *Leading Incators* to accomplish this task.

In the Swedish quarterly Production Accounts, Manufacturing (Y_q) is an important variable that reflects the business cycle, maybe even more distinctly than the much larger aggregate, GDP. The data on manufacturing are published 70 days after the quarter has expired. In Öller & Tallbom (1996) [14] Quarterly Leading Indicators (*QLI*) for this variable were presented, which accurately forecast the preceding quarter in real time (coincident) 30 days after the quarter has expired. A forward-looking indicator provides a first estimate of the current quarter (in real time), which started 30 days ago. *QLI* have been published regularly since 1994, first by the National Institute of Economic Research, Sweden, and since 2003 by Statistics Sweden.

The Index of Industrial Production (*IIP*) is a monthly series, closely related to Y_q. It has been published regularly since 1913, nowadays with a delay of 45 days. In Dahllöf & Öller (2003) [3], Monthly Leading Indicators (*MLI*) are constructed for this series, a coincident and a forward-looking indicator. By combining *QLI* for quarterly data with the monthly *IIP* and *MLI* we want to construct a Leading Flash Estimator (*LFE*) of Y_q. This would precede the *QLI* coincident estimate by one month and is expected to be more accurate than the forward-looking *QLI* for that quarter, published two months earlier. In other words, we combine the early information in quarterly and monthly leading indicators with the early outcome registered in related monthly data. Conventional Flash Estimates (*FE*) use only outcome data; for a European model, see Mitchell & Weale (2001) [10].

Conventional Flash Estimators are intended to speed up the data production process. The estimates are compared to the preliminary quarterly figure and if the discrepancy is considered moderate the *FE* is introduced. In the present case Leading Indicators are also available as early estimates of the forthcoming preliminary figures. For the *LFE* to be contributing something new, it is not enough for them to be earlier than Flash Estimatates, they must also be at least as accurate as the Leading Indicators. We have found only one slightly similar study where a bivariate monthly VAR contains interpolated values for GDP and monthly inflation data, see Salazar & Weale (1999) [12]. They found that monthly data improve the ”nowcast” of the current quarter, but add nothing to the forecast of the next quarter.

Both the quarterly and monthly leading indicators use Business Tendency Survey data for early signals, which are then combined with autoregression of the statistical manufacturing variables in a Kalman filter, see Öller & Tallbom (1996) [14] and Rahiala & Teräsvirta (1993) [11]. The indicators are exponentially smoothed and include a turning point warning mechanism, which has worked well during the 10 years the quarterly indicators have been in use.

In Section 2 we present the model. We then describe the data in Section 3 and Section 4 contains the results. Section 5 concludes.

2 The Model

Consider the linear regression model:

$$y_t = c + \boldsymbol{\alpha}' \mathbf{y}_{t-1} + \boldsymbol{\beta}' \mathbf{x}_t + \varepsilon_t \qquad t = 1,2,\ldots T, \tag{1}$$

where $\boldsymbol{\alpha}$ is an $m \times 1$ kolumn vector of AR coefficients and $\mathbf{y}_{t-1}$ is also $m \times 1$ containing lags from 1 to m of y_t. The regression coefficient vector $\boldsymbol{\beta}$ and the regressor $\mathbf{x}_t$ are both $n \times 1$. The error term ε_t is asumed to be *i.i.d.* $N(0, \sigma^2)$.

Let t denote quarter t and $\hat{\boldsymbol{\alpha}}$ and $\hat{\boldsymbol{\beta}}$ the estimates for $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$, respectively, obtained from (1) using OLS. If $\mathbf{x}_{T+1}$ is known an estimate of y_{T+1} is given by

