

MONITORING THE SPANISH ECONOMY THROUGH THE LENSES OF STRUCTURAL BAYESIAN VARs

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DIRECCIÓN GENERAL DE ECONOMÍA Y ESTADÍSTICA

Introduction



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Banco de España

Documentos Ocasionales

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Introduction



- **Goal:** Provide a suite of empirical models for:
 1. Assessing the structural shocks that mainly affect the Spanish economy over time
 2. Producing forecasts of GDP and inflation conditional on assumptions about key macroeconomic variables
- **Tool:** Suite of Structural Vector Autoregressions (**SVAR**) , estimated with Bayesian methods, which allows us to:
 1. Impose restrictions that help to identify in a relatively accurate way key macroeconomic structural shocks
 2. Easily provide robust and detailed inference about conditional forecasts obtained from the suite of models

Outline



1. Suite of Models

2. Results

2.1. Structural Analysis

2.2. Forecasts

Outline



1. Suite of Models

2. Results

2.1. Structural Analysis

2.2. Forecasts

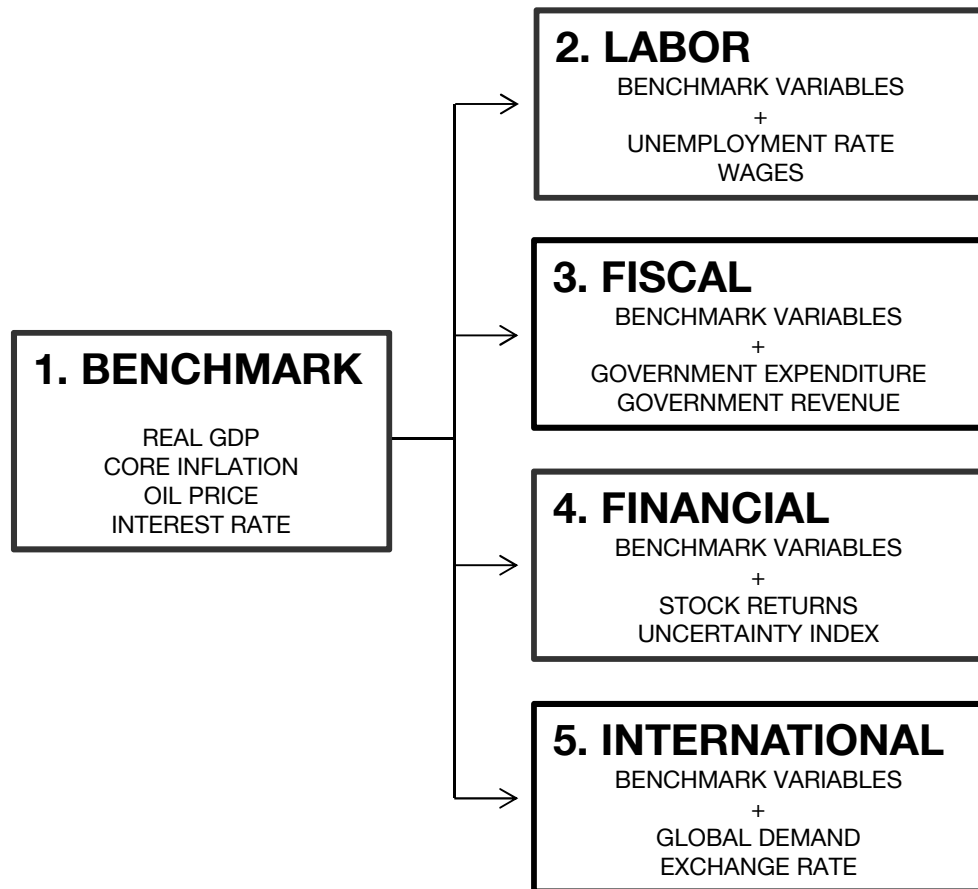
Suite of Bayesian VAR Models



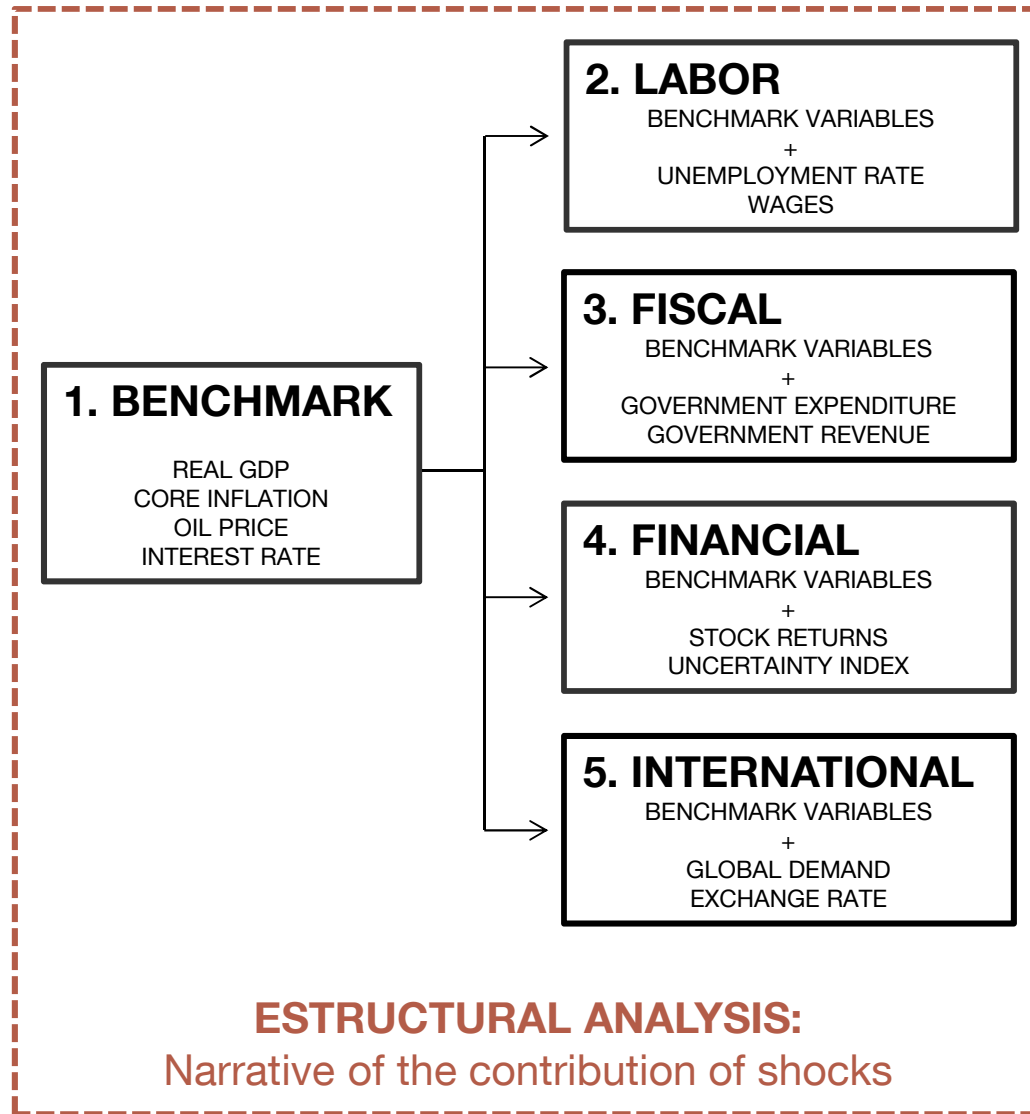
1. BENCHMARK

REAL GDP
CORE INFLATION
OIL PRICE
INTEREST RATE

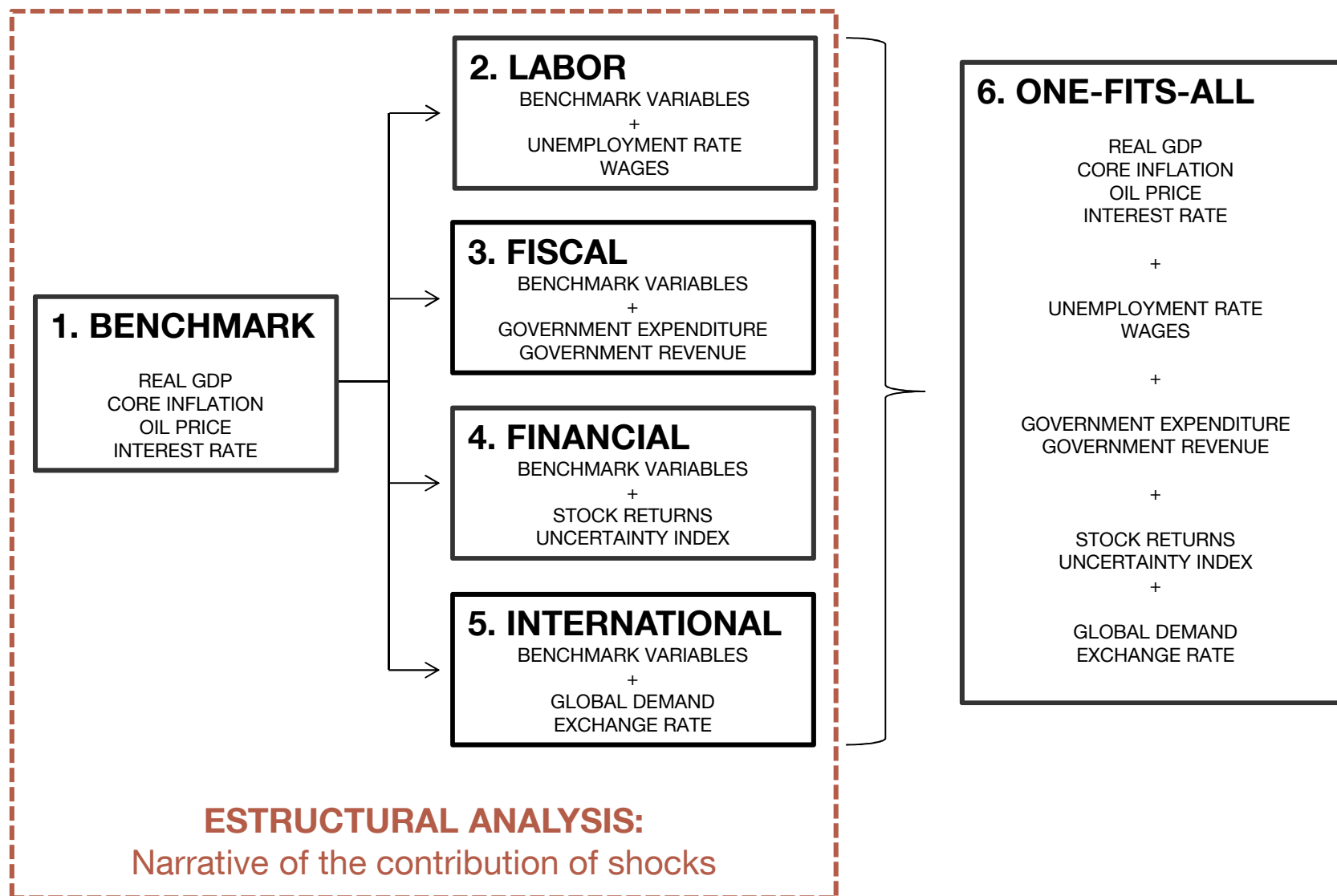
Suite of Bayesian VAR Models



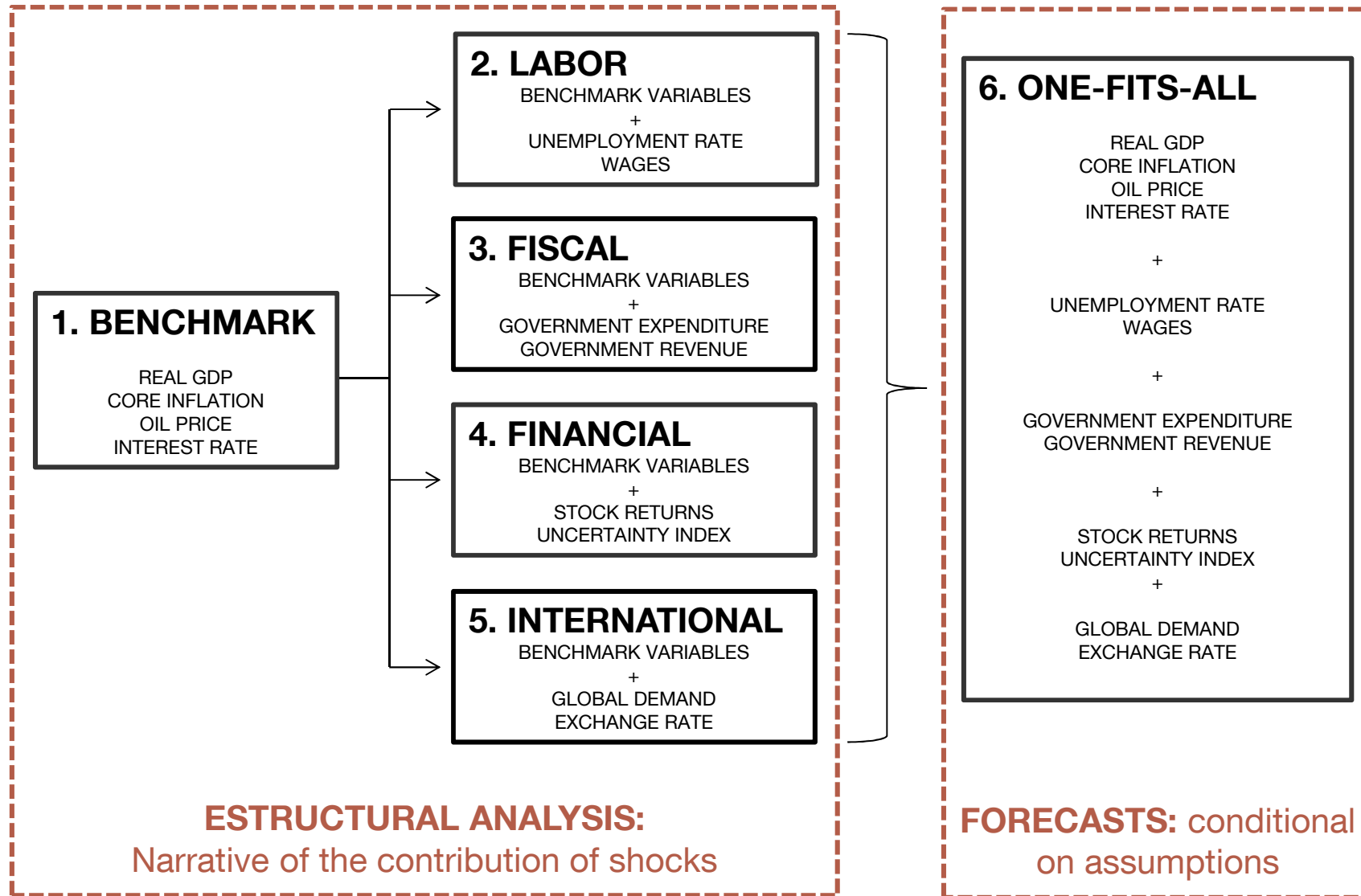
Suite of Bayesian VAR Models



Suite of Bayesian VAR Models



Suite of Bayesian VAR Models



Identification of Shocks: Benchmark Model



- SBVAR mode for the Spanish economy

$$\begin{bmatrix} GDP_t \\ INF_t \\ INT_t \\ OIL_t \end{bmatrix} = C + \Phi(L) \begin{bmatrix} GDP_{t-1} \\ INF_{t-1} \\ INT_{t-1} \\ OIL_{t-1} \end{bmatrix} + \begin{bmatrix} u_{gdp,t} \\ u_{inf,t} \\ u_{int,t} \\ u_{oil,t} \end{bmatrix}$$

- **Sign and Exclusion Restrictions:** The reduced form innovations are a function of the structural innovations

$$\begin{bmatrix} u_{gdp,t} \\ u_{inf,t} \\ u_{int,t} \\ u_{oil,t} \end{bmatrix} = \begin{bmatrix} + & - & - & * \\ + & + & - & * \\ + & + & + & * \\ 0 & 0 & 0 & * \end{bmatrix} \begin{bmatrix} \varepsilon_{demand,t} \\ \varepsilon_{cost-push,t} \\ \varepsilon_{mon-pol,t} \\ \varepsilon_{oil,t} \end{bmatrix}$$

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Identification of Shocks: Benchmark Model



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Identification of Shocks: Labor Model



