BBVA | RESEARCH

Forecasting GDP and inflation in EMU and Spain

Rafael Doménech

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Introduction

- At BBVA Research we use different methodologies and models for forecasting GDP growth and inflation, from univariate time series and dynamic factor models to GVAR and DSGE models
- In this presentation I will discuss the **details of two of those models**:
  - **MICA-BBVA**: Dynamic Factor Model for the short-term forecasting of **GDP growth**
  - **Trimmed mean inflation** for the medium-term forecasting of **inflation**
- **MICA-BBVA** has been extensively used, with very good results:
  - **Spain, EMU**, USA, Mexico, Portugal, Argentina, Venezuela and the world economy
  - Aggregate demand components (private consumption)
- **Trimmed mean inflation** has been applied to:
  - Japan, to study its ability to forecast deflation
  - EMU and Spain, to have a better understanding of price dynamics in context of low inflation expectation for and extended period of time

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1. **MICA-BBVA for short-term forecasting of GDP, with results for Spain and EMU**
2. Trimmed mean inflation for Japan, EMU and Spain

1. MICA-BBVA

Introduction

- **Early assessment of economic activity** is crucial for governments and central banks, financial institutions, consumers…
- Generally accepted: **GDP growth rate**
- But statistical agencies publish GDP with about 1-2 months **delay**
- Typical solution: **economic indicators**
  - Shorter publication delay
  - Track GDP economic fluctuations
- In **EMU and Spain** GDP forecasting is specially problematic
  - Long publication delay
  - Presence of missing values in the historical time series
  - Short length of some indicators.

1. MICA-BBVA

Introduction

- **Distinctive features of MICA-BBVA**:
  - An extension of Stock and Watson (1991): **Dynamic Factor Model** for GDP growth and additional economic indicators
    - Camacho and Pérez-Quiros (2011) use EMU GDP since 1995
    - Camacho and Sancho (2003) use IPI
  - MICA-BBVA includes **financial indicators**
    - In Camacho and Pérez-Quiros (2011) they are non-significant
    - Wheelock and Wohar (2009): do financial series lead growth rate?
    - We have found that some financial indicators lead the business cycle
  - **Examines forecasting accuracy** in pseudo-real time

1. MICA-BBVA

Variables in the model for Spain

Series	Effective Samp	Source	Publication delay	Data transformation
Real GDP (GDP)	2Q80-1Q14	INE	1.5 months	SA, QGR
Real credit card spending (CCS)	1M02-6M14	BBVA based on Servired & INE	0 months	SA, AGR
Consumer confidence (CC)	6M86-5M14	European Commission	0 months	SA, L
Real wage income (RWI)	1M81-5M14	BBVA based on MEC & INE	1.5 months	SA, AGR
Electricity consumption (EC)	1M81-5M14	MEC	0 months	SA, TA, AGR
Industry Confidence (IC)	1M87-5M14	European Commission	0 months	SA, L
Registered Unemployment (U)	1M81-5M14	SEPE	1 month	SA, AGR
Social security affiliation (SSA)	1M83-5M14	MEYSS	1 month	SA, AGR
Real credit to the private sector (RCPS)	1M81-4M14	BBVA based on BdE & INE	2 month	SA, AGR
Mortgage rate minus 12m Euribor (MR12E)	1M89-3M14	BBVA based on BdE & Thompson Reuters	2 month	L
Financial tensions in Europe (FTE)	10M05-5M14	BBVA	0 months	L
Mortgage rate minus 12m Treasury bill rate (MR12TBR)	1M89-3M14	BBVA based on BdE & Thompson Reuters	2 month	L

1. MICA BBVA

Variables in the model for EMU

Series	Effective Sample	Source	Publication delay	Data transformation
Real GDP (GDP)	80.1-10.2	Eurostat	1.5 months	SA, QGR
Unemployment rate (UR)	04.01-10.06	Eurostat	2 months	SA, L
Industrial production (IP)	91.01-10.06	Eurostat	1.5 months	SA, AGR
Exports (Exp)	90.01-10.06	European Commission	1.5 months	SA, AGR
ESI Industry (ESII)	85.01-10.08	European Commission	0 months	SA, L
ESI Consumption (ESIC)	85.01-10.08	European Commission	0 months	SA, L
ESI Services (ESIS)	95.04-10.08	European Commission	0 months	SA, L
LHH	04.01-10.07	European Central Bank	2 months	SA, AGR
Beta	94.01-10.08	BBVA Research	0 months	SA, L

1. MICA-BBVA

The model: mixing frequencies

- How to deal with mixing frequencies in Kalman filter?
  - Series are reduced to **monthly indicators**
  - **Quarterly flow** variable which are *I*(1)
    - Proietti and Moauro (2006): exact filter but nonlinear (implies approximations)
    - Auroba, Diebold and Scotti (2007): exact filter but at the cost of assuming all the indicators to have a linear trend
- Mariano and Murasawa (2003): **approximate filter**
  - Simple mean approximated by geometric mean
  - Good approximation of quarterly GDP (Y_t^*) if changes in the unobservable monthly GDP (Y_t) are small

$$Y_t^* = 3\left(\frac{Y_t + Y_{t-1} + Y_{t-2}}{3}\right) \approx 3\left(Y_t Y_{t-1} Y_{t-2}\right)^{1/3}$$

1. MICA-BBVA

The model: mixing frequencies

- Accordingly

$$\ln Y_t^* = \frac{1}{3}\left(\ln Y_t + \ln Y_{t-1} + \ln Y_{t-2}\right) + \ln 3$$

- Quarterly growth rate

$$\ln Y_t^* - \ln Y_{t-3}^* = \frac{1}{3}\ln\frac{Y_t}{Y_{t-3}} + \frac{1}{3}\ln\frac{Y_{t-1}}{Y_{t-4}} + \frac{1}{3}\ln\frac{Y_{t-2}}{Y_{t-5}}$$

- Defining

$$y_t^* \equiv \ln Y_t^* - \ln Y_{t-3}^* \qquad\qquad y_t \equiv \Delta \ln Y_t$$

- Hence

$$y_t^* = \frac{1}{3}y_t + \frac{2}{3}y_{t-1} + y_{t-2} + \frac{2}{3}y_{t-3} + \frac{1}{3}y_{t-4}$$

1. MICA-BBVA

The model: state-space representation

- There is an unobservable common factor that follows an AR(p1) process:

$$x_t = \rho_1 x_{t-1} + \ldots + \rho_{p1} x_{t-p1} + e_t$$

- Monthly GDP growth

$$y_t = \beta_y x_t + u_t^y \qquad u_t^y = d_1^y u_{t-1}^y + \ldots + d_{p2}^y u_{t-p2}^y + \varepsilon_t^y$$

- Annual growth rates of hard and levels of soft indicators

$$z_t^i = \beta_i \sum_{j=0}^{11} x_{t-j} + u_t^i \qquad u_t^i = d_1^i u_{t-q}^i + \ldots + d_{p3}^i u_{t-p3}^i + \varepsilon_t^i$$

- Financial indicators (in annual growth rates or in levels) may lead the cycle

$$z_t^i = \beta_i \sum_{j=0}^{11} x_{t+h-j} + u_t^f \quad u_t^f = d_1^f u_{t-q}^f + \ldots + d_{p3}^f u_{t-p3}^f + \varepsilon_t^f$$

1. MICA-BBVA

The model: state-space representation

- **Observation equation (e.g., when p1=p2=p3=1 and h=1):**

$$
\begin{pmatrix} y_t^* \\ Z_{it}^* \\ Z_{ft}^* \end{pmatrix} =
\begin{pmatrix}
0 & \frac{\beta_y}{3} & \frac{2\beta_y}{3} & \beta_y & \frac{2\beta_y}{3} & \frac{1\beta_y}{3} & 0 & \cdots & 0 & \frac{1}{3} & \frac{2}{3} & 1 & \frac{2}{3} & \frac{1}{3} & 0 & 0 \\
0 & \beta_i & \beta_i & \cdots & & & & \cdots & \beta_i & 0 & \cdots & & \cdots & 0 & 1 & 0 \\
\beta_f & \beta_f & & & & & & \beta_f & 0 & 0 & \cdots & & & 0 & 0 & 1
\end{pmatrix}
\begin{pmatrix} x_{t+1} \\ x_t \\ \vdots \\ x_{t-11} \\ u_t^y \\ \vdots \\ u_{t-4}^y \\ u_t^i \\ u_t^f \end{pmatrix}
$$

