Freedom of Choice in Macroeconomic Forecasting

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Motivation I1

Simple Questions for Practitioners:

"How do I forecast a specific macroeconomic time series?"

$\Rightarrow$ "Which leading indicator do I choose?"
$\Rightarrow$ "How do I assess a specific indicator?"

Motivation III

Simple Questions for Practitioners:

"How do I forecast a specific macroeconomic time series?"

$\Rightarrow$ "Which leading indicator do I choose?"

$\Rightarrow$ "How do I assess a specific indicator?"

$\Rightarrow$ sheer volume of predictor variables under consideration and an **endless array of forecasting models and time-varying specifications**

$\Rightarrow$ existing literature is mixed

Motivation IV

Contribution of the Paper:

- Illustration of the "Freedom of Choice" in macroeconomic forecasting
- **How does this freedom affects the assessment of an indicator?**
- implications for assessing indicators

We demonstrate the freedom of choice in an extensive case study for German
$\Rightarrow$ **Industrial Production (IP)** and
$\Rightarrow$ *linear models*

$\Rightarrow$ generation of pseudo out-of-sample forecasts in **50** forecasting settings

Motivation V

Related Literature

- Clements and Hendry (2005)
  $\Rightarrow$ eight dichotomies
- Elliot and Timmermann (2008)
  $\Rightarrow$ whole spectrum of the forecasting process

Outline of the Talk

1. Motivation and Background
2. Related Literature for Forecasting German IP
3. The Freedom of Choice
4. Case Study: Results
5. Discussion and Conclusions

Outline of the Talk

1. Motivation and Background
2. **Related Literature for Forecasting German IP**
3. The Freedom of Choice
4. Case Study: Results
5. Open Questions and Future Research

Article	Reference Series	Indicator	Approach	Forecasting method and horizon	Forecast Evaluation
Breitung and Jagodzinski (2001)	Industrial production, seasonal and work-daily adjusted, approximate yearly growth rates (log differences), 1991:01 - 2001: 06	Ifo, ZEW, COM, FAZ	Bivariate VAR, ex ante, restricted and unrestricted	Recursive, one-step ahead forecasts (1999:01 - 2001:06)	Benchmark model: AR , RMSE, Theils U
Fritsche and Stephan (2002)	Industrial production (excluding construction), approximate yearly growth rates (log differences), 1978:01 - 1998:12	Ifo	Bivariate VAR up to 12 lags, restricted to significant t-values	Recursive (constant lag structure), 3 and 6 months ahead (1991:01 - 1998:12)	Benchmark model: AR, RMSE, Theils U
Hüfner and Schröder (2002)	Industrial production, seasonal adjusted from Deutsche Bundesbank, exact yearly growth rates, 1991:12 - 2000:12	Ifo, ZEW	Bivariate VAR with lag structure obtained from univariate regressions for the dependent variable + BIC for the lags of the other variables	Recursive (constant lag structure), forecast horizon: 1, 3, 6, 9, 12 months, (1994:01 - 2000:09)	Benchmark model: RW RMSE, Theils U, Modified Diebold-Mariano test, Encompassing test
Benner and Meier (2004)	Industrial production, seasonal adjusted from Deutsche Bundesbank, exact, monthly growth rates, 1991:12 - 2000:12, dummies for outliers	Ifo, ZEW	Bivariate vector error correction, dummies for outliers, BIC, restricted to significant t-values	Recursive (constant and recursive lag structure), forecast horizon: 1, 3, 6, 9, 12 months (1994:01 - 2000:09)	Benchmark model: AR RMSE, Theils U, Diebold-Mariono test
Dreger and Schumacher (2005)	Industrial production, seasonal unadjusted, approximate yearly growth rates (log differences), 1992:01 - 2004:12	Ifo, ZEW, FAZ, COM	Bivariate VAR	iterated forecasts, ex ante and ex post approach, OSC criterion (flexible lag structure), Forecast horizon: 1, 3, 6, 9, 12 months (1998:01-2004:12)	Benchmark model: AR , Diebold-Mariano test, pooling forecasts

Related Literature IP

Assessment of leading indicators:

Breitung and Jagodzinski (2001): unrestricted: FAZ>ZEW>COM>Ifo,
restricted: COM>IFO>ZEW>FAZ

Hüfner and Schröder (2002): ZEW>Ifo

Benner and Meier (2004): Ifo>ZEW

Dreger and Schumacher (2005): ⇒ Ex Post and Ex Ante: FAZ>ZEW>COM>IFO

Is there a robust indicator for German IP?