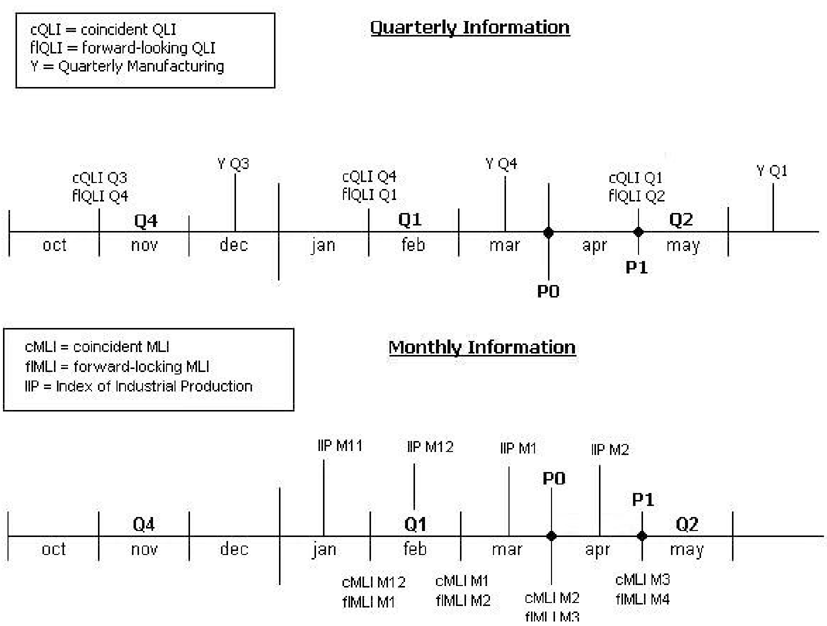
$$\hat{y}_{T+1} = \hat{c} + \hat{\boldsymbol{\alpha}} \mathbf{y}_T + \hat{\boldsymbol{\beta}} \mathbf{x}_{T+1} \tag{2}$$

Let y_t be Manufacturing (Y_q) and use *QLI* and outcome figures of *IIP* as explanatory variables x_t in (1). Estimate the parameters and then use *MLI* instead of unknown figures of *IIP* in (2) to get a *LFE*, also called a *nowcast* of Y_{qT+1}.

Figure 1 shows how the available information depends on where the nowcaster stands in real time. At the end of a quarter, point P_0 (the end of March) the information consists of quarterly and monthly figures. On the quarterly frequency: the outcome Y_{qT} of the last quarter of the previous year and the forward-looking *QLI* for the first quarter, Y_{qT+1}. The latest monthly figures are: *IIP* outcome from January, the coincident *MLI* for February and a forward-looking figure for March.

Moving one month ahead to point P_1 (the end of April) the latest quarterly outcome is still Y_{qT} , but now the *QLI* produces a coincident figure for Y_{qT+1}. Outcomes of *IIP* are available for months one and two. For month three *MLI* has generated a coincident figure. The same procedure repeats itself four times a year.

Figure 1
Publishing times of quarterly and monthly statistics, here specified for quarter one



This timing procedure is made operative by estimating (1) using data on Y_q, *QLI* and *IIP* from the estimation period. Some obsevations at the end of the data set are saved for testing the model in a real situation. Here *MLI* figures substitute for unknown monthly *IIP* outcomes.

3 Data

Quarterly Manufacturing (Y_q) is a Statistical Time Series (*STS*) in levels and constant prices, 1980:Q1–2003:Q2. Here data from 1990:Q1 onwards are used. Calender and outlier effects are estimated in TRAMO and seasonal adjustment is performed on the TRAMO output in SEATS, see Maravall (2002) [9].

The model for *QLI* in Öller & Tallbom (1996) [14] uses data from 1970:Q1–1993:Q4, where 1970:Q1–1987:Q4 was used to estimate the model. The series was transformed into calendar corrected seasonal differences of logarithms; data were not seasonally adjusted. Here the coincident and the forwardlooking *QLI* are transformed into levels, calender and sesonally adjusted using TRAMO/SEATS. The data cover the period 1990:Q1–2003:Q2, of which 2001:Q2 – 2003:Q2 were saved for out of samle testing.

The monthly Index of Industrial Production (*IIP*) is published both as a monthly *STS* (IIP_M) and as a quarterly *STS* (IIP_Q), calculated as a mean of the three months of a quarter. All *IIP* figures in this study are in year 2000 prices and are published in levels. Raw figures were sesonally adjusted using TRAMO/SEATS. The IIP_M is divided into three quartely *STS*, one for each month: IIP_{m1}, IIP_{m2} and IIP_{m3}. Data are from the period 1990:M1–2003:M6.

