1	by 0 1.1 1.2 1.3 1.4	General considerations on composite indicators	17 19 20 21 21 22
I	His	istorical Overview and Definitions	26
2	Bus	siness Cycles Theories: An Historical Overview	
	by C	Gian Luigi Mazzi and Ataman Ozyildirim	27
	2.1	Introduction	29
	2.2	, ,	29
		2.2.1 Jevons' sunspots theory	30
		2.2.2 Moore's Venus theory	30
	2.3		30
	2.4	,	33
		2.4.1 Under-consumption Economic Cycles	34
		2.4.2 The savings-investment theories	34
	2.5	Cambridge School of thought	35
		2.5.1 Purely monetary theory of Hawtrey	35
		2.5.2 The real economic theory of cyclical fluctuations of I	Robertson 36
		2.5.3 The post-great depression theories	36
		2.5.4 Schumpeter's Innovation Theory	37
		2.5.5 Psychological theory of cyclical fluctuations	42
	2.6	,	43
		2.6.1 The Harrod-Domar model	45
		2.6.2 Samuelson's oscillator model	46
	2.7	The empirical revolution of Burns and Mitchell	46
		2.7.1 Measuring the business cycle: the NBER approach	48
		2.7.2 Composite indexes	48
		2.7.3 Calculating the composite indexes	49
		2.7.4 Diffusion indexes	49
		2.7.5 Forecasting recessions	49
	2.8	Other definitions of cycles	50
		2.8.1 Growth cycle	51
		2.8.2 Acceleration cycle	53
		2.8.3 Unified framework	53

	2.9	Contemporary theories	54
		2.9.1 Neo- and post-Keynesian theories	55
		2.9.2 Neoclassical theories	57
	2.10	The evolution of business cycle tools	60
	2.11	New challenges after the global economic and financial crisis	62
	2.12	2 Conclusions	63
3	Defi	initions and Taxonomy of Indicators	
	by A	Andrea Carriero, Massimiliano Marcellino and Gian Luigi Mazzi	73
	3.1	Introduction	75
	3.2	Taxonomy of cyclical composite indicators	76
		3.2.1 CCI by timing	76
		3.2.2 CCI by targeted pattern	77
		3.2.3 CCI by kind of compilation method	77
		3.2.4 More ways to classify indicators	79
	0.0	3.2.5 Summary of Indicators	79
	3.3	Constructing a cyclical composite indicator	81
		3.3.1 Aggregation based composite coincident indicators	81
		3.3.2 Factor-based composite indicators	81
		3.3.3 Markov-switching-based CCI	85 86
	3.4	3.3.4 Pooling-based CCI CCIs for European countries	87
	3.4	3.4.1 Factor-based CCIs	88
		3.4.2 Markov-switching-based CCIs	93
	3.5	Conclusions	95
	Anne		96
		Correlations of alternative CCIs	96
Ш	Sta	atistical and Modelling Prerequisites	108
4	Data	a Availability, Frequency and Adjustment Techniques	
_		Jan van den Brakel, Sabine Krieg, Pim Ouwehand, Frank van de Pol, Floris van Ruth, Marc	
	_	eets and Piet Verbiest	109
	4.1	Overview	111
	4.2	Quantifying discontinuities in sample surveys	111
		4.2.1 Introduction	111
		4.2.2 Quantifying discontinuities in sample surveys	113
		4.2.3 Adjusted series, back-casting	115
	4.3	Missing, delayed or incomplete information	115
		4.3.1 Newly realised buildings	116
		4.3.2 Consumer confidence and social media data	116
		4.3.3 New orders for establishments	117
		4.3.4 Administrative data or surveys?	117
	4.4	Mixed frequency data and delayed results	118
	4.5	Incomplete data and indices	119
		4.5.1 Introduction	119
		4.5.2 An observation period that does not match with the reporting period	119
		4.5.3 On chain estimators and changes in population or sample	120
	1.0	4.5.4 Chain linked versus fixed base price indicators	122
	4.6	Seasonal adjustment in times of strong economic changes	123
		4.6.1 The problem and the options	123