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Freedom of Choice I

This presentation draws partly on Clements and Hendry (2005) and Elliot and Timmermann (2007).

Table 1: Data and Model Considerations

Data	Estimation Window	Forecasting Approach	Model	Restrictions	Selection Criterion
monthly exact	rolling	direct	ARX(p, r)	yes	AIC
yearly exact	recursive	indirect	VAR(p)	no	BIC
					OSC

Freedom of Choice II

Time Series to be forecasted

German Industrial Production (Seasonal and workday adjusted), 1991-2006:

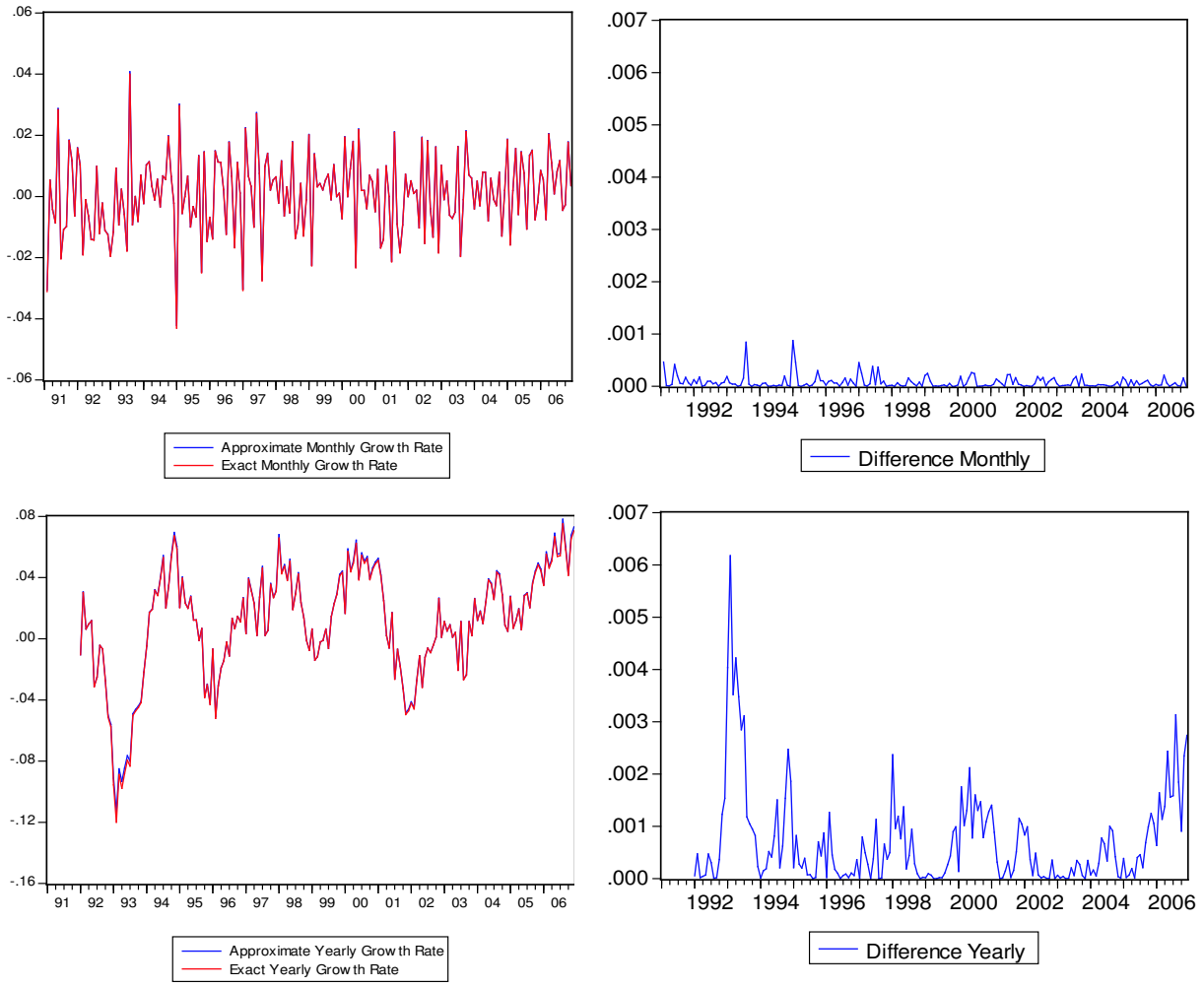
$\Rightarrow$ 4 possible representations