Dahllöf & Öller (2003) [3] estimated their Monthly Leading Indicators (*MLI*) on data from 1996:M1–2000:M5; observations 2000:M6–2003:M7 were saved for testing. *MLI* figures are given in annual diff. log, but here they are transformed into levels. Since these figures are not used in the regression model and because the series are so short they are not seasonally adjusted. The data cover the period from 2001:M1–2003:M6.

4 Results

The Augumented Dickey Fuller (ADF) test for untit roots, shows that all *STS* in log levels have a unit root. All were stationarized by one difference, except Y_q for which ADF did not decisively reject the null of a unit root in the difference. Given the short time series, we trust in earlier results, Öller & Tallbom (1996) [14] and in the econometric literature, assuming that most macroeconomic time series have a single unit root on frequency zero. Consequently, in all models the time series are in differences of log levels.

Table 1 shows the four models for the estimation period 1990:Q2–2001:Q1. There are two models each for points P_O and P_1, in Figure 1. Models 2.0 and 2.1 are identical within the sample. The difference between 1.0 and 1.1 is that in the former we only have a forward-looking *QLI* (flQLI), but one month later in P_1 the more accurate coincident *QLI* (cQLI) is available.

Table 1
Model specification for time P_0 and P_1, see Fig. 1

Model	Model specification
1.0	$\Delta Log\,\hat{Y}_{qT+1} = \hat{\alpha}_2 \Delta LogY_{qT-1} + \hat{\beta}_1 \Delta LogflQLI_{T+1} + \hat{\beta}_6 \Delta LogIIP_{m3_{T+1}}$
2.0	$\Delta Log\,\hat{Y}_{qT+1} = \hat{\alpha}_2 \Delta LogY_{qT-1} + \hat{\beta}_3 \Delta LogIIP_{Q_{T+1}}$
1.1	$\Delta Log\,\hat{Y}_{qT+1} = \hat{\alpha}_2 \Delta LogY_{qT-1} + \hat{\beta}_2 \Delta LogcQLI_{T+1} + \hat{\beta}_6 \Delta LogIIP_{m3_{T+1}}$
2.1	$\Delta Log\,\hat{Y}_{qT+1} = \hat{\alpha}_2 \Delta LogY_{qT-1} + \hat{\beta}_3 \Delta LogIIP_{Q_{T+1}}$

Table 2 presents the estimation results of the models in Table 1. As soon as IIP_Q is included in a model the *QLI* variables become insignificant. The reason seems to be that *IIP* iformation on the entire quarter outperforms the *QLI*. Note, however, that according to the diagnostics in Table 2, Models 1.0 and 1.1 fit data slightly better than Models 2.0 and 2.1. The reason to this could be that the third month of *IIP* includes information that is poorly covered by *QLI*, based on BTS data, in Christofferson et al.(1992) [2][1] it is shown that forward-looking *QLI* indicates the expected situation in the beginning of the next quarter rather than the average of the whole quarter.

[1] Frequency domain methods reveal that BTS respondents tend to focus on the first part of a quarter.

Table 2
Results in sampel of *OLS* estimaton of the models in Table 1, Probabilities of H_0 in parantheses

	Model 1.0	Model 2.0 & 2.1	Model 1.1
$\hat{\alpha}_2$ (p-value)	0,268 (0,038)	0,463 (0,000)	0,305 (0,006)
$\hat{\beta}_1$ (p-value)	0,233 (0,040)	–	–
$\hat{\beta}_2$ (p-value)	–	–	0,233 (0,025)
$\hat{\beta}_3$ (p-value)	–	0,568 (0,000)	–
$\hat{\beta}_6$ (p-value)	0,807 (0,000)	–	0,775 (0,000)
Log-likelihood	134,22	123,65	134,70
BIC	-6,125	-5,710	-6,147
AIC	-6,249	-5,793	-6,271
RMSE	0,0106	0,0124	0,0097
R_2	0,83	0,71	0,83
Jarque-Bera (p-value)	2,219 (0,330)	0,537 (0,764)	1,741 (0,419)

In Table 3 the models of Table 1 are presented as they appear in a real nowcasting situation (2001:Q2–2003:Q2), where *MLI* data have to stand in for *IIP* figures, not known in points P_0 and P_1 respectively.

