Can inflation expectations in business or consumer surveys improve inflation forecasts?

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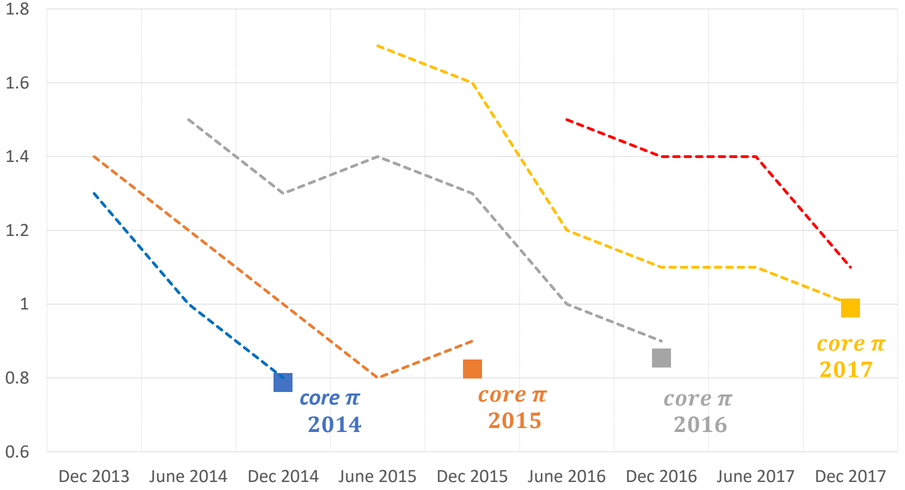
Section 1

Motivation

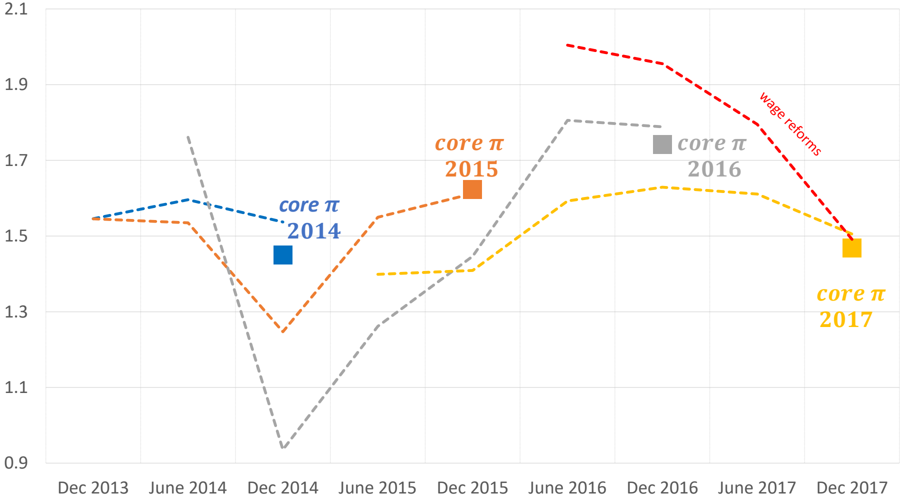
Inflation in the euro area is consistently overestimated

Figure: ECB core inflation forecasts updates over time



In Belgium, we have the opposite case

Figure: NBB core inflation forecasts updates over time



Section 2

Data

Dataset for the Large Model

Name	Description	Source
Total inflation (π_t)	HICP, all items, SA, quarterly growth	Eurostat
Core inflation (π_t^{core})	HICP, all items excluding energy and food	Eurostat
Import deflator (π_t^{M})	Quarterly growth rate of the import deflator	Eurostat
Oil (in euros) (P_t^{Oil})	Brent oil in dollars divided by the euro/dollar exchange rate, average of the quarter	ECB
Real GDP (y_t)	Gross Domestic Product at market prices	Eurostat
Unemployment (u_t)	Unemployment rate as a % of the labour force (quarterly)	Eurostat
Mark-up (μ_t)	YoY growth of GDP deflator minus YoY growth of unit labour costs (quarterly)	Eurostat
BS Global for BE and ESI for EA (S_t^y)	Overall business sentiment indicator, last month of the quarter	NBB
Inflation Survey data (S_t^B, S_t^C)	Businesses' and consumers' medium and short-term assessment of future price developments. Balance of responses, seasonally adjusted, first month of each quarter	DG ECFIN