- The (i) unemployment rate and (ii) wages are incorporated to the *Benchmark* model
- The assumed restrictions follow the line of Peersman and Straub (2009), and Foroni et al. (2015)

$$\begin{bmatrix} u_{gdp,t} \\ u_{inf,t} \\ u_{int,t} \\ u_{une,t} \\ u_{wag,t} \\ u_{oil,t} \end{bmatrix} = \begin{bmatrix} + & - & - & + & * & * \\ + & + & - & - & * & * \\ + & + & + & * & * & * \\ * & * & * & * & * & * \\ * & * & * & - & * & * \\ 0 & 0 & 0 & 0 & 0 & * \end{bmatrix} \begin{bmatrix} \varepsilon_{demand,t} \\ \varepsilon_{cost-push,t} \\ \varepsilon_{mon-pol,t} \\ \varepsilon_{lab-sup,t} \\ \varepsilon_{wage,t} \\ \varepsilon_{oil,t} \end{bmatrix}$$

Identification of Shocks: Fiscal Model



- The (i) government revenues and (ii) government expenditures are incorporated to the *Benchmark* model
- The assumed restrictions follow the line of Mountford y Uhlig (2009)

$$\begin{bmatrix} u_{gdp,t} \\ u_{inf,t} \\ u_{int,t} \\ u_{exp,t} \\ u_{rev,t} \\ u_{oil,t} \end{bmatrix} = \begin{bmatrix} + & - & - & + & - & * \\ + & + & - & * & * & * \\ + & + & + & * & * & * \\ * & * & * & + & * & * \\ * & * & * & * & + & * \\ 0 & 0 & 0 & 0 & 0 & * \end{bmatrix} \begin{bmatrix} \varepsilon_{demand,t} \\ \varepsilon_{cost-push,t} \\ \varepsilon_{mon-pol,t} \\ \varepsilon_{gob-exp,t} \\ \varepsilon_{gov-rev,t} \\ \varepsilon_{oil,t} \end{bmatrix}$$

Identification of Shocks: Financial Model



- The (i) stock returns and (ii) a financial uncertainty index are incorporated to the *Benchmark* model
- Gil, Pérez and Urtasun (2016) have documented significantly negative effects of uncertainty on real activity

$$\begin{bmatrix} u_{gdp,t} \\ u_{inf,t} \\ u_{int,t} \\ u_{sto,t} \\ u_{unc,t} \\ u_{oil,t} \end{bmatrix} = \begin{bmatrix} + & - & - & * & - & * \\ + & + & - & * & * & * \\ + & + & + & * & * & * \\ * & * & * & * & - & * \\ * & * & * & * & + & * \\ 0 & 0 & 0 & 0 & 0 & * \end{bmatrix} \begin{bmatrix} \varepsilon_{demand,t} \\ \varepsilon_{cost-push,t} \\ \varepsilon_{mon-pol,t} \\ \varepsilon_{sto-ret,t} \\ \varepsilon_{uncert,t} \\ \varepsilon_{oil,t} \end{bmatrix}$$

Identification of Shocks: International Model



- A measure of global demand and the Dollar-Euro exchange rate are incorporated to the *Benchmark* model
- Sign restriction of the *Benchmark* model are kept, and exclusion restrictions are added

$$\begin{bmatrix} u_{gdp,t} \\ u_{inf,t} \\ u_{int,t} \\ u_{gde,t} \\ u_{exr,t} \\ u_{oil,t} \end{bmatrix} = \begin{bmatrix} + & - & - & * & * & * \\ + & + & - & * & + & * \\ + & + & + & * & * & * \\ 0 & 0 & 0 & * & * & * \\ 0 & 0 & * & 0 & + & * \\ 0 & 0 & 0 & 0 & 0 & * \end{bmatrix} \begin{bmatrix} \varepsilon_{demand,t} \\ \varepsilon_{cost-push,t} \\ \varepsilon_{mon-pol,t} \\ \varepsilon_{glo-dem,t} \\ \varepsilon_{exr-rate,t} \\ \varepsilon_{oil,t} \end{bmatrix}$$

