

Online Appendix: Combined Density Nowcasting in an Uncertain Economic Environment

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The online appendix contains supplementary material. In the first section we document the estimation algorithm for our Combined Density Nowcasting (CDN) approach. In the next section we provide details on the data set that we use.

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The Combined Density Nowcasting algorithm

The two stage-method of our CDN approach is given as:

Stage 1: Estimate K DFM models, generate draws for $\tilde{F}_{k,t+h}$, $k = 1, \dots, K$ and conditional on $\tilde{F}_{k,t+h}$ generate the K vector of draws \tilde{y}_{t+h} .

Stage 2: Combine the predictions from the K models, accounting for uncertainty on the number of factors (K) and information set (I_K), using the convolution mechanism.

We elaborate briefly on each stage.

On stage 1: We follow the bootstrapping procedure in Aastveit et al. (2014) to construct simulated nowcasts. Let \hat{A}_0 , \hat{B}_0 , \hat{u}_{0,t_m^x} , $\hat{\xi}_{0,t_m^x}$, $\hat{\Lambda}_0$, $\hat{\alpha}_0$, $\hat{\beta}_0$, and \hat{e}_{0,t_m+h_m} denote the initial point estimates. Then, for $d = 1, \dots, D$:

1. Simulate monthly $\tilde{F}_{t_m^x} = \hat{A}_0 \tilde{F}_{t_m^x-1} + \hat{B}_0 u_{t_m^x}^*$, where $u_{t_m^x}^*$ is re-sampled from \hat{u}_{0,t_m^x} .
2. Simulate $\tilde{X}_{t_m^x} = \hat{\Lambda}_0 \tilde{F}_{t_m^x} + \xi_{t_m^x}^*$, where $\xi_{t_m^x}^*$ is re-sampled from $\hat{\xi}_{0,t_m^x}$.
3. Based on $\tilde{X}_{t_m^x}$, re-estimate the model to get a new set of parameter and factor estimates. Use these to generate factor nowcasts according to equation (9) in the main text, where shock uncertainty is included by re-sampling from \hat{u}_{0,t_m^x} .

Next, estimate equation (11) in the main text based on the monthly factor estimated in the previous step and converted to quarterly as described in the previous section, and construct nowcasts for \tilde{y}_{t+h} where shock uncertainty is included by re-sampling from \hat{e}_{0,t_m+h_m} .

On stage 2: Apply an extension of the parallelized version of the sequential Monte Carlo algorithm of Billio et al. (2013) and Casarin et al. (2015) to the case of Dynamic Factor Models. For a technical description of this algorithm, we refer the reader to Casarin et al. (2015). Here, we provide some details on the prior. The combination weights are $[0,1]$ -valued processes and one can interpret them a sequence of prior probabilities over the set of models. In our framework, the prior probability on the set of models is random, as opposite to the standard model selection or BMA frameworks, where the model prior is fixed. The likelihood, given by the combination scheme, allows us to compute the posterior distribution on the model set.

In this sense the proposed combination scheme shares some similarities with the dilution and hierarchical model set prior distributions for BMA, proposed in George (2010) and Ley and Steel (2009) respectively. The learning strategy also plays a crucial role and we propose to use scores depending on the loss function of interest. In section 2.4 in the main text we describe our scores for nowcast evaluation and for each metric we apply the corresponding score in the learning mechanism in equation (6) in the main text.

We repeat steps 1-3 recursively for every block in each quarter vintage. The exercise is very time consuming and requires parallelization to be implemented. We parallelize the code in two directions. First, step 1 and step 2 are parallelized across models, vintages and blocks. Then, step 3 is parallelized across draws using the MATLAB toolbox DeCo described in Casarin et al. (2015).¹

¹If the user was in the last vintage and block, parallelization across models in steps 1 and 2 and parallelization across predictive draws in step 3 are required to derive predictive densities for future values.