- Monthly exact growth rates
- Monthly approximate growth rates (log differences)
- Yearly exact growth rates
- Yearly approximate growth rates (log differences)

We employ the exact transformations.

Freedom of Choice III

Figure 1: Representations of Industrial Production in Germany



Freedom of Choice IV

Leading Indicators for IP

Table 2: Leading Indicators

Indicator	Provider	Label
Ifo Business Climate	Ifo Institute	ifo
ZEW Economic Sentiment	ZEW Institute	zew
Early Bird Indicator	Commerzbank	com
OECD Composite leading indicator for Germany	OECD	OECD
FAZ Indicator	FAZ Institute	faz
Employment Growth	Bundesbank	emp
Interest Rate: overnight	IMF	rovnght
Interest rate spread = long term Gov. Bonds − rovnght	IMF	rspread
Factor		factor
AR Benchmark		AR

Freedom of Choice V

Estimation Window: Rolling vs. Recursive

Rolling: fixed data window to re-estimate the parameters of the out-of-sample period

Recursive: increasing data window

Freedom of Choice VI

Forecasting Approach: Direct vs. indirect

Direct: regression of a multiperiod ahead value of the dependent variable on current and past values of the variable

$$y_{t+h} = \beta + \sum_{i=1}^{p} \delta_i y_{t+1-i} + \sum_{j=1}^{r} \gamma_j x_{t+1-j} + \varepsilon_{t+h} \tag{1}$$

Indirect (iterated or plug-in): estimation of an autoregression then iterating to obtain the multiperiod forecast

$$y_{t+1} = \alpha + \sum_{i=1}^{p} \phi_i y_{t+1-i} + \sum_{j=1}^{r} \theta_j x_{t+1-j} + \varepsilon_t \tag{2}$$

$\Rightarrow$ trade off between bias and estimation variance

$\Rightarrow$ decision is an empirical one (Marcellino et al. 2006), indirect specification seem to be superior

Freedom of Choice VII

Information Set: Ex ante vs. ex post

Ex ante: uses only information available at the forecast horizon $\Rightarrow$ indicator has to be forecasted (in the indirect approach)

Ex post: information from the period being forecasted is used ("perfect foresight")

Freedom of Choice VIII

Forecasting Models

$\Rightarrow$ **ARX(p, r)**

$\Rightarrow$ **VAR(p)**

$\Rightarrow$ No non-linear time series models

Freedom of Choice IX

Model Selection Criterion

$\Rightarrow$ **AIC**

$\Rightarrow$ **BIC**

$\Rightarrow$ **OSC** (out-of-sample criterion, or final prediction criterion)

Freedom of Choice X

Restricted vs. unrestricted

possibility of overparametrization

⇒ **unrestricted:** inclusion of insignificant lags

⇒ **Restricted:** deletion of insignificant parameters and re-estimation until all parameters are significant