1. MICA-BBVA

The model: dealing with missing observations

- Quarterly series are observed once each quarter, but for some soft and have indicators we have missing observations
- We follow Mariano and Murasawa (2003)
- **Substitute missing values by random draws** N(0,1)

$$Y_{it}^{*} = \begin{cases} Y_{it} & \text{if observable} \\ \theta_t & \text{otherwise} \end{cases}$$

- While keeping all the matrices conformable, it has no impact on MLE
- At each time t,
    - Observed data are used to estimate the state vector
    - State vector and the idiosyncratic component are used to estimate missing values
    - Forecasting can be done by adding missing values at the end

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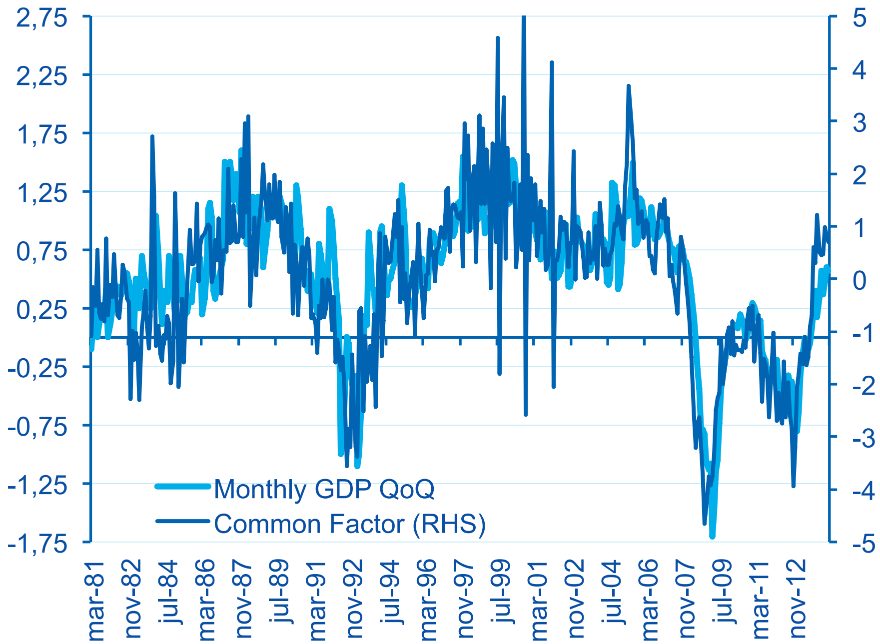
Results: common factors

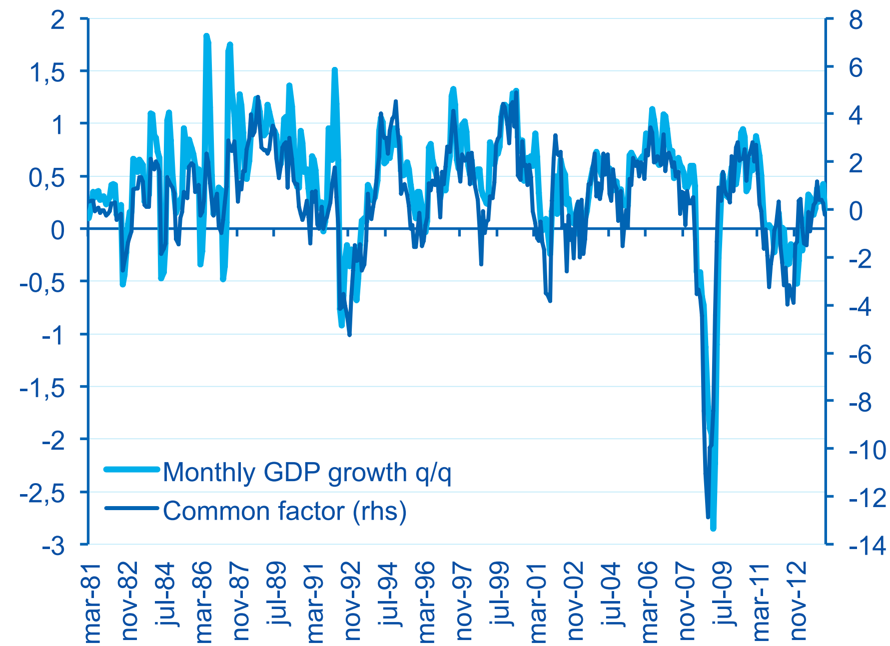
Spain: GDP growth (q/q) and common factor

Source: BBVA



EMU: GDP growth (q/q) and common factor

Source: BBVA



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Results: loading factors

Spain: loading factors

Source: Camacho and Doménech (2012), t-ratios in parentheses

	GDP	CCS	CC	EC	RWI	IC	U	SSA	RCPS	MR12E	FTE	MR12TBR
Loading factor	0.200	0.024	0.039	0.045	0.045	0.045	-0.011	0.064	0.014	-0.013	-0.033	-0.19
t-ratio	(12.3)	(1.7)	(4.1)	(5.5)	(15.3)	(5.5)	(3.5)	(32.4)	(3.5)	(2.0)	(2.2)	(1.4)

EMU: loading factors

Source: Camacho and García-Serrador (2014), standard errors in parentheses

	GDP	UR	IPI	EXP	ESII	ESIC	ESIS	LHH	BETA
Loading factor	0.10	-0.005	0.04	0.03	0.03	0.02	0.02	0.011	0.02
std. errors	(0.04)	(0.03)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.005)	(0.01)

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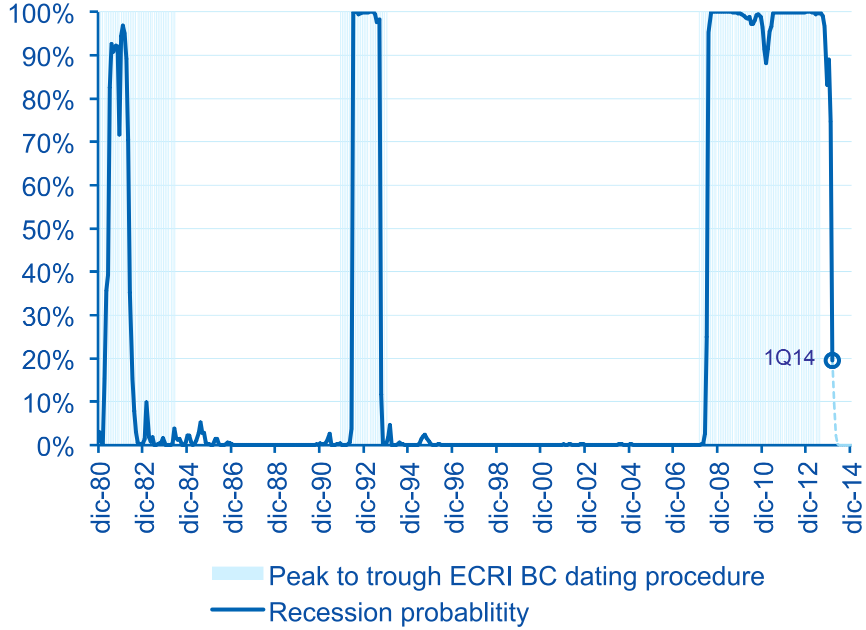
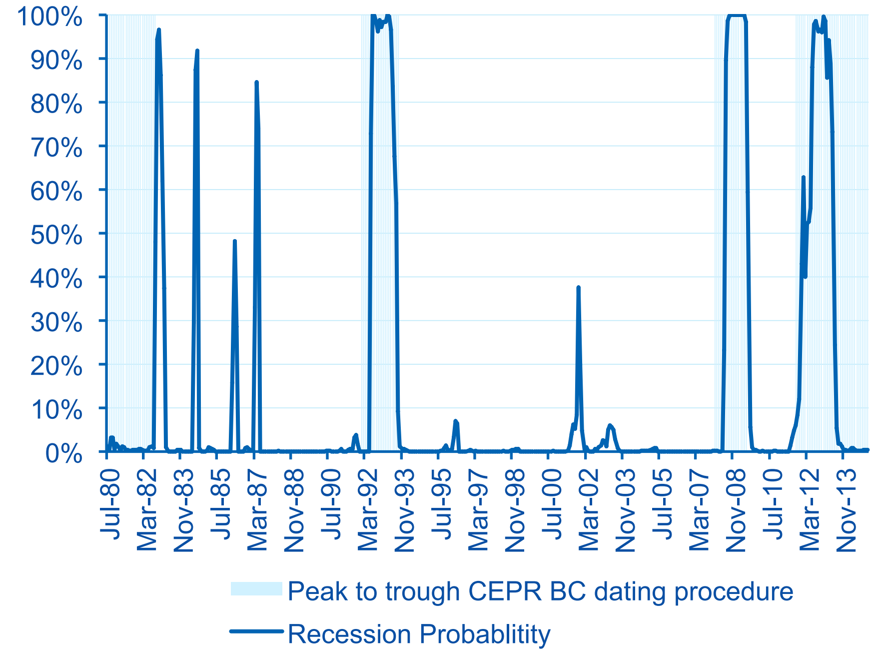
Results: recession probabilities