Esquema



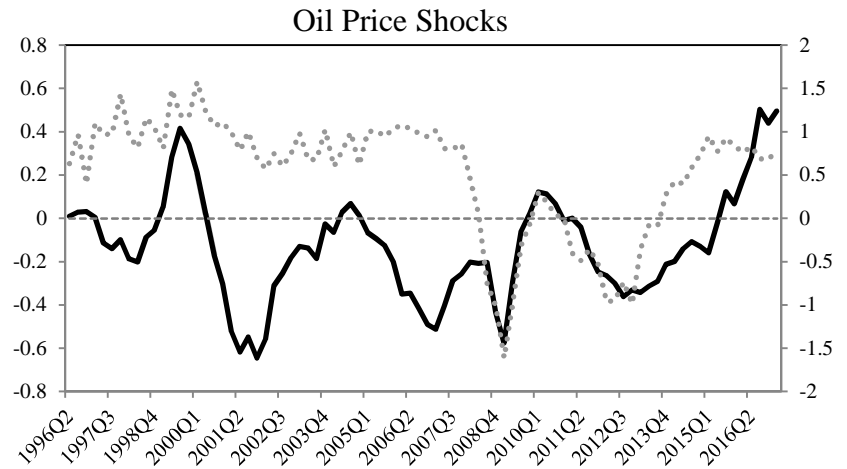
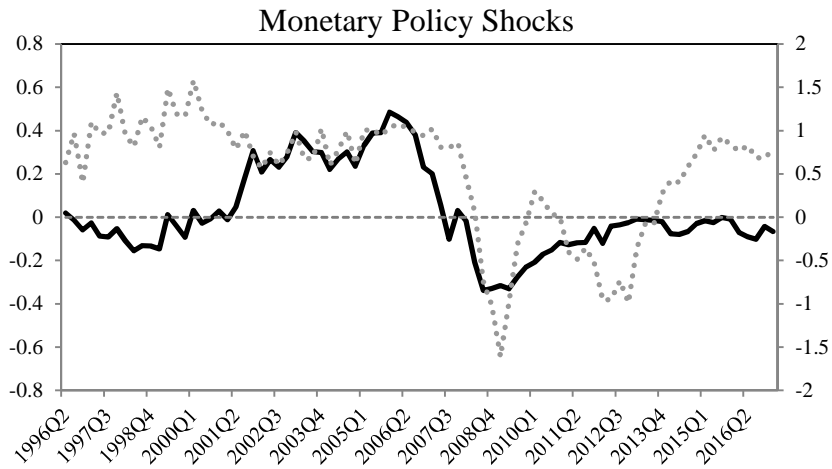
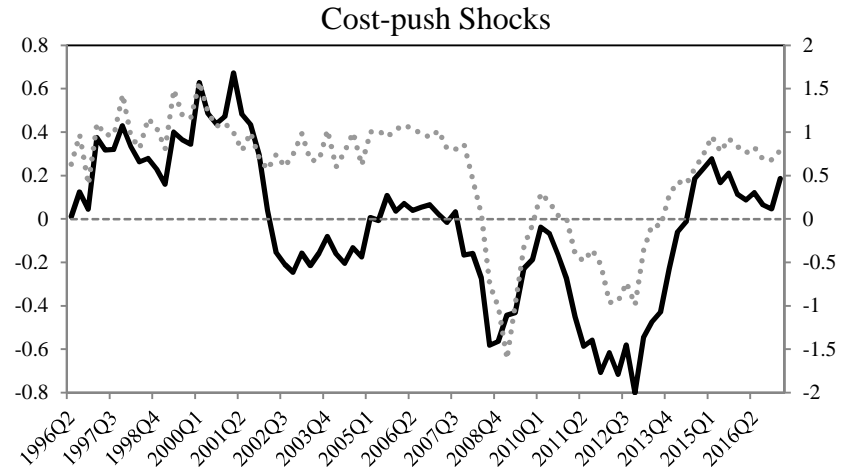
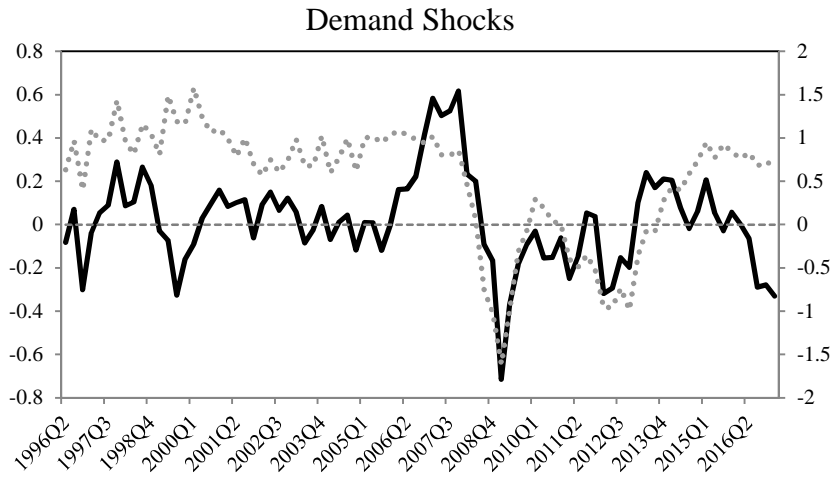
1. Suite of Models