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Section 3

Model

- Trend component

$$\pi_t = \boxed{\tau_t^\pi} + \lambda_\pi \delta_t + \zeta_\pi \vartheta_t + \eta_t^\pi$$

- Cyclical component
- Oil effects

$$u_t = \tau_t^u + \kappa_u \delta_t + \eta_t^u$$

$$P_t^{oil} = \tau_t^{oil} + \lambda_{oil} \delta_t + \zeta_{oil} \vartheta_t + \eta_t^{oil}$$

Modeling inflation

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Unobserved Components Model (UCM)

$$\pi_t = \tau_t^{\pi} + \lambda_{\pi}\delta_t + \zeta_{\pi}\vartheta_t + \eta_t^{\pi} \quad (1)$$

$$\pi_t^{core} = \tau_t^{\pi} + \lambda_{core}\delta_{t-4} + \eta_t^{core} \quad (2)$$

$$\pi_t^{m} = \tau_t^{m} + \lambda_{m}\delta_t + \zeta_{m}\vartheta_t + \eta_t^{M} \quad (3)$$

$$P_t^{oil} = \tau_t^{oil} + \lambda_{oil}\delta_t + \zeta_{oil}\vartheta_t + \eta_t^{oil} \quad (4)$$

$$u_t = \tau_t^{u} + \kappa_{u}\delta_t + \eta_t^{u} \quad (5)$$

$$y_t = \tau_t^{y} + \kappa_{y}\delta_t + \eta_t^{y} \quad (6)$$

$$S_t^{Y} = m_S + \kappa_S(\delta_t - \delta_{t-4}) + \eta_t^{S} \quad (7)$$

$$\mu_t = m_{\mu} + \kappa_{\mu}(\delta_t - \delta_{t-4}) + \eta_t^{\mu} \quad (8)$$

Forecasts for inflation can be expressed as:

$$\boxed{\mathbb{E}\left[\pi_{t+h}|\Omega_t\right] = \mathbb{E}\left[\tau_{t+h}^{\pi}|\Omega_t\right] + \lambda_{\pi}\,\mathbb{E}\left[\delta_{t+h}|\Omega_t\right] + \zeta_{\pi}\,\mathbb{E}\left[\vartheta_{t+h}|\Omega_t\right]}$$

Unobserved Components Model (UCM)

$$\pi_t = \tau_t^\pi + \lambda_\pi \delta_t + \zeta_\pi \vartheta_t + \eta_t^\pi \quad (1)$$
$$\pi_t^{core} = \tau_t^\pi + \lambda_{core} \delta_{t-4} + \eta_t^{core} \quad (2)$$
$$\pi_t^m = \tau_t^m + \lambda_m \delta_t + \zeta_m \vartheta_t + \eta_t^M \quad (3)$$
$$P_t^{oil} = \tau_t^{oil} + \lambda_{oil} \delta_t + \zeta_{oil} \vartheta_t + \eta_t^{oil} \quad (4)$$
$$u_t = \tau_t^u + \kappa_u \delta_t + \eta_t^u \quad (5)$$
$$y_t = \tau_t^y + \kappa_y \delta_t + \eta_t^y \quad (6)$$
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Unobserved Components Model (UCM)

$$
\begin{aligned}
\pi_t &= \tau_t^{\pi} + \lambda_{\pi}\delta_t + \zeta_{\pi}\vartheta_t + \eta_t^{\pi} & (1)\\
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\pi_t^{m} &= \tau_t^{m} + \lambda_{m}\delta_t + \zeta_{m}\vartheta_t + \eta_t^{M} & (3)\\
P_t^{oil} &= \tau_t^{oil} + \lambda_{oil}\delta_t + \zeta_{oil}\vartheta_t + \eta_t^{oil} & (4)\\
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\end{aligned}
$$