Data description

Data Group	Description	Transformation	Publication Lag	Start Vintage
Hard	Federal funds rate	1	One month	Last vintage
Hard	3 month Treasury Bills	1	One month	Last vintage
Hard	6 month Treasury Bills	1	One month	Last vintage
Soft	Spot USD/EUR	2	One month	Last vintage
Soft	Spot USD/JPY	2	One month	Last vintage
Soft	Spot USD/GBP	2	One month	Last vintage
Soft	Spot USD/CAD	2	One month	Last vintage
Soft	Price of gold on the London market	2	One month	Last vintage
Soft	NYSE composite index	2	One month	Last vintage
Soft	Standard & Poors 500 composite index	2	One month	Last vintage
Soft	Standard & Poors dividend yield	2	One month	Last vintage
Soft	Standard & Poors P/E Ratio	2	One month	Last vintage
Soft	Moodys AAA corporate bond yield	1	One month	Last vintage
Soft	Moodys BBB corporate bond yield	1	One month	Last vintage
Soft	WTI Crude oil spot price	2	One month	Last vintage
Soft	Purchasing Managers Index (PMI)	1	One month	03.03.1997
Soft	ISM mfg index, Production	1	One month	02.11.2009
Soft	ISM mfg index, Employment	1	One month	02.11.2009
Soft	ISM mfg index, New orders	1	One month	02.11.2009
Soft	ISM mfg index, Inventories	1	One month	02.11.2009
Soft	ISM mfg index, Supplier deliveries	1	One month	02.11.2009
Hard	Civilian Unemployment Rate	1	One month	05.01.1990
Hard	Civilian Participation Rate	1	One month	07.02.1997
Hard	Average (Mean) Duration of Unemployment	2	One month	05.01.1990
Hard	Civilians Unemployed - Less Than 5 Weeks	2	One month	05.01.1990
Hard	Civilians Unemployed for 5-14 Weeks	2	One month	05.01.1990
Hard	Civilians Unemployed for 15-26 Weeks	2	One month	05.01.1990
Hard	Civilians Unemployed for 27 Weeks and Over	2	One month	05.01.1990
Hard	Employment on nonag payrolls: Total nonfarm	2	One month	05.01.1990
Hard	Employment on nonag payrolls: Total Private Industries	2	One month	05.01.1990
Hard	Employment on nonag payrolls: Goods-Producing Industries	2	One month	05.01.1990
Hard	Employment on nonag payrolls: Construction	2	One month	05.01.1990
Hard	Employment on nonag payrolls: Durable goods	2	One month	05.01.1990
Hard	Employment on nonag payrolls: Nondurable goods	2	One month	05.01.1990
Hard	Employment on nonag payrolls: Manufacturing	2	One month	05.01.1990
Hard	Employment on nonag payrolls: Mining and logging	2	One month	05.01.1990

Data Group	Description	Transformation	Publication Lag	Start Vintage
Hard	Employment on nonag payrolls: Service-Providing Industries	2	One month	05.01.1990
Hard	Employment on nonag payrolls: Financial Activities	2	One month	05.01.1990
Hard	Employment on nonag payrolls: Education & Health Services	2	One month	06.06.2003
Hard	Employment on nonag payrolls: Retail Trade	2	One month	05.01.1990
Hard	Employment on nonag payrolls: Wholesale Trade	2	One month	05.01.1990
Hard	Employment on nonag payrolls: Government	2	One month	05.01.1990
Hard	Employment on nonag payrolls: Trade, Transportation & Utilities	2	One month	05.01.1990
Hard	Employment on nonag payrolls: Leisure & Hospitality	2	One month	06.06.2003
Hard	Employment on nonag payrolls: Other Services	2	One month	05.01.1990
Hard	Employment on nonag payrolls: Professional & Business Services	2	One month	06.06.2003
Hard	Average weekly hours of PNW: Total private	2	One month	Last vintage
Hard	Average weekly overtime hours of PNW: Mfg	2	One month	Last vintage
Hard	Average weekly hours of PNW: Mfg	2	One month	Last vintage
Hard	Average hourly earnings:Construction	2	One month	Last vintage
Hard	Average hourly earnings: Mfg	2	One month	Last vintage
Hard	M1 Money Stock	2	One month	30.01.1990
Hard	M2 Money Stock	2	One month	30.01.1990
Soft	Consumer credit: New car loans at auto finance companies, loan-to-value	2	Two months	Last vintage
Soft	Consumer credit: New car loans at auto finance companies, amount financed	2	Two months	Last vintage
Hard	Federal government total surplus or deficit	2	One month	Last vintage
Hard	Exports of goods, total census basis	2	Two months	Last vintage
Hard	Imports of goods, total census basis	2	Two months	Last vintage
Hard	Industrial Production Index	2	One month	17.01.1990
Hard	Industrial Production: Final Products (Market Group)	2	One month	14.12.2007
Hard	Industrial Production: Consumer Goods	2	One month	14.12.2007
Hard	Industrial Production: Durable Consumer Goods	2	One month	14.12.2007
Hard	Industrial Production: Nondurable Consumer Goods	2	One month	14.12.2007
Hard	Industrial Production: Business Equipment	2	One month	14.12.2007
Hard	Industrial Production: Materials	2	One month	14.12.2007
Hard	Industrial Production: Durable Materials	2	One month	14.12.2007
Hard	Industrial Production: nondurable Materials	2	One month	14.12.2007
Hard	Industrial Production: Manufacturing (NAICS)	2	One month	14.12.2007
Hard	Industrial Production: Durable Manufacturing (NAICS)	2	One month	14.12.2007
Hard	Industrial Production: Nondurable Manufacturing (NAICS)	2	One month	14.12.2007
Hard	Industrial Production: Mining	2	One month	14.12.2007
Hard	Industrial Production: Electric and Gas Utilities	2	One month	14.12.2007
Hard	Capacity Utilization: Manufacturing (NAICS)	1	One month	05.12.2002
Hard	Capacity Utilization: Total Industry	1	One month	15.11.1996
Soft	Housing starts: Total new privately owned housing units started	2	One month	18.01.1990