Spain: Recession probability (%)
Source: BBVA Research



EMU: Recession probability (%)
Source: BBVA Research



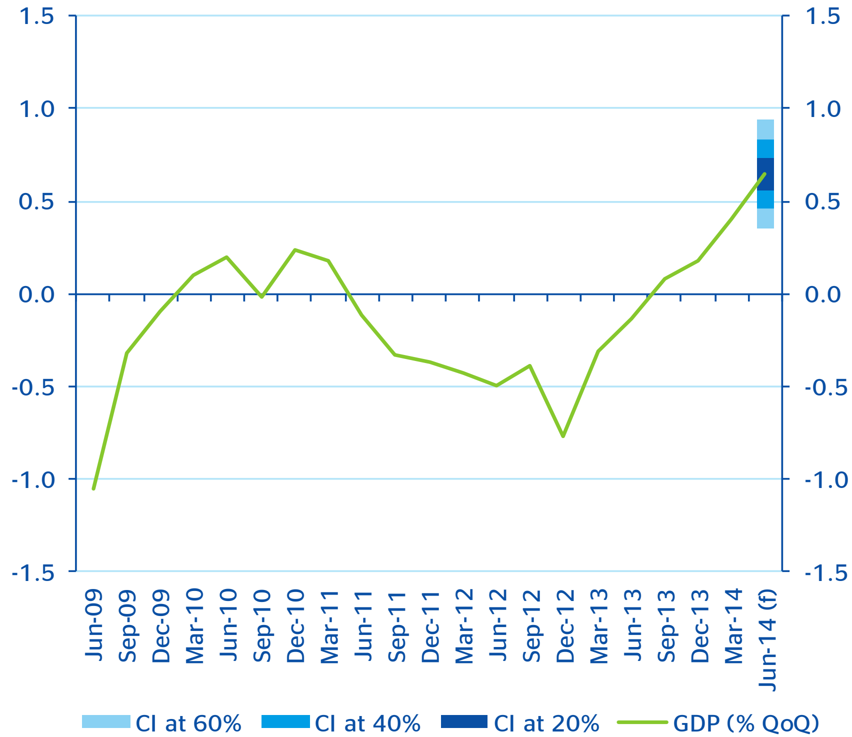
EMU: Markov-switching estimates
Source: Camacho and García-Serrador (2014)

c_0	c_1	α_1	σ^2	p_{00}	p_{11}
0.34 (0.11)	−5.30 (0.61)	0.88 (0.02)	3.51 (0.28)	0.98 (0.01)	0.76 (0.10)

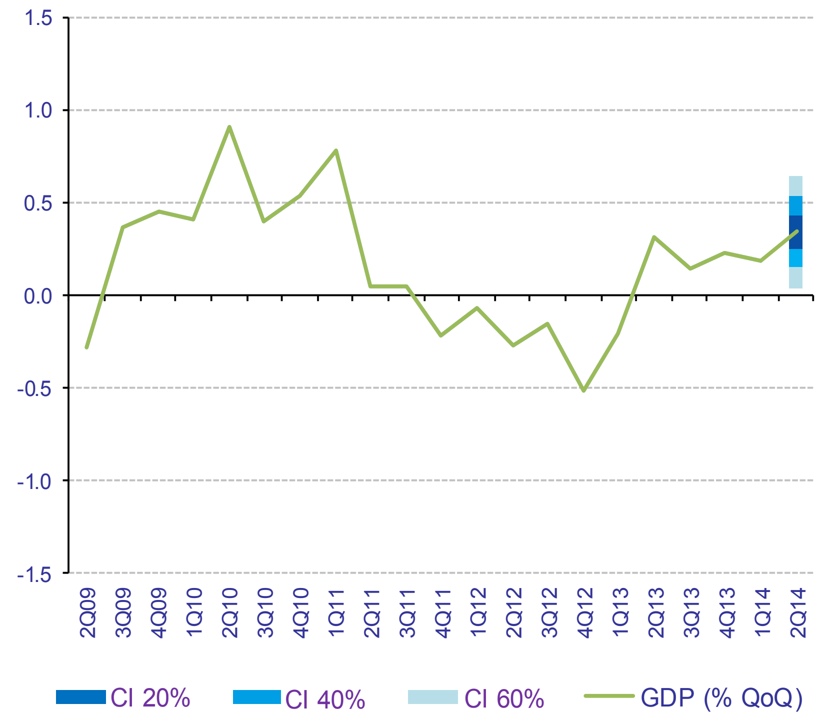
Note: The estimated model is $x_t = c_{s_t} + \alpha_1 x_{t-1} + \varepsilon_t$, where x_t is the common factor and $\varepsilon_t \sim \text{i.i.d.} N(0,\sigma)$, and $p(s_t = i / s_{t-1} = j) = p_{ij}$.

1. MICA-BBVA
Results: nowcasting

Spain:MICA-BBVA and GDP growth (% QoQ)
Source: BBVA Research based on INE



Eurozone: MICA-BBVA and GDP growth (% QoQ)
Source: Eurostat and BBVA Research



1. MICA-BBVA

Results: predictive accuracy for Spain

	Back	Now	Fore
MSE-MICA	0.1377	0.1938	0.2596
MSE-RW	0.3513	0.3567	0.3605
MSE-MICA/MSE-RW	0.3919	0.5432	0.7201
MSE-AR	0.2069	0.2802	0.3089
MSE-MICA/MSE-AR	0.6652	0.6916	0.8404
Equal predictive accuracy tests			
DM-RW	0.0001	0.0004	0.0046
DM-AR	0.0002	0.0008	0.0581
MDM-RW	0.0001	0.0004	0.0049
MDM-AR	0.0002	0.0009	0.0590
WSR-RW	0.0000	0.0000	0.0000
WSR-AR	0.0000	0.0000	0.0000
MGN-RW	0.0000	0.0000	0.0000
MGN-AR	0.0000	0.0000	0.0000
MR-RW	0.0000	0.0000	0.0000
MR-AR	0.0000	0.0000	0.0000
Encompassing tests			
RW/MICA	0.0000	0.0000	0.0000
AR/MICA	0.0000	0.0000	0.0000

$$y_t - \hat{y}_{t,i} = a_0 + a_1 \hat{y}_{t,MICA} + e_t$$

1. MICA-BBVA

Results: predictive accuracy for EMU

Table IV. Predictive accuracy

		Backcasts			Nowcasts			Forecasts	
Mean squared errors									
MICA		0.138			0.298			0.403	
	E: 0.080		R: 0.449	E: 0.108		R: 0.916	E: 0.223		R: 1.358
RW		0.370			0.361			0.377	
	E: 0.111		R: 1.746	E: 0.107		R: 1.707	E: 0.113		R: 1.779
MICA/RW		0.374			0.824			1.070	
AR		0.297			0.369			0.377	
	E: 0.098		R:1.350	E: 0.127		R: 1.651	E: 0.114		R: 1.769
MICA/AR		0.466			0.806			1.071	
MICA2		0.151			0.348			0.4647	
	E: 0.128		R: 0.374	E: 0.178		R: 1.062	E: 0.177		R: 1.962
MICA/MICA2		0.914			0.856			0.867	
MS		0.212			0.321			0.403	
	E: 0.119		R: 0.708	E: 0.163		R: 1.165	E: 0.168		R: 1.012
MICA/MS		0.652			0.928			1.333	
TAR		0.297			0.322			0.323	
	E: 0.085		R: 1.420	E: 0.189		R: 0.981	E: 0.157		R: 1.205
MICA/TAR		0.466			0.923			1.205	
STING		0.254			0.298			0.385	
	E: 0.176		R: 0.667	E: 0.252		R: 0.750	E: 0.194		R: 1.400
MICA/STING		0.544			0.898			1.047	
Equal predictive accuracy tests									
MICA vs RW		0.004			0.356			0.629	
MICA vs AR		0.001			0.259			0.614	
MICA vs MICA2		0.002			0.006			0.023	
MICA vs MS		0.015			0.693			0.237	
MICA vs TAR		0.005			0.637			0.128	
MICA vs STING		0.022			0.516			0.682	

Note: The forecasting sample is 1990.Q1–2010.Q1, which implies comparisons over 492 forecasts. Entries in rows 1–13 are mean squared errors (MSE) of dynamic factor model with ESI indicators (MICA), random walk (RW), autoregressive of order two (AR), dynamic factor model with PMI indicators (MICA2), Markov switching of order two (MS), TAR of order two (TAR), and the Euro-STING model (STING), along with the relative MSEs over that of ESI. R and E refer to recessions and expansions periods according to CEPR. The last six rows show the *p*-values of the Diebold–Mariano (DM) test of equal forecast accuracy.