Forecasts for inflation can be expressed as:

$$\boxed{\mathbb{E}\left[\pi_{t+h}|\Omega_t\right] = \mathbb{E}\left[\tau^{\pi}_{t+h}|\Omega_t\right] + \lambda_{\pi}\,\mathbb{E}\left[\delta_{t+h}|\Omega_t\right] + \zeta_{\pi}\,\mathbb{E}\left[\vartheta_{t+h}|\Omega_t\right]}$$

Linking surveys to expected factors: X-model

Key contribution: our framework connects the surveys (and any variable reflecting expectations) with the factors derived from the model. Remember, forecasts for inflation can be expressed as:

$$\mathbb{E}\left[\pi_{t+h}|\Omega_t\right] = \mathbb{E}\left[\tau^{\pi}_{t+h}|\Omega_t\right] + \lambda_\pi \, \mathbb{E}\left[\delta_{t+h}|\Omega_t\right] + \zeta_\pi \, \mathbb{E}\left[\vartheta_{t+h}|\Omega_t\right]$$

- If S^B_t is proportional to a measure of $\mathbb{E}\left[\pi_{t+1}|\Omega_t\right]$:

$$S^B_t \propto \mathbb{E}\left[\tau^{\pi}_{t+1}|\Omega_t\right] + \lambda_\pi \, \mathbb{E}\left[\delta_{t+1}|\Omega_t\right] + \zeta_\pi \, \mathbb{E}\left[\vartheta_{t+1}|\Omega_t\right] + \eta^B_t \quad (9)$$

- If S^C_t is proportional to a measure of $\mathbb{E}\left[\pi_{t+1} + \ldots + \pi_{t+4}|\Omega_t\right]$:

$$S^C_t \propto \sum_{h=1}^{4} \left\{\mathbb{E}\left[\tau^{\pi}_{t+h}|\Omega_t\right] + \lambda_\pi \, \mathbb{E}\left[\delta_{t+h}|\Omega_t\right] + \zeta_\pi \, \mathbb{E}\left[\vartheta_{t+h}|\Omega_t\right]\right\} + \eta^C_t \quad (10)$$

- η^C_t and η^C_t are idiosyncratic terms

Linking surveys to expected factors: X-model

- Cyclical components follow a stationary AR(2) process:

$$\begin{aligned}\delta_t &= \alpha_1 \delta_{t-1} + \alpha_2 \delta_{t-2} + \zeta_t^\delta \\ \vartheta_t &= \rho_1 \delta_{t-1} + \rho_2 \delta_{t-2} + \zeta_t^\vartheta\end{aligned}$$

- The trends related to inflation follow a random walk.
- Output and unemployment have *smoother* $I(2)$ trends:

$$\begin{aligned}\tau_t^u (1-L)^2 &= \epsilon_t^u \\ \tau_t^y (1-L)^2 &= \epsilon_t^y\end{aligned}$$

- This implies:

$$\begin{aligned}S_t^B &= \mathbb{E}\left[\tau_{t+1}^\pi | \Omega_t\right] + \lambda_\pi \mathbb{E}\left[\delta_{t+1} | \Omega_t\right] + \zeta_\pi \mathbb{E}\left[\vartheta_{t+1} | \Omega_t\right] + \eta_t^B \\ S_t^B &= \tau_t^\pi + \underbrace{\lambda_\pi \alpha_1}_{\alpha_1^*} \delta_t + \underbrace{\lambda_\pi \alpha_2}_{\alpha_2^*} \delta_{t-1} + \underbrace{\zeta_\pi \rho_1}_{\rho_1^*} \vartheta_t + \underbrace{\zeta_\pi \rho_2}_{\rho_2^*} \vartheta_{t-1} + \eta_t^B\end{aligned}$$

- Hasenzagl et al. (2018) estimate α_i^*, ρ_i^* freely, so do not incorporate the implied cross-equation restrictions

Linking surveys to expected factors: X-model

- Surveys may not be fully rational expectations forecasts
- Coibion et al. (2018)'s rational inattention proposal for survey respondents could result in:

$$
\begin{aligned}
S_t^{inat} = \mathbb{E}\left[\pi_{t+h} | \Omega_t\right] + \quad & \eta_t^{inat} \\
& \eta_t^{inat} \quad = \rho \eta_{t-1}^{inat} + \epsilon_t^{inat}
\end{aligned}
$$