Outline of the Talk

1. Motivation and Background
2. Related Literature for Forecasting German IP and GDP
3. The Freedom of Choice
4. **Case Study: Results**
5. Open Questions and Future Research

Case Study

9 indicators plus benchmark and 2 time series to be forecasted

For each combination:

- Rolling vs. Recursive
- Restricted vs. Unrestricted
- AIC vs. BIC vs. OSC
- ex post vs. ex ante
- direct vs. indirect

Case Study: Results

We present the results in three steps

1. The Winners
2. The Ordinal Ranking
3. Forecast combinations

Table 5: Forecast Competition - Yearly Growth Rates - Best Indicator

	Horizon →	1		3		6		12	
Model	Criterion ↓	Recursive	Rolling	Recursive	Rolling	Recursive	Rolling	Recursive	Rolling
ARX(p, r)	AIC	factor	**factor**	factor	factor	factor	factor	oecd	oecd
unrestricted	BIC	factor	faz	factor	factor	factor	factor	rovnght	rovnght
indirect, ex ante	OSC	factor	factor	factor	factor	factor	factor	com	ifo
ARX(p, r)	AIC	factor	factor	factor	factor	factor	factor	zew	com
restricted	BIC	factor	factor	factor	factor	factor	factor	rovnght	rovnght
indirect, ex ante									
ARX(p, r)	AIC	factor	factor	**faz**	factor	faz	factor	faz	factor
unrestricted	BIC	factor	faz	faz	faz	faz	faz	**faz**	faz
indirect, ex post	OSC	factor	factor	faz	faz	faz	**faz**	faz	faz
ARX(p, r)	AIC	factor	factor	faz	factor	faz	faz	faz	factor
restricted	BIC	factor	factor	faz	faz	faz	faz	faz	faz
indirect, ex post									
ARX(p, r)	AIC	AR	AR	AR	AR	com	AR	com	AR
unrestricted	BIC	AR	AR	factor	AR	com	AR	com	AR
direct, ex ante	OSC	factor	factor	faz	AR	faz	AR	com	AR
ARX(p, r)	AIC	AR	AR	AR	AR	com	AR	com	AR
restricted	BIC	AR	AR	factor	AR	com	AR	com	AR
direct, ex ante									
Bivariate VAR(p)	AIC	factor	factor	factor	factor	rovnght	AR	rovnght	rovnght
unrestricted	BIC	AR	AR	factor	factor	factor	factor	rovnght	rovnght
indirect, ex ante	OSC	faz	faz	faz	faz	faz	faz	com	com
Bivariate VAR(p)	AIC	faz	factor	factor	factor	faz	factor	rovnght	com
restricted	BIC	AR	AR	factor	factor	rspread	factor	rovnght	com
indirect, ex ante									
Bivariate VAR(p)	AIC	factor	factor	faz	AR	AR	AR	rovnght	rovnght
unrestricted	BIC	AR	AR	rovnght	com	rspread	AR	com	AR
direct, ex ante	OSC	faz	faz	faz	faz	factor	AR	rovnght	emp
Bivariate VAR(p)	AIC	faz	factor	faz	AR	com	AR	rovnght	rovnght
restricted	BIC	AR	AR	rovnght	com	rspread	AR	com	AR
direct, ex ante									