		4.6.2 The case of the economic crisis of 2008-2010 as reported in the Netherlands	124
	Anne		131
	4.A	Modelling interrupted time series	131
5	Revi	iew of Parametric and Non-Parametric Variable and Model Selection Techniques	
		Dominique Guégan	143
	-	Introduction	145
		Parametric modellings for variable and model selection	145
	5.3	Non-Parametric Modellings	146
	5.4	Model and Variable selection	150
		5.4.1 Encompassing test: a simple approach for linear modelling	150
		5.4.2 Criteria for model selection	151
		5.4.3 Encompassing tests using a predictive approach	153
		5.4.4 Model selection for linear and non-linear dynamics with non-parametric techniques	154
	5.5	Discussion	155
		5.5.1 The data	155
		5.5.2 Encompassing test and linear modellings	156
	5.6	Conclusion	160
	Anne	ex .	161
	5.A	Tables	161
6	Varis	able Reduction and Variable Selection Methods using Small, Medium and Large Datasets:	
		precast Comparison for the PEEIs	
		George Kapetanios, Massimiliano Marcellino and Fotis Papailias	169
	_	Introduction	171
	6.2	Methodology	172
		6.2.1 Variable Selection Methods	172
		6.2.2 Non-Standard Optimisation Algorithms	173
		6.2.3 Variable Reduction Methods	176
		6.2.4 From Large to Small and Medium Datasets	178
		6.2.5 Parameters Setup and Normalisation	179
	6.3	Forecasting Exercise and Data Description	180
		6.3.1 Benchmark: AR(1)	181
	6.4	Discussion of Results	182
		6.4.1 Forecasting the GDP Growth Rate	182
		6.4.2 Forecasting the Consumption Growth Rate	182
		6.4.3 Forecasting the Industrial Production Growth Rate	183
		6.4.4 Forecasting the HICP Growth Rate	183
	6.5	Conclusions	183
	Anne	ex	185
	6.A	Tables	185
	6.B	Labels and Groups of Variables used and Transformations	206
	6.C	Transformations	208
	Co	mposite Indicators to Anticipate Cyclical Movements	214
10.0		imposite indicators to Anticipate Cyclical Movements	<u> </u>
7		Overview of Cyclical Indicators	
	by G	Gian Luigi Mazzi and Ludovic Calès	215
	7.1	Introduction	217
	7.2	Identification of the reference variable	217
	7.3	Choice of the reference cycle	218

	7.4	Selection of the statistical methods	218
	7.5	Review of the literature	219
	7.6	On existing leading indicators	220
	7.7	Guide to the part	220
	7.8	Conclusions	221
8	Busi	iness Cycle Indicator Approach at The Conference Board	
		Ataman Ozyildirim	225
	8.1	Introduction	227
	8.2	How are Indicators Selected	227
		8.2.1 Classification by Cyclical Timing	228
		8.2.2 Classification by Economic Process	228
	8.3	Composite Indexes	229
	8.4	Aggregating Cyclical Indicators	230
		8.4.1 Changes to Index Methodology	230
		8.4.2 Trend Adjustment of the Composite Indexes	231
	8.5	Benchmarking the Composite Indexes	232
		8.5.1 Reasons for Changes in the Composition of the Indexes	232
		8.5.2 Criteria based on quality of component indicators	233
		8.5.3 Criteria based on how the LEI is used or interpreted	233
		8.5.4 2012 Comprehensive Revisions to the LEI for the United States	235
	Anne		236
		Index Calculation Methodology	236
	8.B	United States Composite Economic Indexes: Components	238
9	Alte	rnative Detrending Methods	
	by G	Gian Luigi Mazzi, James Mitchell and Ataman Ozyildirim	241
	9.1	Introduction: The importance of detrending time-series	243
	9.2	Distinguishing the "growth" and "classical" business cycles	244
	9.3	Classifying detrending methods	245
		9.3.1 Trend-cycle decompositions methods	245
	0.4	9.3.2 Deterministic versus stochastic trends	246
	9.4	Parametric vs nonparametric	247
		9.4.1 Parametric measures	247
		9.4.2 Non-parametric measures	251
	0.5	9.4.3 BN trends as limiting trends	255
	9.5	Univariate versus multivariate methods	255
		9.5.1 Theoretical foundations9.5.2 Multivariate UC models	255
		9.5.3 Multivariate HP trends	256 257
		9.5.4 Multivariate nonparametric filters	257
		9.5.5 Multivariate BN trends	257
		9.5.6 Structural VAR (SVAR) decompositions	258
		9.5.7 Production function approaches	260
		9.5.8 DSGE Models and the Output Gap	260
	9.6	Linear versus nonlinear detrending models	261
	9.7	Accommodating uncertainty when detrending	261
	9.8	Performance in real-time: The "end point" problem	262
	0.0	9.8.1 The nature of real-time or end-of-sample cyclical estimates	262
		9.8.2 Improving the reliability of end-of-sample cyclical estimates	262
	9.9	Evaluating alternative detrending methods	263
		Aggregate and disaggregate European growth cycle	263