- Since $S_t^C \propto \sum_{h=1}^{4} S_{t+h}^{inat}$ the discrepancy (η_t^C) term may be very persistent:

$$
\Rightarrow S_t^C = \sum_{h=1}^{4} \left\{ \mathbb{E}\left[\pi_{t+h} | \Omega_t\right] \right\} + \underbrace{\mathbb{E}\left[\sum_{h=1}^{4} \left\{ \eta_{t+h}^{inat} \right\} \right]}_{\eta_t^C}
$$

- This approach may lead to more systematic discrepancy than in the set-up of Mertens and Nason (2018)

Set of models described in the paper

Variables included	Small	X-Small	Large	X-Large
Total inflation (π_t)	x	x	x	x
Core inflation (π_t^{core})	x	x	x	x
Import deflator (π_t^M)			x	x
Oil (in euros) (P_t^{Oil})			x	x
Real GDP (y_t)	x	x	x	x
Unemployment (u_t)	x	x	x	x
Mark-up (μ_t)			x	x
Activity surveys (S_t^y)			x	x
Business surveys (S_t^B)		x		x
Consumer surveys (S_t^C)		x		x

- Stella and Stock (2013) or Chan et al. (2016) consider π_t and u_t alone for US data
- Today, focus on the large systems, with model consistent expectations
- We consider fixed parameters, as opposed to Mertens and Nason (2018)

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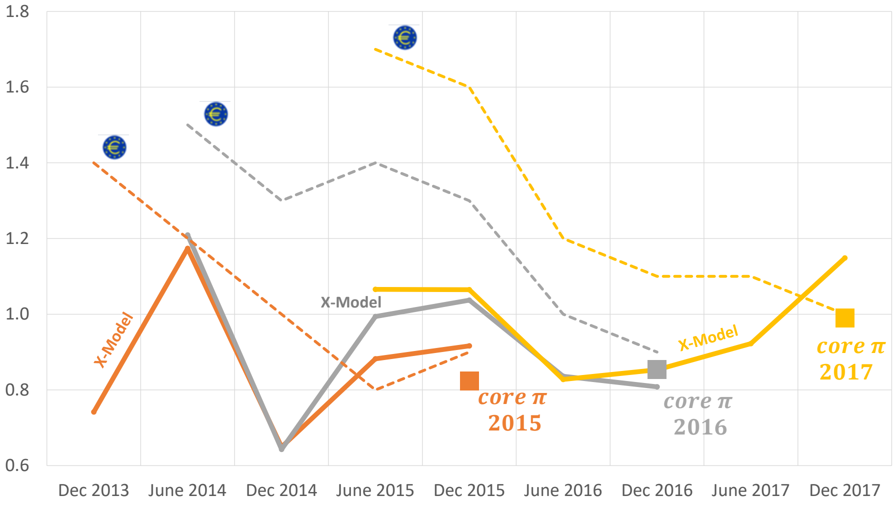
Section 4

X-models at work

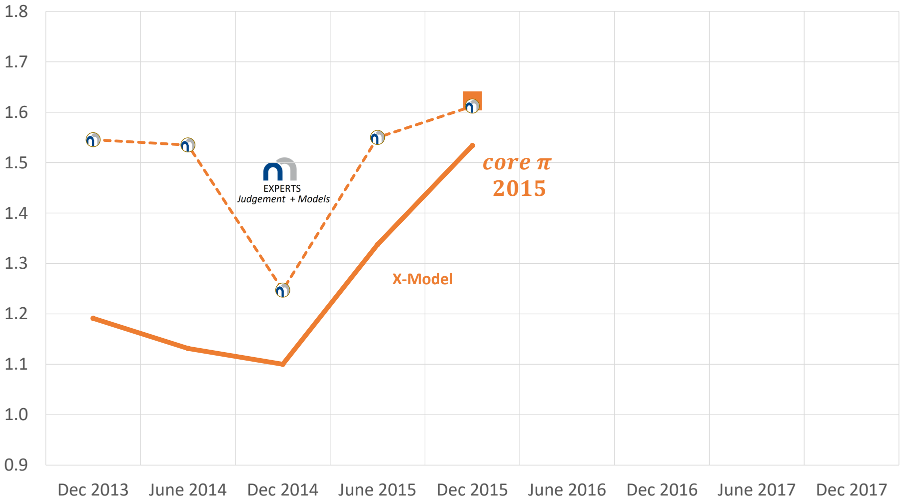
X-model does not reproduce the *missing inflation puzzle* for the euro area