1. MICA-BBVA

Conclusions

- We have proposed an extension of the Stock and Watson (1991) single-index **dynamic factor model** for the Spanish and EMU quarterly GDP growth
- The model combines information from **real and financial indicators** with different frequencies, short samples and publication lags
- The **common factor** reflects the behavior of the Spanish and EMU GDP growth during expansions and contractions very well
- **Financial indicators** are useful for forecasting output growth especially when assuming that some financial variables lead the common factor
- We provide a simulated pseudo-real-time exercise, showing that the model is a valid tool to be used for short-term analysis and **better that other alternative models**
- **Extensions**:
  - Models for **aggregate demand components**
  - Stock vs **gross flow of credit**

1. MICA-BBVA

Extension: gross flows of credit and economic activity

Both real activity variables (consumption, investment) and new credit operations are flows. New loans provide a better match of activity than the stock of credit

The process of deleveraging (reduction of the stock of credit) is compatible with new credit provision (increase in the flow of credit) for solvent projects

A turning point is already visible in EMU: an improvement in credit flows to household and SMEs, which will be strengthened over second half of 2013 and 2014

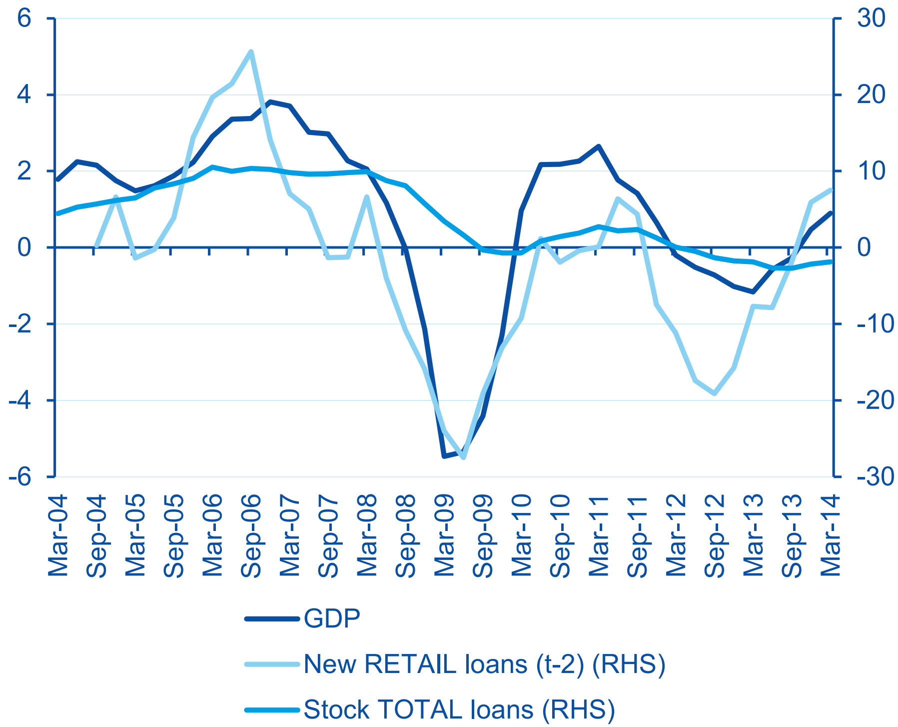
At the EMU level, there is a stronger correlation of GDP growth with new loans growth (0.9) than with credit stock growth (0.6)

The growth of new loans leads GDP growth in two quarters. Loans to households lead consumption, whereas loans to SME are contemporaneous to investment. On the contrary, GDP growth leads credit stock growth.

1. MICA-BBVA

Extension: gross flows of credit and economic activity

Eurozone: GDP and credit growth (% YoY)
Note: Retail loans is the sum of loans to households and to firms up to €1M
Source: ECB, Eurostat and BBVA Research



New retail loans (for household consumption and SME's investment) are growing, despite the fall of their stock

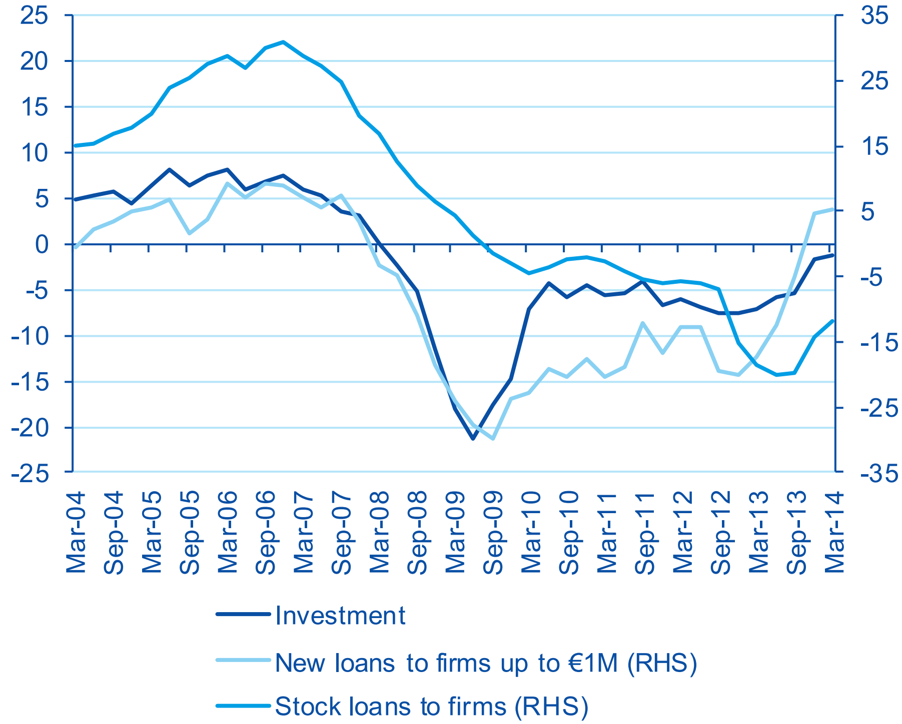
Stronger correlation of GDP growth with new loans growth (0.9) than with credit stock growth (0.6)

The growth of new loans leads GDP by two quarters, mostly because credit to households leads consumption

1. MICA-BBVA

Extension: gross flows of credit and economic activity

Spain: investment and credit growth (% YoY)
Source: ECB, Eurostat and BBVA Research



The process of debt reduction is compatible with credit provision for solvent projects

Turning point: Investment is already recovering (machinery and equipment), with new loans to SME's accelerating …

… despite the fact that the credit stock is still falling, due to the high repayments that accompany the deleveraging process