Data Group	Description	Transformation	Publication Lag	Start Vintage
Soft	New private housing units authorized by building permits	2	One month	17.08.1999
Soft	Philly Fed Business outlook survey, New orders	1	Current month	Last vintage
Soft	Philly Fed Business outlook survey, General business activity	1	Current month	Last vintage
Soft	Philly Fed Business outlook survey, Shipments	1	Current month	Last vintage
Soft	Philly Fed Business outlook survey, Inventories	1	Current month	Last vintage
Soft	Philly Fed Business outlook survey, Unfilled orders	1	Current month	Last vintage
Soft	Philly Fed Business outlook survey, Prices paid	1	Current month	Last vintage
Soft	Philly Fed Business outlook survey, Prices received	1	Current month	Last vintage
Soft	Philly Fed Business outlook survey, Number of employees	1	Current month	Last vintage
Soft	Philly Fed Business outlook survey, Average workweek	1	Current month	Last vintage
Hard	Producer Price Index: Finished Goods	2	One month	12.01.1990
Hard	Producer Price Index: Finished Goods Less Food & Energy	2	One month	11.12.1996
Hard	Producer Price Index: Finished Consumer Goods	2	One month	11.12.1996
Hard	Producer Price Index: Intermediate Materials: Supplies & Components	2	One month	12.01.1990
Hard	Producer Price Index: Crude Materials for Further Processing	2	One month	12.01.1990
Hard	Producer Price Index: Finished Goods Excluding Foods	2	One month	11.12.1996
Hard	Producer Price Index: Finished Goods Less Energy	2	One month	11.12.1996
Hard	Consumer Prices Index: All Items (urban)	2	One month	18.01.1990
Hard	Consumer Prices Index: Food	2	One month	12.12.1996
Hard	Consumer Prices Index: Housing	2	One month	Last vintage
Hard	Consumer Prices Index: Apparel	2	One month	Last vintage
Hard	Consumer Prices Index: Transportation	2	One month	Last vintage
Hard	Consumer Prices Index: Medical care	2	One month	Last vintage
Hard	Consumer Prices Index: Commodities	2	One month	Last vintage
Hard	Consumer Prices Index: Durables	2	One month	Last vintage
Hard	Consumer Prices Index: Services	2	One month	Last vintage
Hard	Consumer Prices Index: All Items Less Food	2	One month	12.12.1996
Hard	Consumer Prices Index: All Items Less Food & Energy	2	One month	12.12.1996
Hard	Consumer Prices Index: All items less shelter	2	One month	Last vintage
Hard	Consumer Prices Index: All items less medical care	2	One month	Last vintage
Hard	Real Gross Domestic Product	2	One quarter	28.01.1990
Hard	Real Disposable Personal Income	2	One month	29.01.1990
Hard	Real Personal Consumption Expenditures	2	One month	29.01.1990
Hard	Real Personal Consumption Expenditures: Durable Goods	2	One month	29.01.1990
Hard	Real Personal Consumption Expenditures: Nondurable Goods	2	One month	29.01.1990
Hard	Real Personal Consumption Expenditures: Services	2	One month	29.01.1990
Hard	Personal Consumption Expenditures: Chain-type Price Index	2	One month	01.08.2000
Hard	Personal Consumption Expenditures: Chain-Type Price Index Less Food & Energy	2	One month	01.08.2000
Soft	New one family houses sold	2	One month	30.07.1999

Data Group	Description	Transformation	Publication Lag	Start Vintage
Soft	New home sales: Ratio of houses for sale to houses sold	2	One month	Last vintage
Soft	Existing home sales: Single-family and condos	2	One month	Last vintage
Soft	Chicago Fed MMI Survey	2	One month	Last vintage
Soft	Composite index of 10 leading indicators	1	One month	Last vintage
Soft	Consumer confidence surveys: Index of consumer confidence	1	Current month	Last vintage
Soft	Michigan Survey: Index of consumer sentiment	1	Current month	31.07.1998
Hard	Average weekly initial claims	2	Current month	Last vintage

Note: In column 4, 1 denotes differencing to the initial series and 2 denotes log differencing to the initial series.

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