2. Results

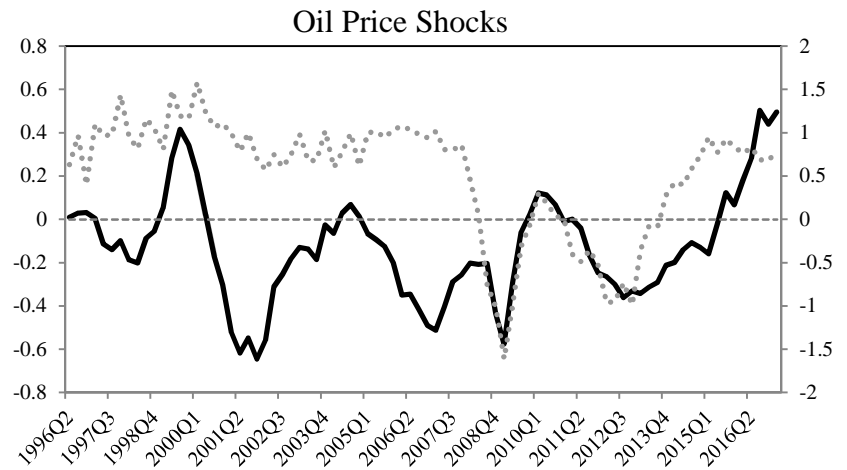
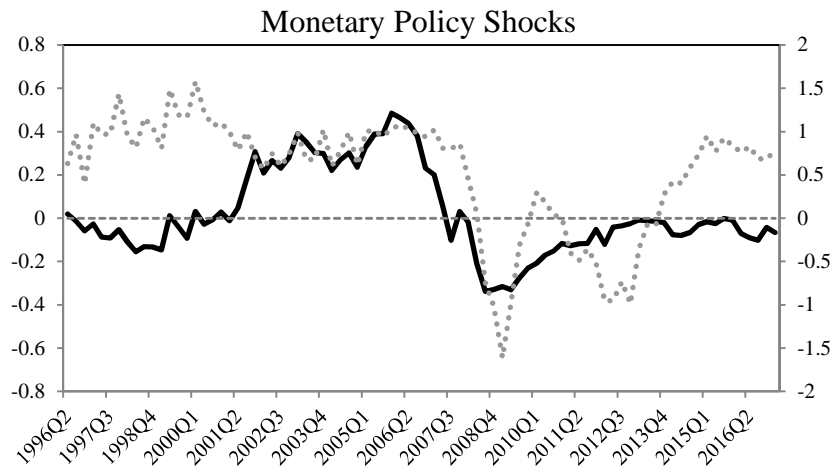
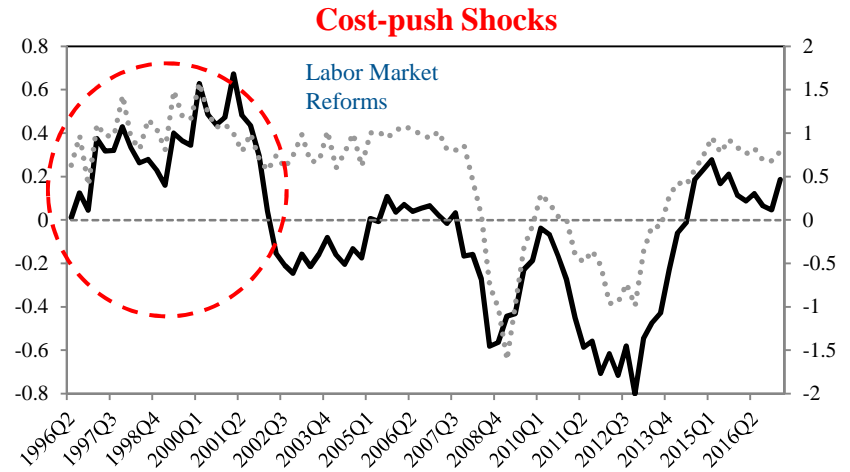
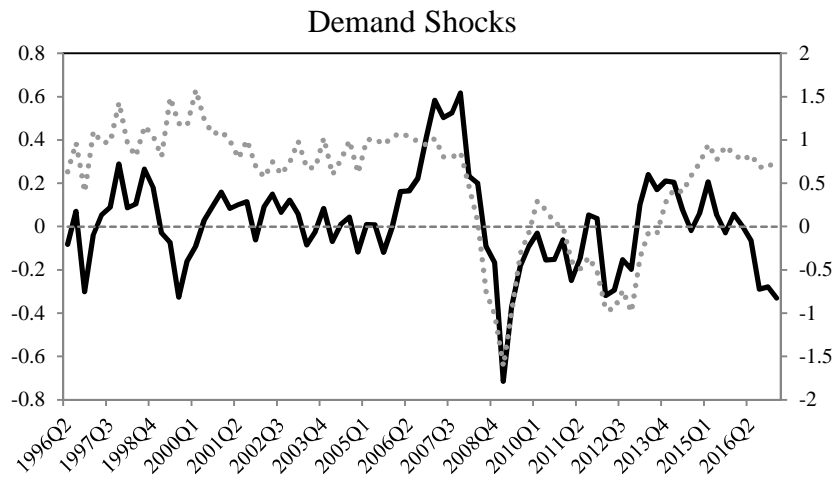
2.1. Structural Analysis

2.2. Forecasts