Table 3
Model specification for nowcasting models in table 2 at time P_0 and P_1, see Fig. 1

Model	Model specification
1.0*	Model 1.0 with month three from forward-looking *MLI*
2.0*	Model 2.0 with $IIP_{Q_{T+1}}$ as a mean of *IIP* outcome for month one, coincident and forward-looking *MLI* for month two and three respectively
1.1*	Model 1.1 with month three from coincident *MLI*
2.1*	Model 2.1 with $IIP_{Q_{T+1}}$ as a mean of *IIP* outcome for month one and two and coincident *MLI* for month three

Table 4 shows RMSE and the Granger-Newbold test statistic in and out of sample. Within sample the relevant comparison is between the models of Table 2 and *QLI*. One wants to know if the new models of Table 2 are more accurat than the old *QLI*. If the answer is ”yes” then the next question is: does substituting leading monthly data for missing obsevations in a real nowcasting situation significantly impair accuracy? If the answer is ”no” then the *LFE* of Table 3 can be expected to improve on the *QLI*, both in accurancy, of the forward-looking *QLI* and in timeliness, of the coincident *QLI*.

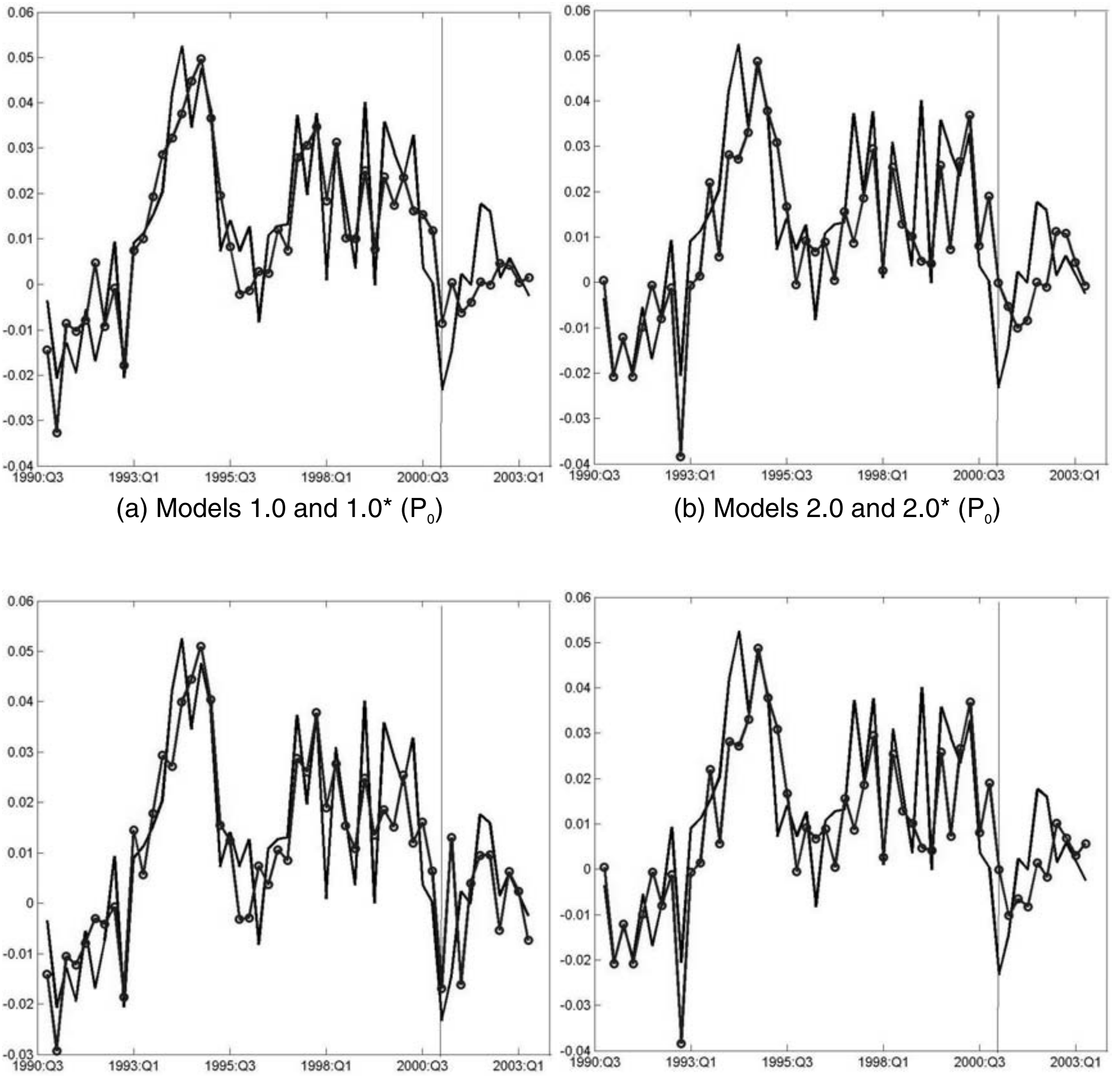
Table 4
Models compared in and out of sample