Table 6: Forecast Competition - Monthly Growth Rates - Best Indicator

	Horizon →	1		3		6		12	
Model	Criterion ↓	Recursive	Rolling	Recursive	Rolling	Recursive	Rolling	Recursive	Rolling
ARX(p,r)	AIC	rspread	factor	rspread	rspread	rovnght	rovnght	rovnght	rovnght
unrestricted	BIC	factor	factor	faz	zew	com	rovnght	rovnght	rovnght
indirect, ex ante	OSC	rovnght	factor	rspread	factor	oecd	ifo	zew	zew
ARX(p,r)	AIC	factor	rspread	rspread	**rspread**	ifo	ifo	rovnght	rovnght
restricted	BIC	factor	factor	faz	zew	com	rspread	rovnght	zew
indirect, ex ante									
ARX(p,r)	AIC	rspread	factor	rspread	rspread	rspread	rspread	rspread	rspread
unrestricted	BIC	factor	factor	emp	com	faz	emp	faz	emp
indirect, ex post	OSC	rovnght	factor	ifo	ifo	ifo	factor	factor	**factor**
ARX(p,r)	AIC	factor	rspread	rspread	rspread	rspread	rspread	oecd	rspread
restricted	BIC	factor	factor	faz	com	**faz**	com	faz	oecd
indirect, ex post									
ARX(p,r)	AIC	AR	AR	faz	AR	rovnght	AR	AR	AR
unrestricted	BIC	AR	AR	rspread	AR	oecd	AR	emp	AR
direct, ex ante	OSC	AR	AR	faz	AR	emp	emp	emp	emp
ARX(p,r)	AIC	AR	AR	faz	AR	rovnght	oecd	AR	AR
restricted	BIC	AR	AR	zew	AR	oecd	AR	faz	AR
direct, ex ante									
Bivariate VAR(p)	AIC	factor	factor	faz	zew	rovnght	rovnght	rovnght	factor
unrestricted	BIC	faz	faz	factor	factor	rovnght	rovnght	rovnght	rovnght
indirect, ex ante	OSC	factor	**factor**	rspread	rspread	emp	AR	factor	rovnght
Bivariate VAR(p)	AIC	rspread	factor	rspread	rspread	ifo	rspread	rovnght	zew
restricted	BIC	faz	com	factor	factor	rovnght	ifo	rovnght	zew
indirect, ex ante									
Bivariate VAR(p)	AIC	factor	factor	factor	factor	factor	rspread	AR	AR
unrestricted	BIC	faz	faz	factor	factor	rovnght	ifo	com	com
direct, ex ante	OSC	factor	factor	factor	factor	rovnght	rspread	rovnght	com
Bivariate VAR(p)	AIC	rspread	factor	factor	factor	com	rspread	AR	AR
restricted	BIC	faz	com	factor	factor	faz	ifo	com	AR
direct, ex ante									