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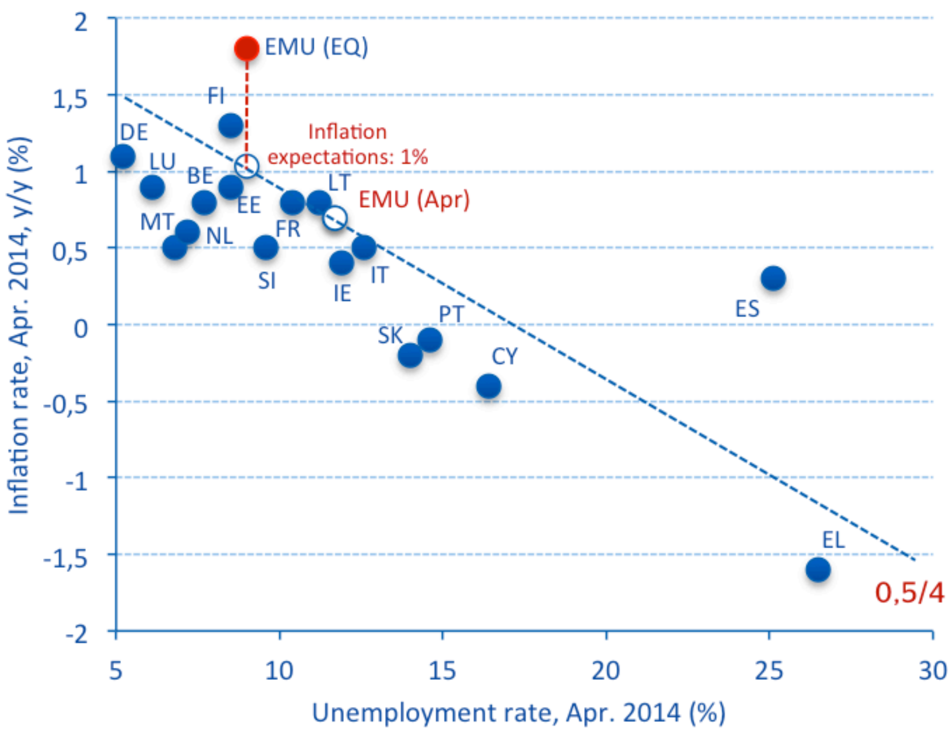
2. Trimmed mean inflation for Japan, EMU and Spain

Motivation: inflation expectations below the ECB target

Eurozone: unemployment rate and inflation

Source: Eurostat and BBVA Research



The regression coefficient of the inflation rate on the unemployment rate is equal to 0.125, statistically significant and robust to the exclusion of Cyprus, Greece and Spain.

The double-dip recession (unemployment) and M3 growth partially explain the low rate of inflation in EMU

If 3 pp of higher unemployment explain 0.4 pp lower inflation, inflation expectations are currently less than 1% -> drag for the economic recovery

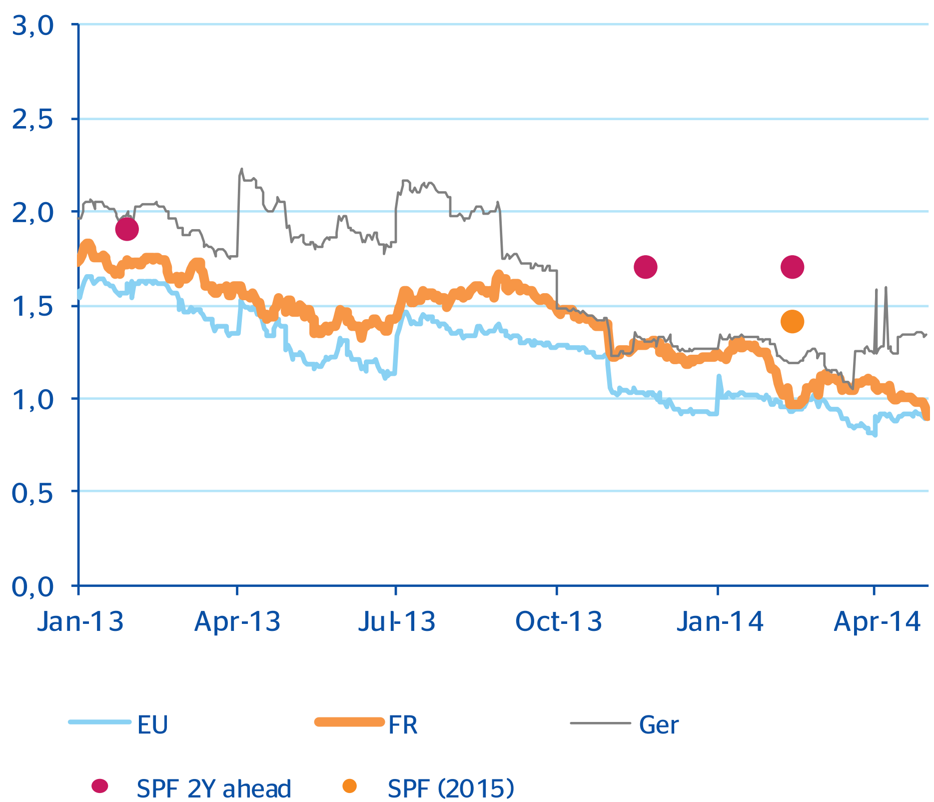
Inflation expectations in swaps and trimmed mean inflation (optimal selection in terms of inflation prediction for next 2/3 years) are slightly below 1%

Although inflation will be above 1% in 2015 in our base scenario and the probability of deflation is low (<10%), adverse shocks could increase this probability

2. Trimmed mean inflation for Japan, EMU and Spain

Motivation: inflation expectations below the ECB target

2Y Inflation swaps, spot rates (%)
Source: Bloomberg, ECB and BBVA Research



The double-dip recession (unemployment) and M3 growth partially explain the low rate of inflation in EMU

If 3 pp of higher unemployment explain 0.4 pp lower inflation, inflation expectations are currently less than 1% -> drag for the economic recovery

EMU Inflation expectations in swaps are slightly below 1%

Although inflation will be above 1% in 2015 in our base scenario and the probability of deflation is low (<10%), adverse shocks could increase this probability

2. Trimmed mean inflation for Japan, EMU and Spain

Methodology

- Following Bryan, Cecchetti and Wiggins (1997) and Dolmas (2005), the trimmed mean is given by

$$\bar{\pi}_{\alpha,\beta} = \frac{1}{n-j-k}\sum_{i=j+1}^{n-k} w_i \pi_i, \qquad \alpha,\beta = (1,2,\ldots,50)$$

  where π is the monthly price growth rate and *w* its weight

- We compute 2,601 **symmetric and asymmetric trimmed means** using the weighted distribution of the CPI subclasses (95 for EMU, 126 for Spain and 589 for Japan)
- As Meyer and Venkatu (2014), we then selected the optimal trimmed mean based on its **predictive capacity** with respect to annualized mean inflation **over a forecast horizon of 30 months**
- Finally, we compute **confidence intervals** around the optimum trimmed-mean selected using the predictive capacity test proposed by Diebold and Mariano (1995)
- See also BBVA Research (2014)

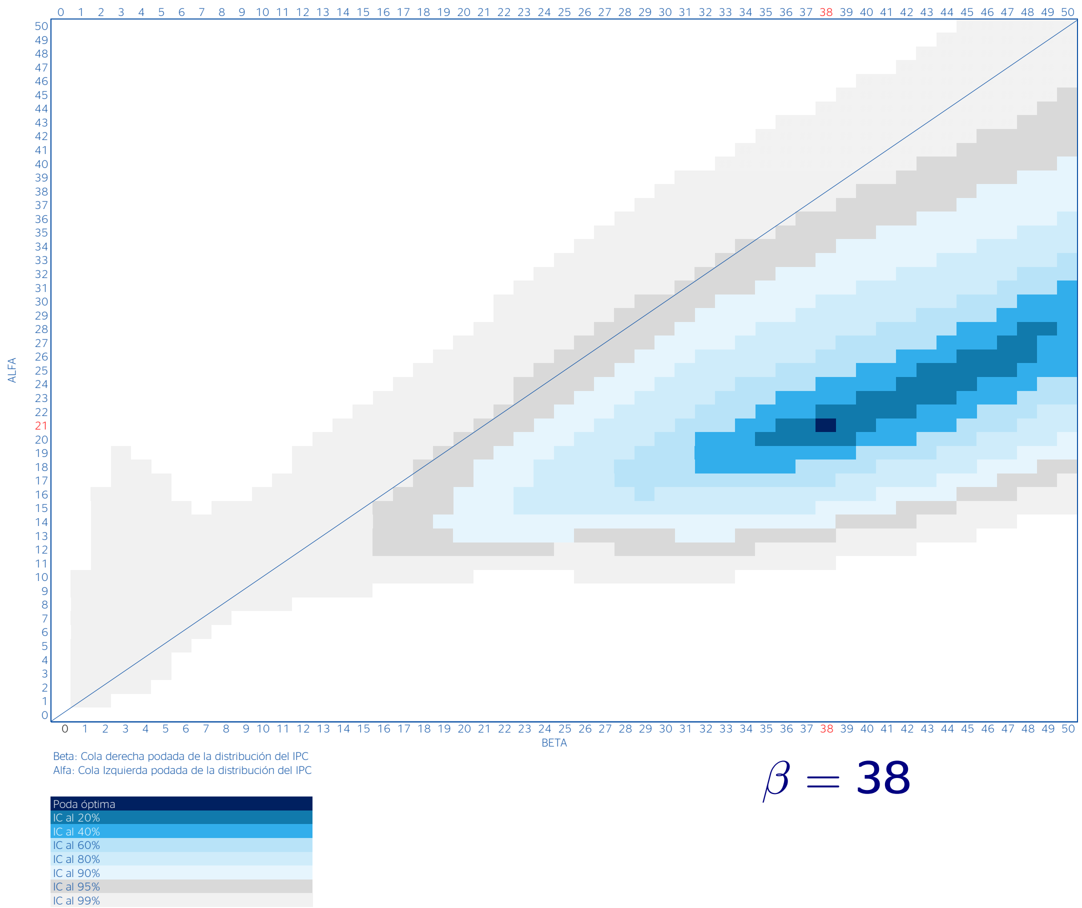
2. Trimmed mean inflation for Japan, EMU and Spain