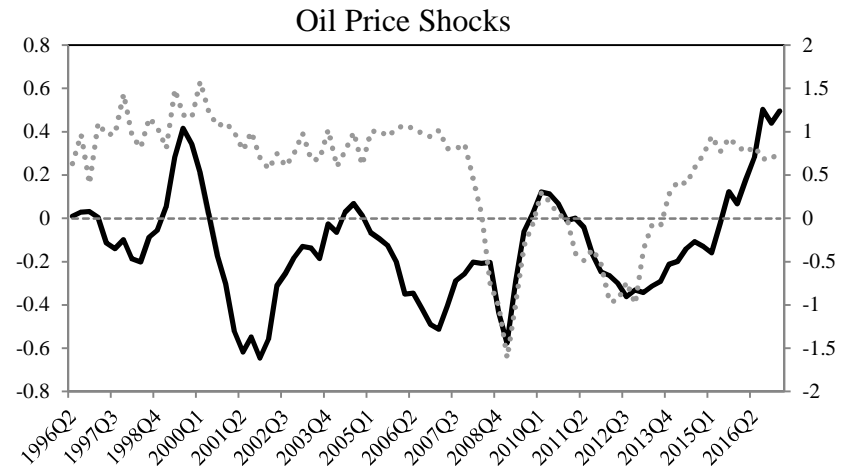
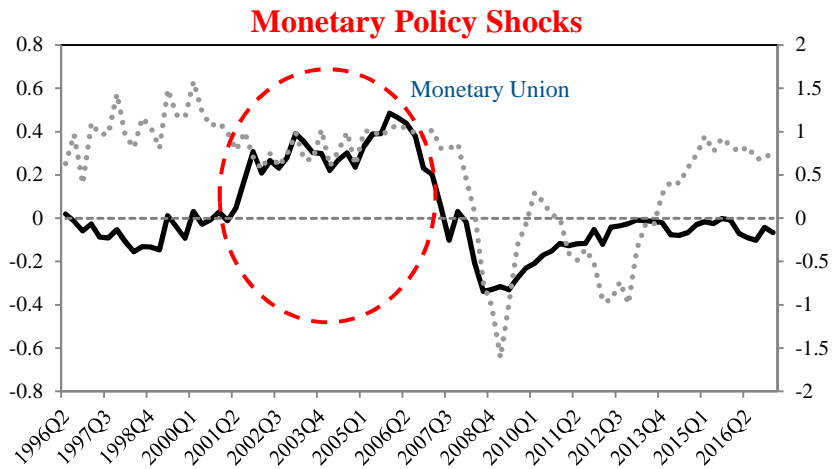
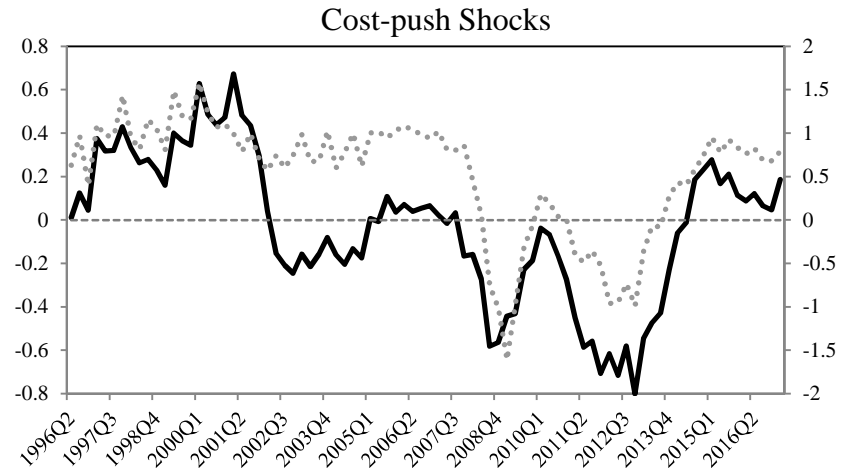
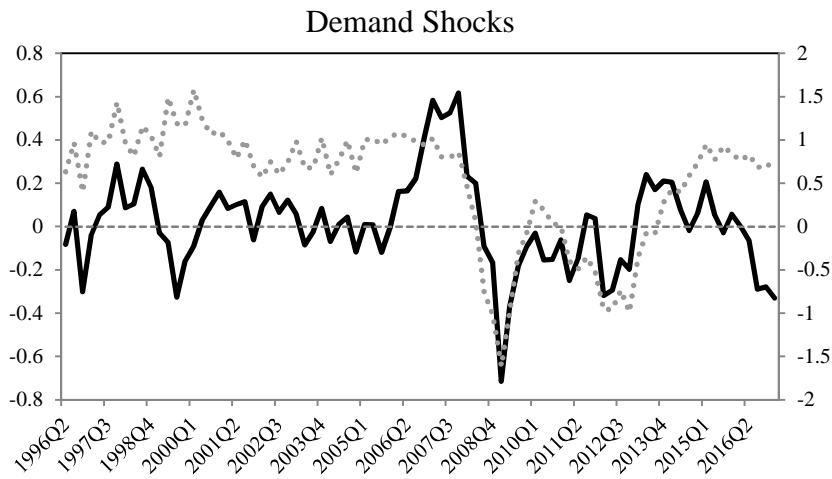
GDP Historical Decomposition: Benchmark Model