Figure: X-model for the euro area: core HICP



X-model emulates the NBB forecasts

Figure: X-model for Belgium: core HICP



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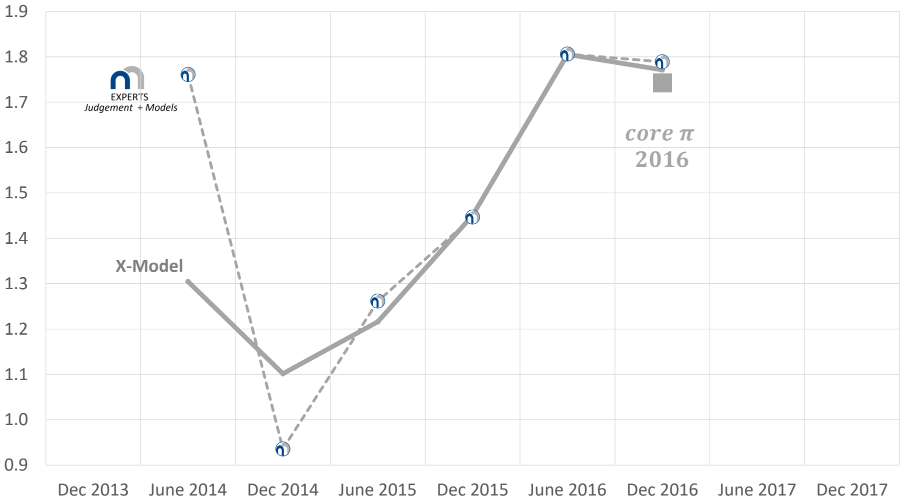

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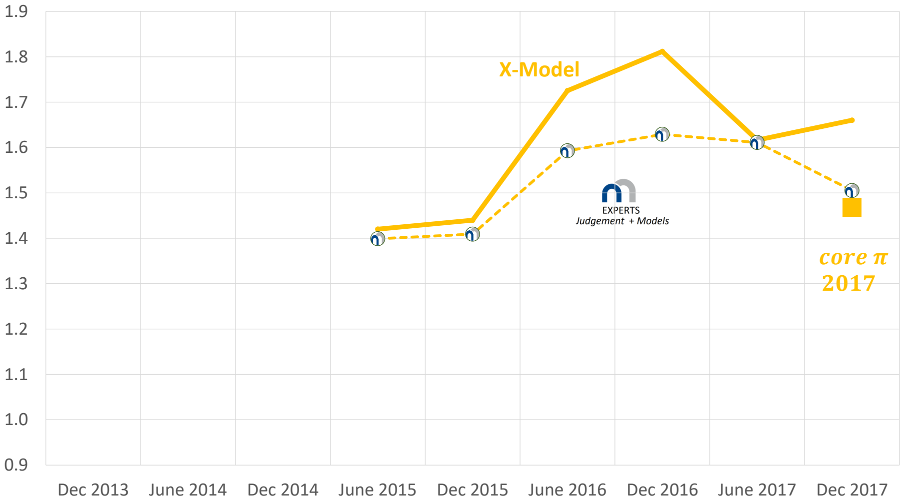