Results for Japan

Japan: optimal trimmed mean for inflation and confidence intervals (forecast horizon: 30 months, 1980-2013)

Source: BBVA Research

$\alpha = 21$

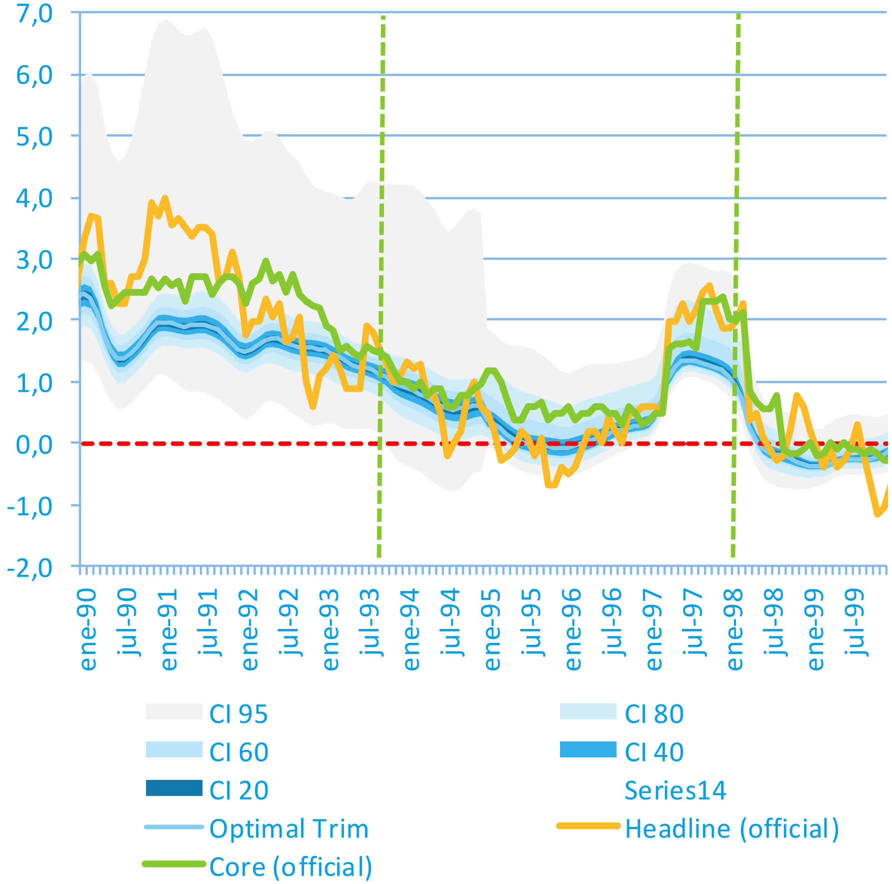


$\beta = 38$

2. Trimmed mean inflation for Japan, EMU and Spain

Results for Japan

Japan: inflation, core and trimmed mean inflation (% YoY)
Source: BBVA Research



The trimmed mean confidence intervals started pointing non-negligible deflation probabilities before it already happened

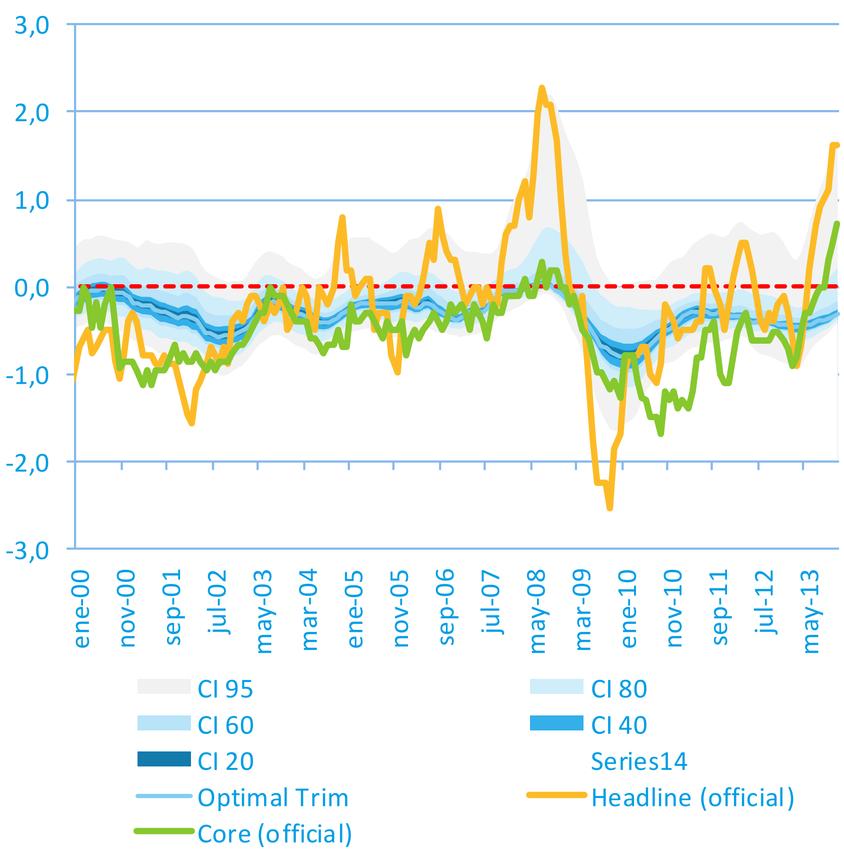
The optimal trimmed mean inflation dropped below zero about a quarter before the headline inflation started to fall

Between two to three quarters before the core inflation started to fall

2. Trimmed mean inflation for Japan, EMU and Spain

Results for Japan

Japan: inflation, core and trimmed mean inflation (% YoY)
Source: BBVA Research



A deflationary scenario still cannot be ruled out in Japan

Recently headline and core inflation returned to positive …

… but the optimal trimmed mean inflation still remains below zero

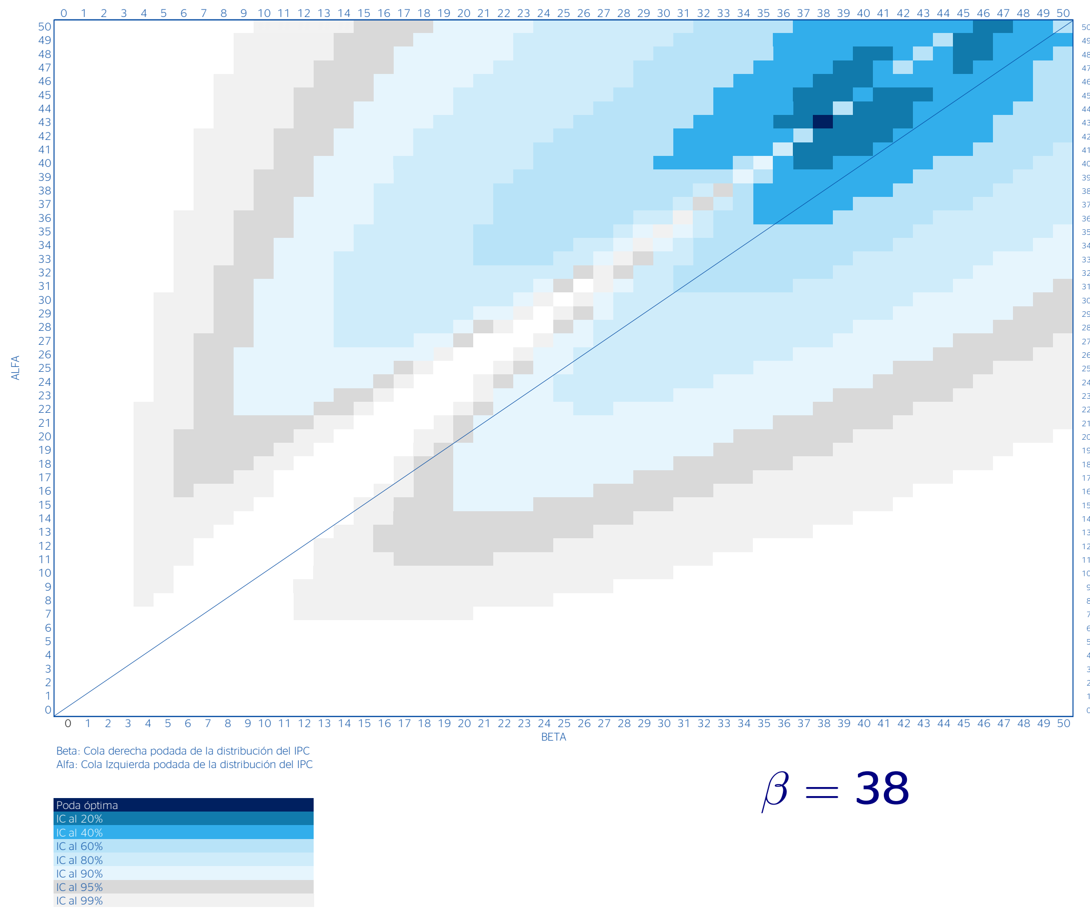
2. Trimmed mean inflation for Japan, EMU and Spain