	9.11 Conclusions	266
10	The OECD System of Composite Leading indicators	
	by Gyorgy Gyomai, Nadim Ahmad and Roberto Astolfi	273
	10.1 Historical background	275
	10.2 Purpose	275
	10.2.1 Defining and measuring the business-cycle	275
	10.2.2 Qualitative nature of the CLIs	277
	10.2.3 The short-term outlook	278
	10.3 Why rely on composite indicators?	279
	10.4 Methodology	279
	10.4.1 Overview: Building blocks	279
	10.4.2 Pre-selection	280
	10.4.3 Filtering	282
	10.4.4 Evaluation	285
	10.4.5 Aggregation	286
	10.5 Dissemination	287
	10.5.1 Audience	287 288
	10.5.2 Coverage 10.5.3 Presentation of results	288
	10.5.3 Presentation of results 10.6 Revisions	290
	10.7 Conclusion	290
	10.7 Conclusion	230
11	The Stock and Watson Approach to Composite Indexes of Coincident and Leading Indicators	
	by Filippo Moauro	293
	11.1 Introduction	295
	11.2 Main motivations and historical elements	295
	11.3 The coincident index	296
	11.3.1 Model formulation	296
	11.3.2 Identifying assumptions	297
	11.3.3 Preliminary analysis	298
	11.3.4 Statistical treatment	298
	11.3.5 Empirical application	299
	11.4 The leading index	299
	11.4.1 Deriving the model	299
	11.4.2 The leading index for the US economy	300
	11.5 The recession index	301
	11.6 Stock and Watson's pros and cons	303
	11.7 Extensions, application and link to related literature	304
	11.7.1 Empirical applications outside US	305
	11.8 Main applications by statistical agencies 11.8.1 Extensions towards mixed frequency models	306
	11.8.2 Extensions towards multi-factor models	307
	11.8.3 The application to the Euro Area	308
	11.9 Conclusions	309
	11.5 Conductions	000
13.7	Tourism Deint Indicators	04.4
IV	Turning Point Indicators	314
12	An Overview of Alternative Turning Points Composite Indicators	
	by Gian Luigi Mazzi and Ludovic Calès	315
	12.1 Introduction	317

	12.2	Identification of the reference variable	317
	12.3	Identification of the reference cycle	319
	12.4	Methodology	319
	12.5	Review of the literature	320
	12.6	Guide to the part	321
	12.7	Conclusions	322
13		metric Models for Cyclical Turning Point Indicators	
	-	aurent Ferrara and Gian Luigi Mazzi	327
		Introduction	329
	13.2	Binary response models	330
		13.2.1 The standard model	330
		13.2.2 Inference for standard models	330
		13.2.3 Extensions of binary response models for business cycle analysis	331
	100	13.2.4 Applications of standard binary response models	334
	13.3	Markov-Switching models	335
		13.3.1 The Markov-Switching model 13.3.2 Statistical inference	335 336
		13.3.3 Extensions	337
		13.3.4 Applications	338
	13 /	Threshold models	339
	13.4	13.4.1 The standard model	340
		13.4.2 Statistical inference	340
		13.4.3 Extensions	342
		13.4.4 Applications	343
	13.5	Smooth transition models	344
	10.0	13.5.1 The standard model	344
		13.5.2 Statistical inference	345
		13.5.3 Extensions	346
		13.5.4 Applications	347
	13.6	Evaluation of models for construction of CCIs	348
14		posite Cyclical Indicators Detecting Turning Points Within the ABCD Framework	
	-	acques Anas, Leonardo Carati, Monica Billio, Laurent Ferrara and Gian Luigi Mazzi	357
		Introduction	359
	14.2	Extended $\alpha AB\beta CD$ approach	359
		14.2.1 The $ABCD$ approach for business and growth cycles	360
		14.2.2 Extension of the $ABCD$ approach to the acceleration cycle	360
		14.2.3 Examples	362
	14.3	Dating chronologies	363
		14.3.1 Why is it important?	363
		14.3.2 Methodology	363
		14.3.3 Comparing chronologies	367
		14.3.4 Euro area chronologies	368
	14.4	Construction of turning point indicators	368
		14.4.1 Data selection	369
		14.4.2 Model selection	370
		14.4.3 Assessment of turning point indicators	373
	445	14.4.4 A set of euro area coincident indicators: An empirical illustration	375
		Conclusions Annex	384
	14.0	14.6.1 Introduction	385 385
		TT.O. I IIII OUUGIOH	പ്ര