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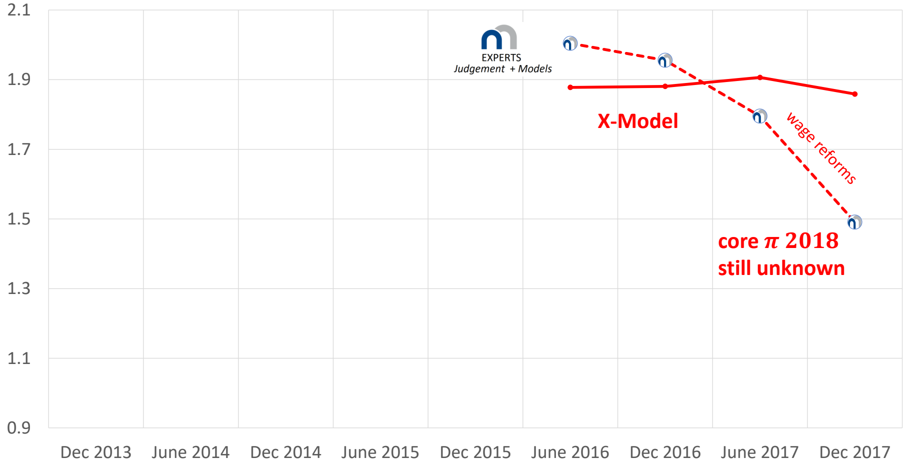
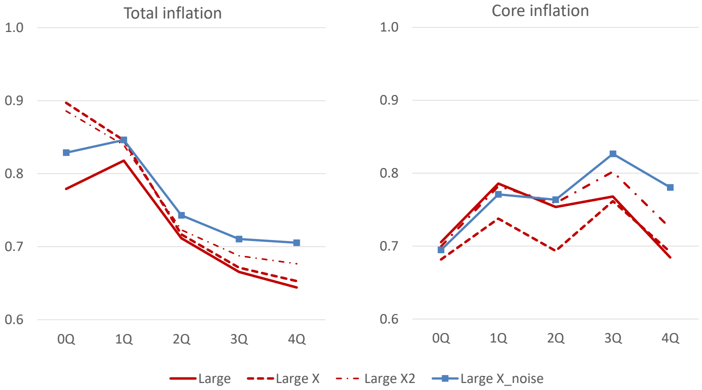


Section 5

Out-of-sample validation

Value added of surveys for Belgium is mostly clear for core inflation

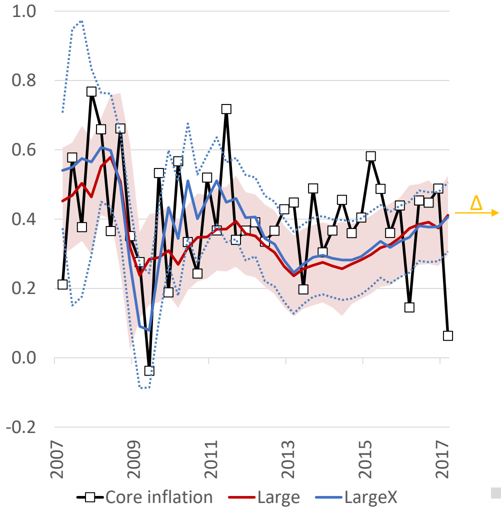
Figure: Belgium: relative RMSE for six models for total and core inflation

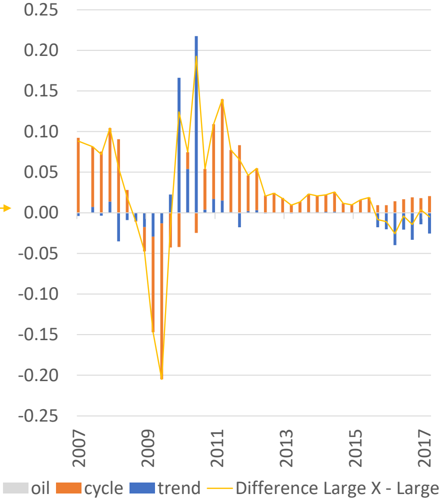


Source: NBB.
Note: the forecast evaluation period runs from 2007Q4 to 2017Q4.