Results for EMU

EMU: optimal trimmed mean for inflation and confidence intervals (forecast horizon: 30 months, 1996-2013)

Source: BBVA Research

$\alpha = 43$

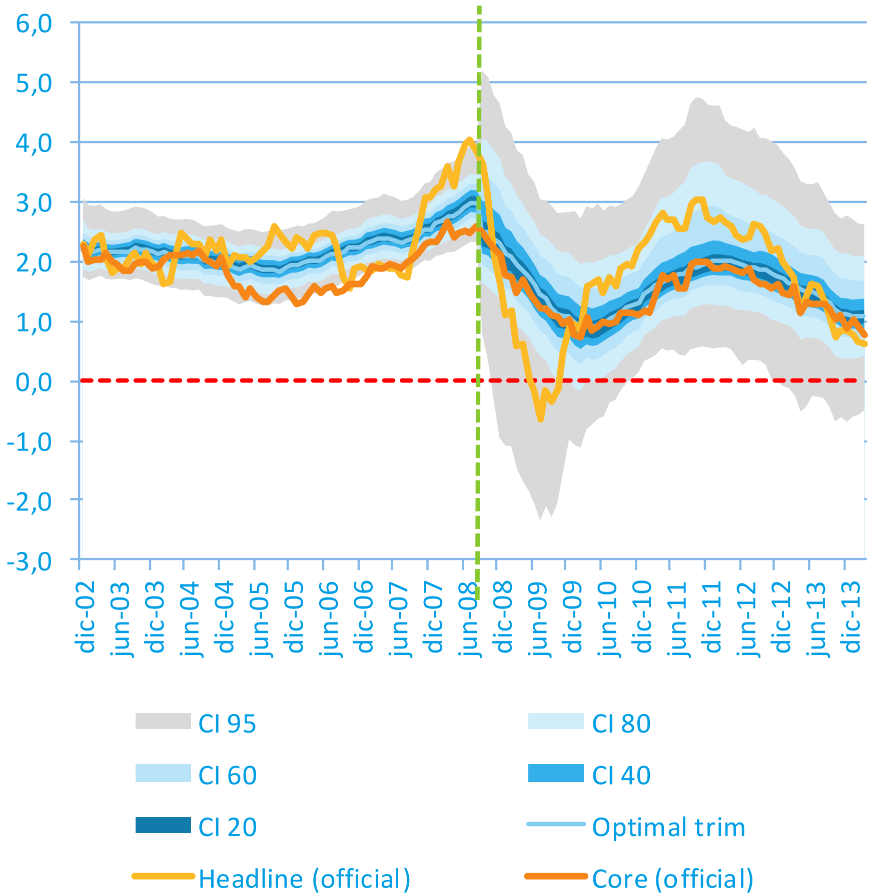


$\beta = 38$

2. Trimmed mean inflation for Japan, EMU and Spain

Results for EMU

EMU: inflation, core and trimmed mean inflation (% YoY)
Source: BBVA Research



The optimal trimmed mean inflation signals future inflation at around 1,0%

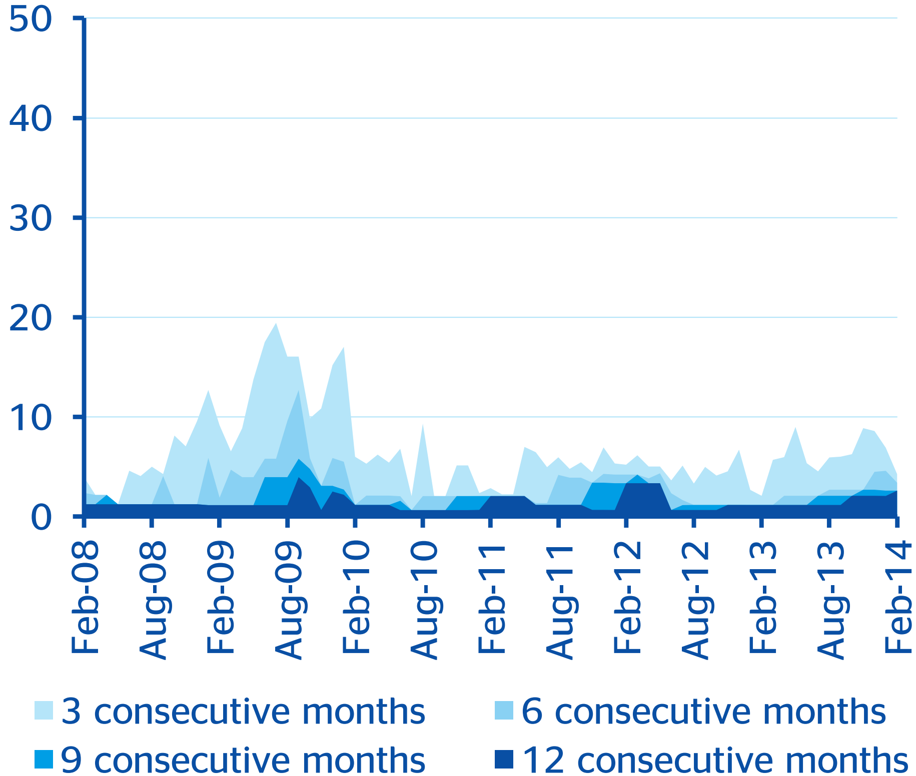
Uncertainty has increased…

… but probability of deflations seems to be well quite low (between 2,5% and 10%)

2. Trimmed mean inflation for Japan, EMU and Spain

Results for EMU

EMU: CPI items with persistent negative growth rates rates (%)
Source: BBVA Research



Deflation probability in EMU is quite low

Less than 3% of the CPI components show negative inflation, with a persistence between 9 and 12 months

less than 10% of the CPI components show negative inflation, with a persistence between 3 and 6 months