	 14.6.2 Preliminary steps to the construction of turning points indicators 14.6.3 Steps towards the construction of turning points indicators 14.6.4 Model validation and the identification of the best indicator(s) 14.6.5 Conclusions 	385 388 392 395
V	Growth Composite Indicators	400
15	An Overview of Growth Composite Indicators	
	by Gian Luigi Mazzi, Ludovic Calès	401
	15.1 Introduction	403
	15.2 The selection of the reference variable	403
	15.3 The definition of the short-term pattern	404
	15.4 Methodology	404
	15.5 Review of the literature	405
	15.6 Some regularly available coincident and leading indicators15.7 Guide to the part	406 406
	15.8 Conclusions	407
16	An Automatic Leading Indicator, Variable Reduction and Variable Selection Methods using Small and Large Datasets: Forecasting the Industrial Production Growth for Euro Area Econo	mies
	by Gonzalo Camba-Mendez, George Kapetanios, Martin R. Weale and Fotis Papailias	411
	16.1 Introduction	413
	16.2 Methodology	413
	16.3 Forecasting and Data Description16.4 Discussion of Results	414 416
	16.4.1 Small Dataset of Predictors	416
	16.4.2 Large Dataset of Predictors	416
	16.5 Concluding Remarks	417
	Annex	418
	16.A Tables	418
	16.B Large dataset of predictors: Labels	423
	16.C Large dataset of predictors: Transformations	425
17	Large-Dimensional Dynamic Factor Models in Real-Time	
	by Matteo Luciani	429
	17.1 Introduction	431
	17.2 Dynamic Factor Models	432
	17.2.1 Representation	432
	17.2.2 Estimation	433
	17.2.3 Large-Dimensional Factor Models in Real-Time	435
	17.3 Predicting Economic Activity	436
	17.3.1 Nowcasting	438
	17.4 Constructing Business Cycle Indicators	439
	17.5 Large-Dimensional Databases	443
	17.5.1 Large- vs. Small-Dimensional Databases	443
	17.5.2 How to construct the database 17.6 Conclusions	444 445
	Annex	445
	17.A Annex	447
	17.A.1 Pervasive and non-pervasive shocks	447
	17.A.2 Generalized Principal Components	448
	- It is a second account.	

	17.A.3 The Expectation-Maximization Algorithm	448
	17.A.4 State-Space representation with mixed frequencies	451
	17.A.5 Extensions of the Dynamic Factor Model	451
18	Regression, Principal Components and Small Scale Factors Based Models	
	by Françoise Charpin	461
	18.1 Introduction	463
	18.2 Data issues	464
	18.2.1 About hard data	464
	18.2.2 About survey data	464
	18.2.3 About financial data	465
	18.3 Bridge equations	465
	18.3.1 Description of bridge equations	465
	18.3.2 Estimation of the French GDP growth by a bridge error correction model	467
	18.3.3 Estimation of the US GDP growth by a bridge error correction model	468
	18.4 Principal components regression	470
	18.4.1 Description of principal components regression	470
	18.4.2 Estimation of the euro area GDP growth by a factor model	472
	18.5 Forecasting missing data	473
	18.5.1 Methodology	474
	18.5.2 Forecasting the euro area IPI monthly growth by a factor model	474
	18.6 Mixed-data sampling (MIDAS) models	475
	18.7 Conclusion	477
	Annex	478
	18.A LARS algorithm: A short description	478
	18.A.1 Definition of an equiangular vector	478
	18.A.2 Notations	478
	18.A.3 Iterations	479
VI	Evaluation and Dissemination of Cyclical Composite Indicators	482
19	How did the OECD Composite Leading Indicators Perform in the Run-up to, and During, the	
	Great Recession? A Real-Time Analysis with a Focus on G7 Countries	
	by Roberto Astolfi, Michela Gamba, Emmanuelle Guidetti and Pierre-Alain Pionnier	483
	19.1 Introduction	485
	19.2 When were the turning points of the Great Recession identified and first announced?	485
	19.3 Turning point detection	486
	19.3.1 Chronology of events	487
	19.3.2 Assessment of CLI leading properties based on the latest CLI vintage	487
	19.3.3 Real-time analysis	488
	19.4 Conclusions	491
	Annex	493
	19.A Annex	493
20	An overview of Existing Business Cycle Clock Applications and Some Proposals for Further	
	Improvement	0/05
	by Jaques Anas, Gian Luigi Mazzi, Rosa Ruggeri Cannata, Dan A. Rieser and Claudio Parrach	
	20.1 Introduction	497
	20.2 Main features of existing Business Cycle Clocks (BCC) 20.2.1 Historical overview	498 498
		498
	20.2.2 Methodology	450