Figure 2: Ranking of leading indicators: Yearly growth rates

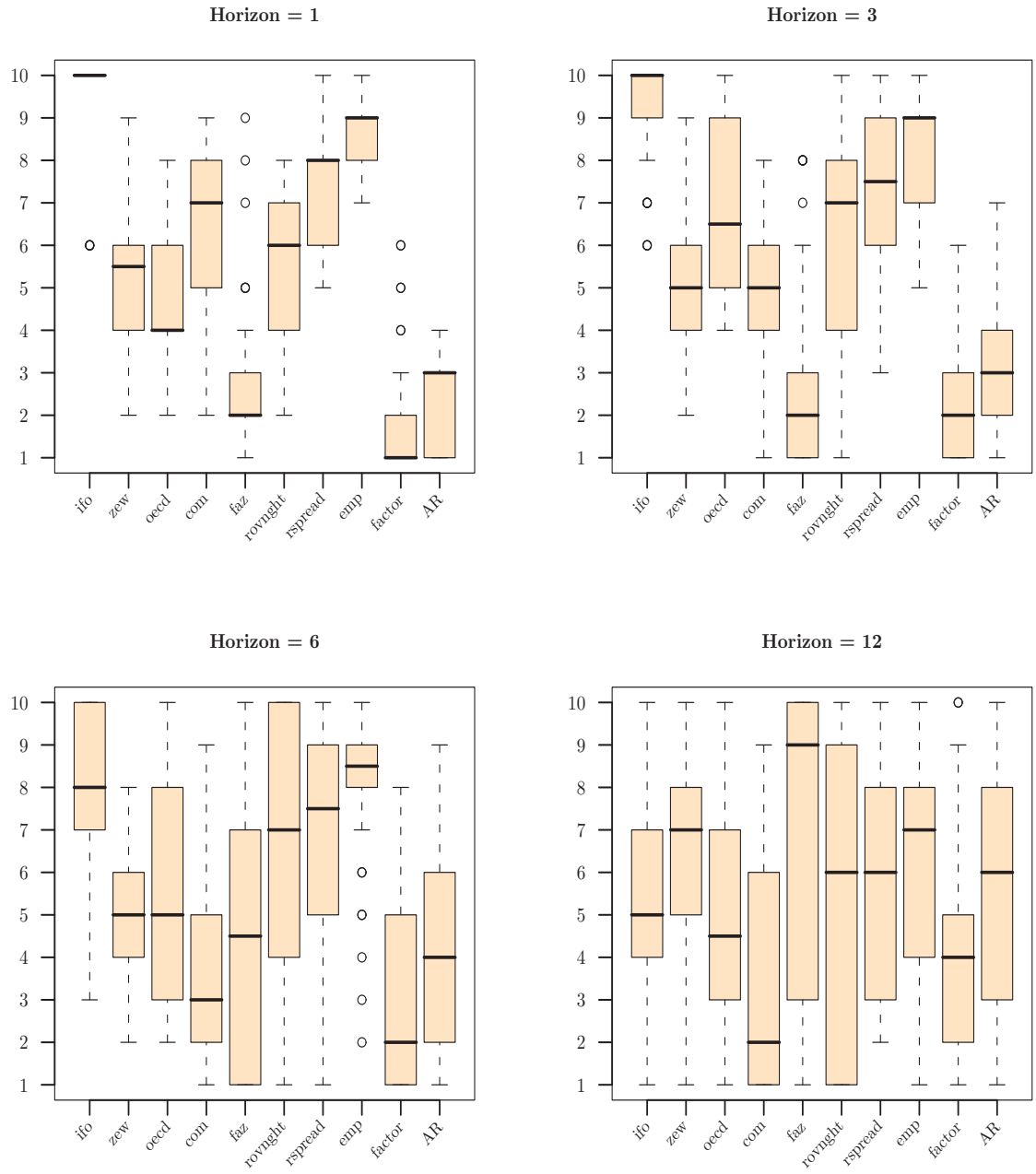
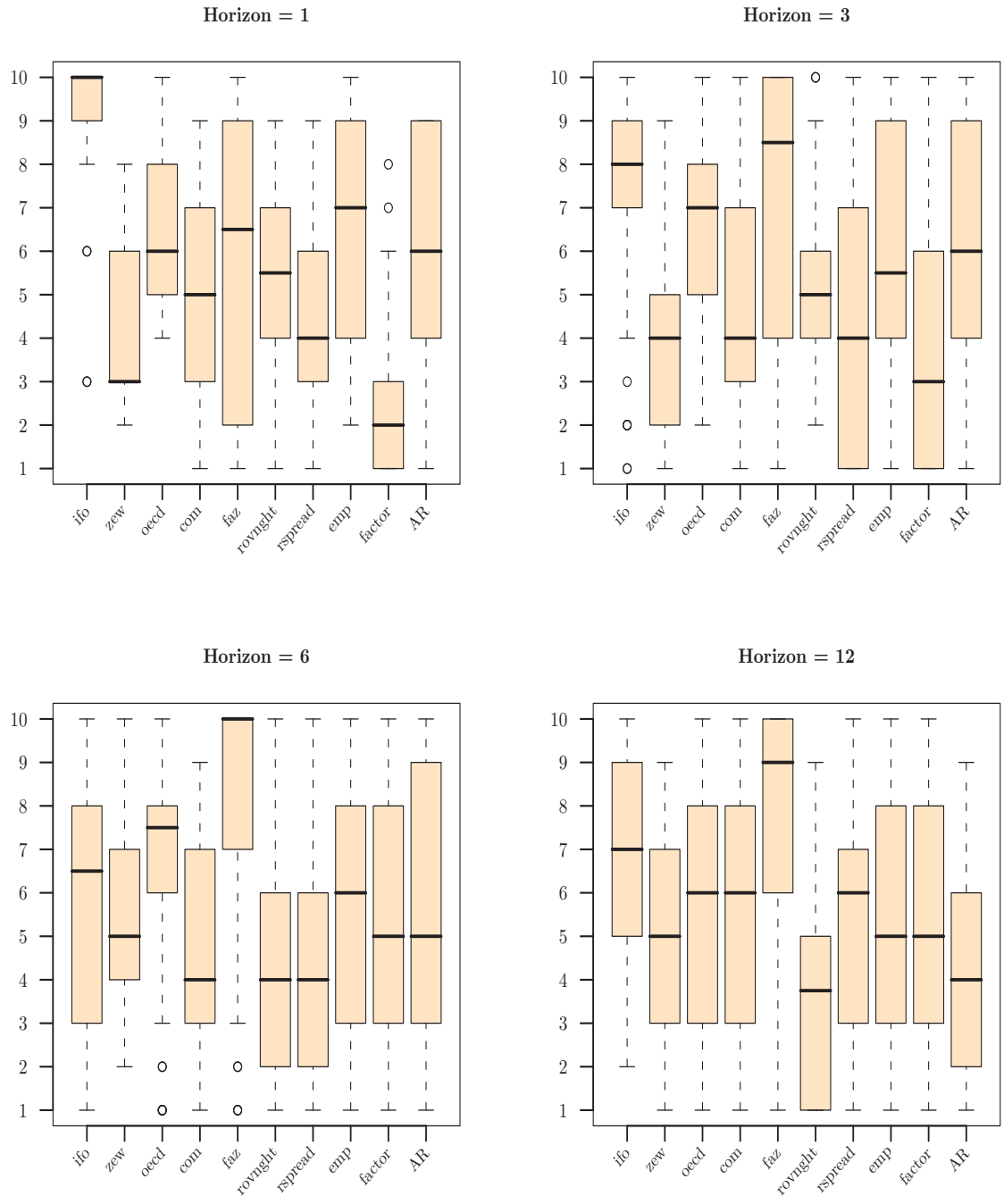