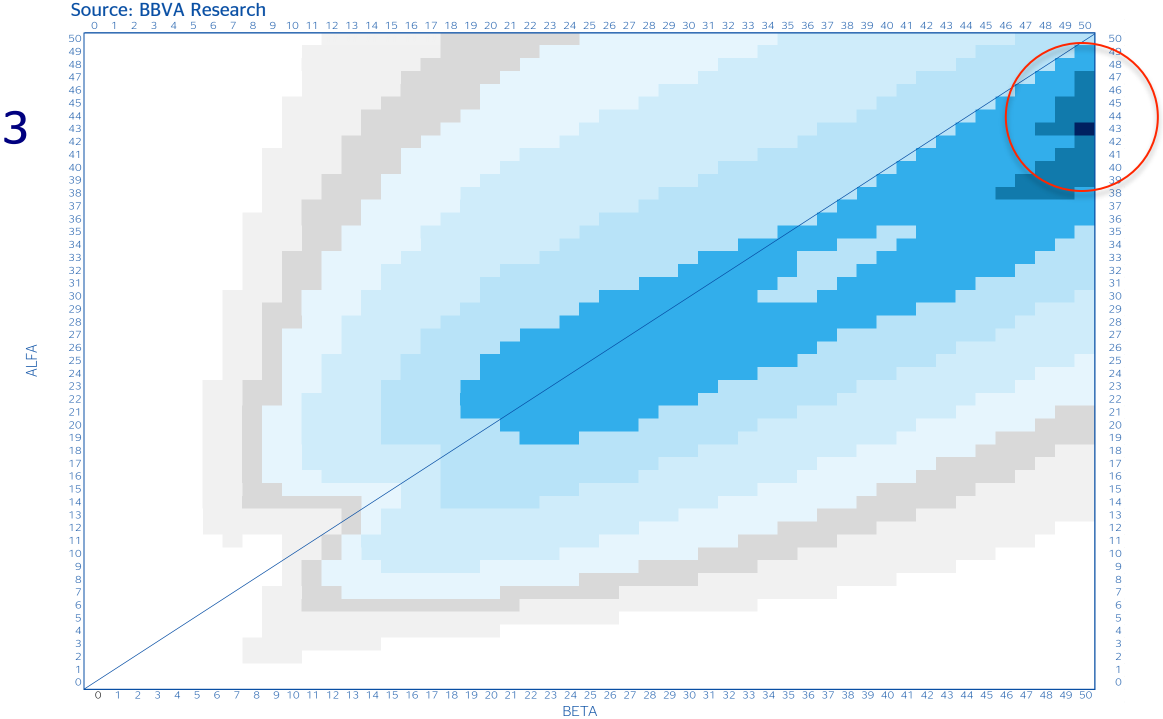
2. Trimmed mean inflation for Japan, EMU and Spain

Results for Spain: trimmed mean close to the median

Spain: optimal trimmed mean for inflation and confidence intervals (forecast horizon: 30 months, 2002-2013)

Source: BBVA Research

$\alpha = 43$



$\beta = 50$

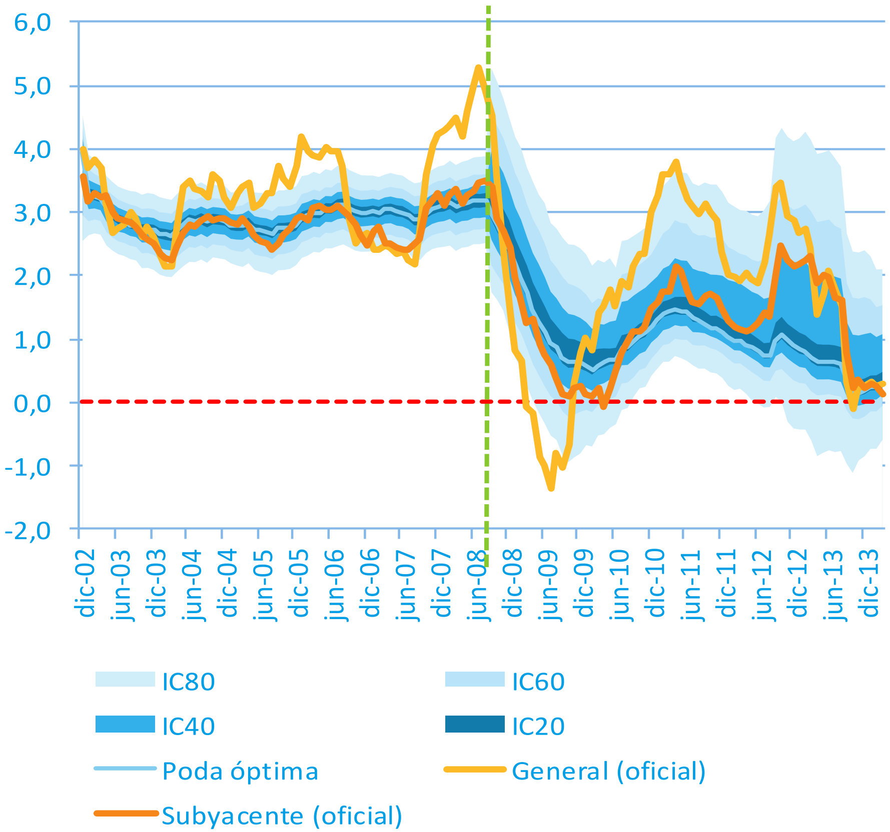
Beta: Cola derecha podada de la distribución del IPC
Alfa: Cola Izquierda podada de la distribución del IPC

- Poda óptima
- IC al 20%
- IC al 40%
- IC al 60%
- IC al 80%
- IC al 90%
- IC al 95%
- IC al 99%

2. Trimmed mean inflation for Japan, EMU and Spain

Results for Spain: trimmed mean close to the median

Spain: inflation, core and trimmed mean inflation (% YoY)
Source: BBVA Research



The optimal trimmed mean inflation shows a negative trend that is more stable than in the case of core inflation

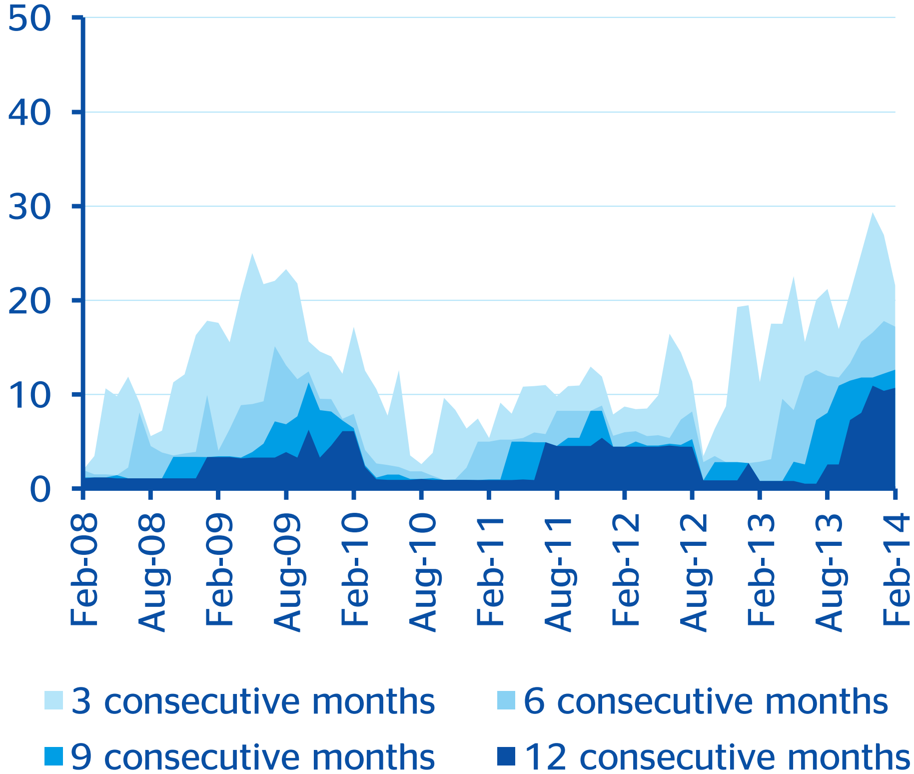
Core inflation is more volatile due to changes in indirect taxes and the volatility of commodities

20% of probability of having negative inflation rates in the next 30 months

2. Trimmed mean inflation for Japan, EMU and Spain

Results for Spain

Spain: CPI items with persistent negative growth rates rates (%)
Source: BBVA Research



Deflation probability in Spain is higher than in EMU

10% of the CPI components show negative inflation, with a persistence between 9 and 12 months

20% of the CPI components show negative inflation, with a persistence between 3 and 6 months

2. Trimmed mean inflation for Japan, EMU and Spain

Conclusions

- Current inflation levels and expectation for the next 2 years point to a scenario of "**too low inflation for too long**", both in Spain and in EMU
- Given the risks of a deflationary scenario, it is necessary to have good **forecasting models** over horizons of 2 to 3 years and **trimmed mean measures are complementary to other alternative approaches**
- **Trimmed mean inflation** rates have better predictive properties than core inflation
- **Medium-term expectations**: the most likely scenario is that trending inflation remains low but positive in EMU, close to zero in Spain and still negative in Japan
- **Policy implications**:
  - **Japan**: the BoJ should continue quantitative easing until trimmed mean inflation rate is positive
  - **EMU**: the ECB should anchor 2y inflation expectations close to 2%
  - **Spain** must continue to improve competitiveness, with a negative inflation differential

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Rafael Doménech

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