	20.2.3 Indicators and graphical representation	499
	20.3 Overview and comparison of existing Business Cycle Clocks	499
	20.3.1 Overview of existing Business Cycle Clocks	499
	20.3.2 Comparison of existing Business Cycle Clocks	503
	20.4 Remarks on the former Eurostat business cycle clock and lines of improvement	504
	20.4.1 Remarks on the former Eurostat business cycle clock	504
	20.4.2 Lines of development for the new Eurostat BCC	505
	20.5 Methodology: Eurostat system for cyclical analysis	505
	20.6 Layout of the new BCC	508
	20.7 Structure of the clock	
		509
	20.8 Examples	511
	20.9 Conclusions	513
21	Comparing Alternative Composite Indicators for Euro Area GDP	517
	by Gian Luigi Mazzi and Rosa Ruggeri Cannata 21.1 Introduction	517
		519
	21.2 Improving GDP timeliness	519
	21.3 Some freely available euro area leading indicators	520
	21.3.1 The Euroframe Euro Growth Indicator	520
	21.3.2 The €-coin indicator	520
	21.4 Eurostat coincident indicators of GDP growth	521
	21.4.1 The factor model based on soft information (FS model)	522
	21.4.2 The factor model base on hard and soft information (FHS model)	522
	21.4.3 The bridge model based on hard and soft information (BHS model)	522
	21.4.4 The disaggregated model	522
	21.5 Real-time assessment	525
	21.6 Conclusions	528
VI	Guidelines	532
22	Guidelines for the Construction of Composite Cyclical Indicators	
	by Gian Luigi Mazzi and Ataman Ozyildirim	533
	22.1 Introduction	535
	22.1.1 Motivation for the guidelines	535
	22.1.2 Scope of the guidelines	535
	22.1.3 Advantages and drawbacks	536
	22.1.4 Main principles for the compilation of cyclical composite indicators	537
	22.2 General policy	538
	22.2.1 Statistical institutions and their role in compiling cyclical composite indicators	538
	22.2.2 A general policy for the compilation of cyclical composite indicators	
		539
	22.2.3 Stability of the general policy	540
	22.2.4 Quality framework for cyclical composite indicators	541
	22.3 Data issues	542
	22.3.1 Data availability and quality	542
	22.3.2 Real-time vintages	543
	22.3.3 Unavailability of seasonally adjusted data	544
	22.3.4 Lack of history	545
	22.3.5 Variable selection	546
	22.3.5 Variable selection 22.4 Composite indicators for estimating in real-time or forecasting cyclical movements	546 547
	22.4 Composite indicators for estimating in real-time or forecasting cyclical movements	547

	22.4.3 Detrending methods	550
	22.4.4 Estimation/aggregation methods	551
22.5	Composite indicators for detecting and forecasting turning points	552
	22.5.1 The reference variable	552
	22.5.2 The identification of the reference cycle	553
	22.5.3 Turning points historical dating	554
	22.5.4 The dating algorithms	555
	22.5.5 Methodology for the construction of turning points composite indicators	556
22.6	Growth composite indicators	557
	22.6.1 The reference or target variable	557
	22.6.2 The methodology	558
22.7	Revisions of cyclical composite indicators	559
	22.7.1 Regular revisions	559
	22.7.2 Major revisions	560