X-model has a more positive contribution from the business cycle

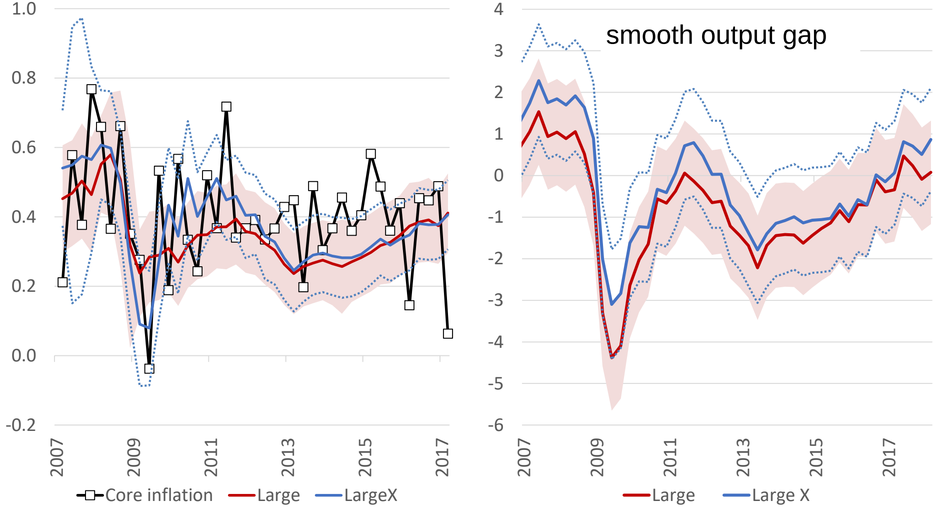
Figure: Belgium: one-step ahead forecasts for core inflation





X-model's forecasts are more connected with the business cycle

Figure: Belgium: one-step ahead forecasts for core inflation



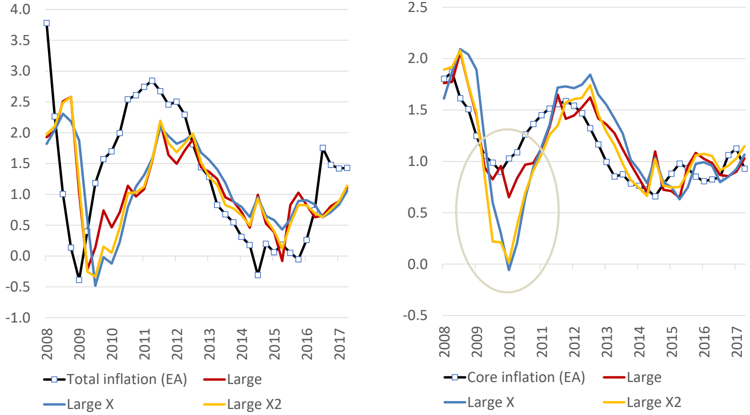
Information from price-setters contributes most to these forecast improvements

Figure: Belgium: relative RMSE of business versus consumer survey-augmented models

Source: NBB.
Note: the forecast evaluation period runs from 2007Q4 to 2017Q4.

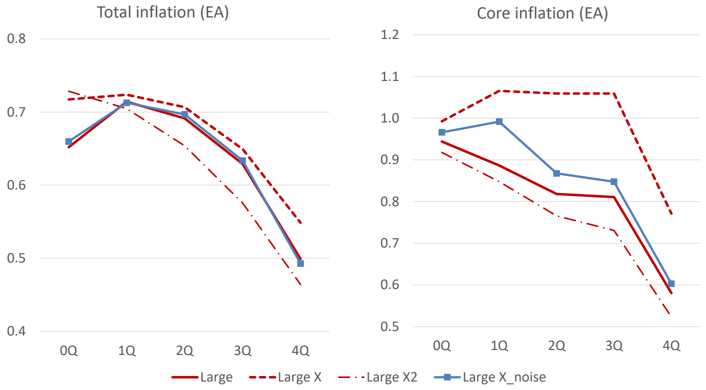
Using surveys deteriorates the forecasts only during one year over the Great Recession, but the X2-model is the best over the recent sample

Figure: Euro area: 4-steps ahead inflation forecasts



Relaxing the rationality assumption (X2 model and persistent noise) seems to help in recent period

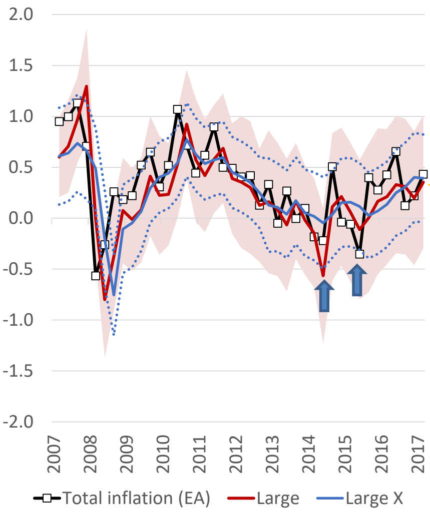
Figure: Euro area: relative RMSE for six models for total and core inflation