Figure 3: Ranking of leading indicators: Monthly growth rates



Case Study: Results

Table 3: Forecast combinations: Yearly growth rates

	$h = 1$	$h = 3$	$h = 6$	$h = 12$
Minimum RMSE	0.100	0.142	0.213	0.401
Indicator	factor	faz	faz	faz
Equal weights (EW)	0.155	0.206	0.362	0.820
Trimmed (50% of EW)	0.135	0.162	0.280	0.612
Inverse MSE weights (IW)	0.169	0.215	0.314	0.369
Trimmed (50% of IW)	0.150	0.190	0.293	0.371

Case Study: Results

Table 4: Forecast combinations: Monthly growth rates

	$h = 1$	$h = 3$	$h = 6$	$h = 12$
Minimum RMSE	0.069	0.101	0.115	0.091
Indicator	factor	rspread	faz	factor
Equal weights (EW)	0.083	0.114	0.121	0.110
Trimmed (50% of EW)	0.074	0.109	0.118	0.104
Inverse MSE weights (IW)	0.106	0.123	0.123	0.133
Trimmed (50% of IW)	0.083	0.103	0.114	0.098

Case Study: Summary I

General Summary

$\Rightarrow$ indicator performance depends on the forecasting setting

- Rolling dominates Recursive (70:30)
- OSC>BIC>AIC
- indirect seems to dominate the direct approach

Case Study: Summary II

General Summary

$\Rightarrow$ it is almost always possible to find forecasting settings where one indicator is better than another and vice versa

- FAZ and Factor are robust indicators
- Forecast combinations do not improve the best single model

$\Rightarrow$ The variety of forecasting settings allows you to identify robust indicators

Implications

Implications for the assessment of indicators

1. Justify your data transformation
2. Consider a wide range of indicators
3. Consider more than one model class (ARX, VAR, VECM, ...) and specifications (AIC, BIC ...)

Given the large information set:

$\Rightarrow$ Robustness of indicators

$\Rightarrow$ Forecast combinations across indicators, models and estimation windows