In sample			Out of sample		
Model	RMSE	*G-N(p-value)*	Model	RMSE	*G-N(p-value)*
Forward-looking QLI	0,0215		Model 1.0	0,0136	
		$8,9 \times 10^{-8} (t > 0)$			0,4111
Model 1.0	0,0106		Model 1.0*	0,0099	
Forward-looking QLI	0,0215		Model 2.0	0,0105	
		$2,2 \times 10^{-5} (t > 0)$			0,9324
Model 2.0	0,0124		Model 2.0*	0,0107	
Coincident QLI	0,0172		Model 1.1	0,0095	
		$3,4 \times 10^{-5} (t > 0)$			0,5320
Model 1.1	0,0097		Model 1.1*	0,0120	
Coincident QLI	0,0172		Model 2.1	0,0105	
		$0{,}0158\ (t > 0)$			0,6576
Model 2.1	0,0124		Model 2.1*	0,0099	

The Granger-Newbold test (*G-N*) confirms that in P_0, Models 1.0 and 2.0 provide a significantly better fit to Y_q than the forward-looking *QLI*. The same conclusion can be made about Models 1.1 and 2.1 vs. the coincident *QLI*.

The same statistical camaparison is made between the models using *IIP* outcome and the ”asterisk models” with *MLI* ”stand ins”. There are no major differences in *RMSE*; in fact in two cases *RMSE* decreases using surrogate *MLI* figures. *G-N* finds no significant differences in accuracy. In other words, we have been able to find Leading Flash Estimators that improve on the present *QLI* both in accuracy and in timeliness. The performance of the models is shown graphically in Figure 2. If one had to chose between the two model specifications in Table 1, the larger models (1.0) and (1.1) would be selected as slightly better than (2.0) and (2.1). The choise of (1.0) instead of (2.0) in P_0 is supported by records in Table 4. But for P_1 the record is ambivalent: (1.1) is more accurate within, but less accurate outside the sample. Anyway, as Figure 2 shows, differences between model nowcasts are small. This is the reason to suggesting two more or less even candidates for monitoring Manufacturing.

Figure 2
Model forecasts within and out of sample compared to outcome



(a) Models 1.0 and 1.0* (P_0)

(b) Models 2.0 and 2.0* (P_0)

(c) Models 1.1 and 1.1* (P_1)

(d) Models 2.1 and 2.1* (P_1)

5 Conclusions

The results show that monthly observations, both real and survey-based leading indicator estimates can improve on the accuracy of a reliable quarterly leading indicator and the timeliness of an ordinary *FE* of Manufacturing. Although this variable is an often cited and sensitive business cycle indicator, many people would prefer to see GDP in its place.

When attempting at a leading flash estimator of GDP, the models presented here could be both a building block and a blueprint for other variables included in GDP. Exports is an analogous case. Long time series of monthly exports are available to proxy for the slightly differently defined quarterly exports of the National Accounts. Business Tendency Survey data concerning quarterly exports have been recorded for decades and monthly analogues are available from 1996 on. The Exports share in Swedish GDP is close to one half. A third GDP component is Private Consumption, which also amounts to one half in the Expenditures Accounts of GDP. In this case the monthly proxy is Retail Trade. The leading information can in this case be obtained from the Consumer Survey.

Assuming that Leading Flash Estimators could be constructed for Exports and Consumption, too, a linear combination of all three could be quite close to GDP. All components would be important for analysts and forcasters in their own right, but the combination would be of even greater interest. Recall that the Leading Indicators contain a turning point alarm. This would be an additional asset, not provided by ordinary Flash Estimators.

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