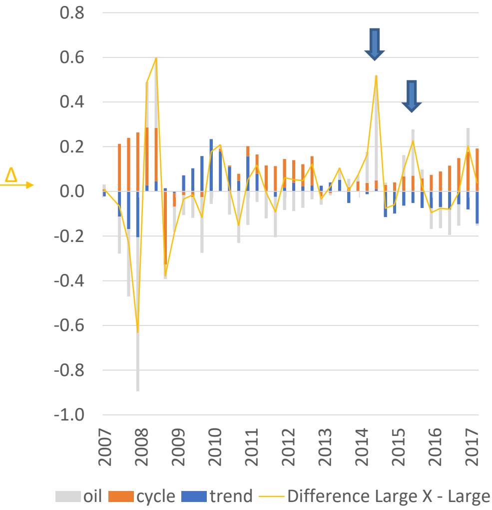


Source: NBB.
Note: the forecast evaluation period runs from 2012Q1 to 2017Q4.

Surveys reduce the short-term impact of oil

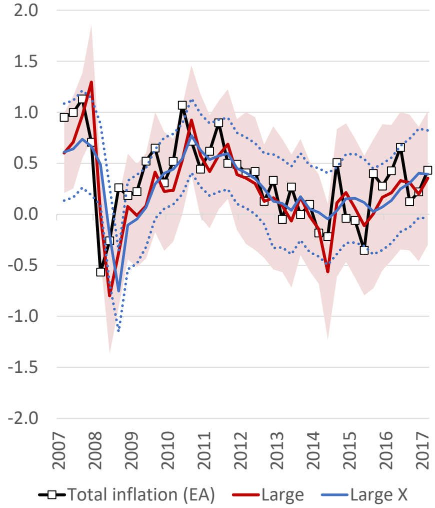
Figure: Euro area: one-step ahead forecasts for total inflation

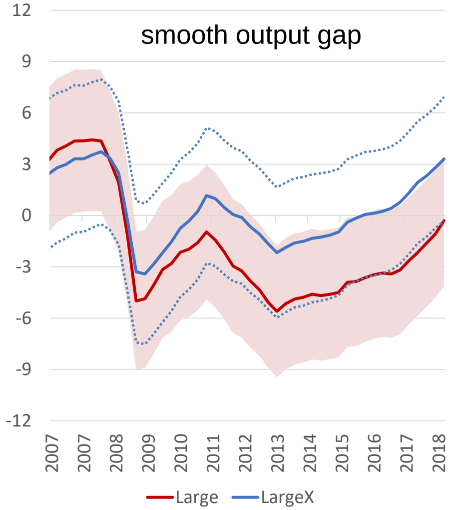




According to the X-model, the gap closes earlier (but the trend inflation is lower)

Figure: Euro area: one-step ahead forecasts for total inflation





Section 6

Conclusion

Concluding remarks (1/2)

- This paper explores the potential of consumer and business (price setters) surveys for forecasting inflation.
- Assuming surveys are model consistent is a strong assumption, but we show that business surveys do help to improve the forecasts for Belgian core inflation
- For the euro area, model-consistent surveys under-perform over the recession period
- For the recent sample, all models produce very similar forecasts even though the output gap is very different in the models with surveys

Concluding remarks (2/2)

- The proposed methodology provides a parsimonious way to incorporate variables reflecting inflation expectations (cummulative or not) for any forecasting horizon
- R codes needed to specify and estimate this kind of models with the state-space methods of JDemetra+ have been made publicly available
- Examples: quantitative surveys for both real activity and inflation (e.g. Survey of Professional Forecasters), interest rate derivative products, official forecasts from different institutions
- One possible application: revisit the results by Ang, Bekaert and Wei (2007), who claim that inflation surveys in the US are more useful than expectations generated by the financial markets