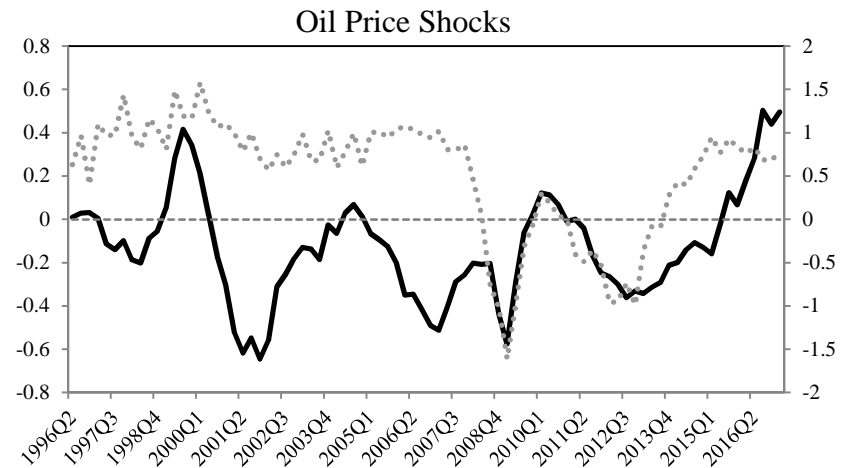
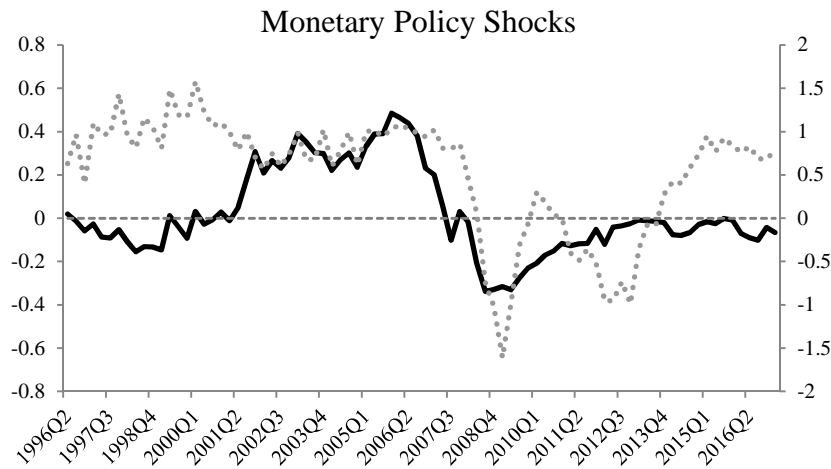
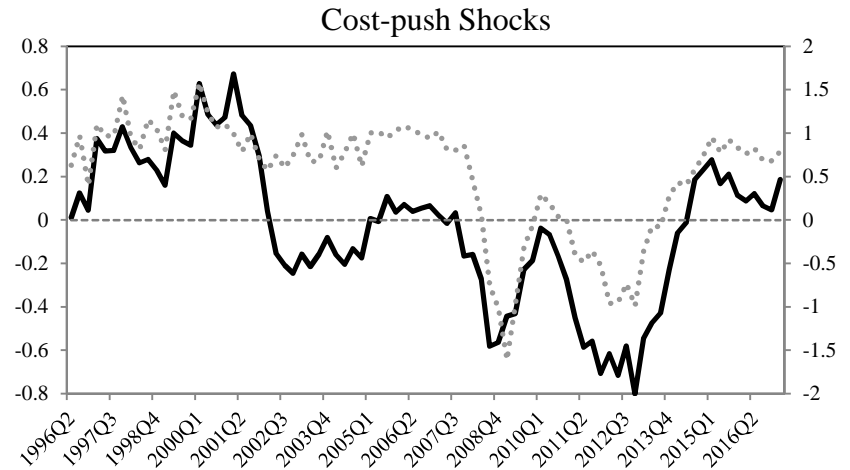
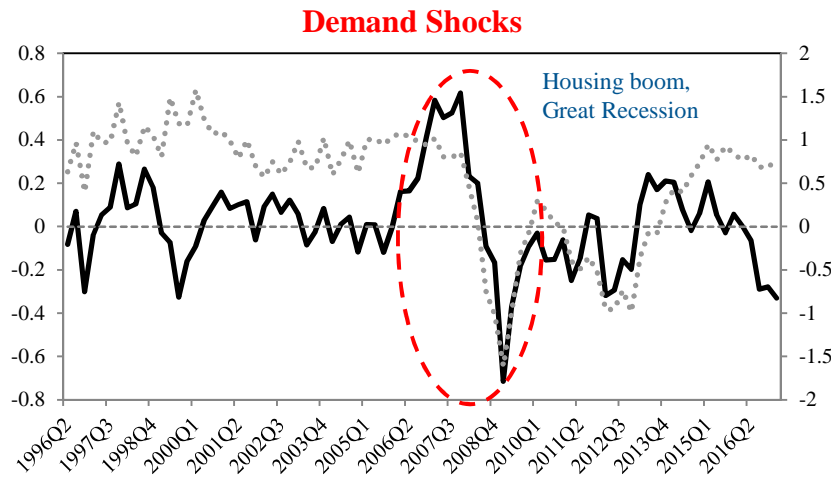
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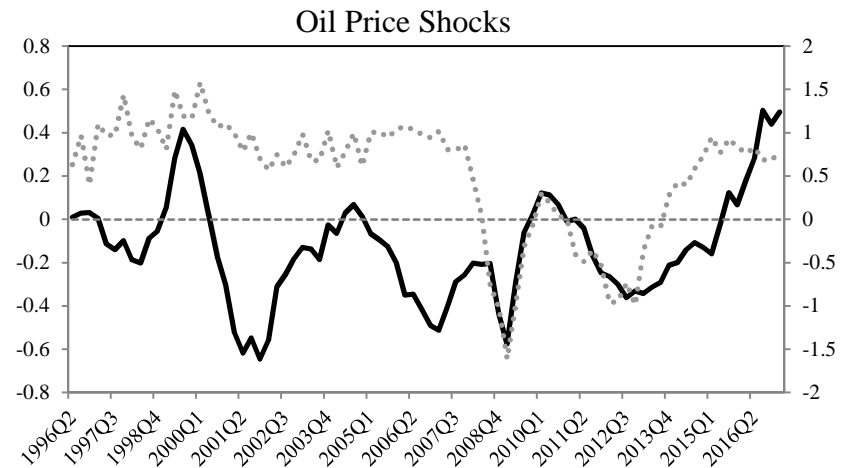
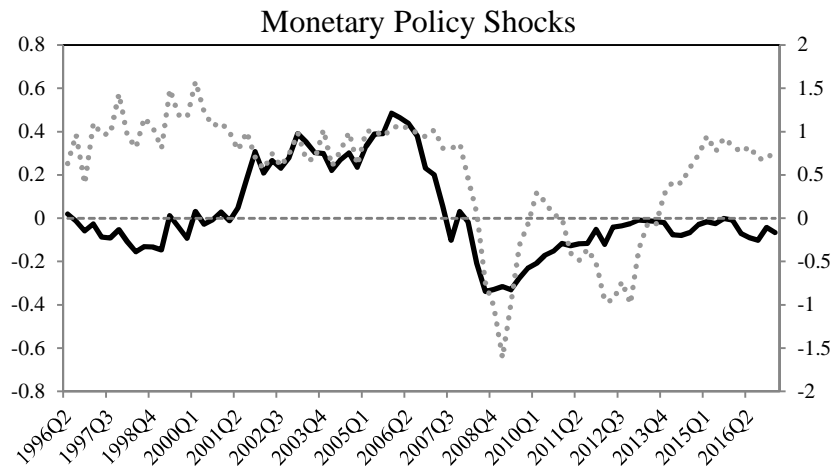
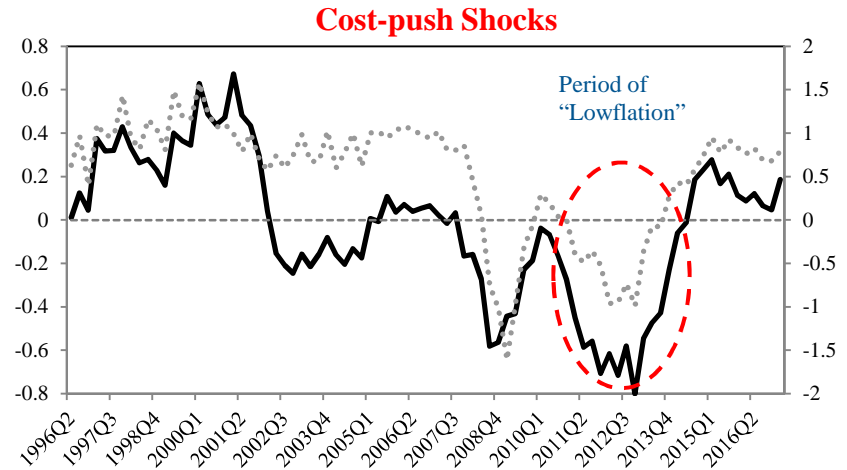
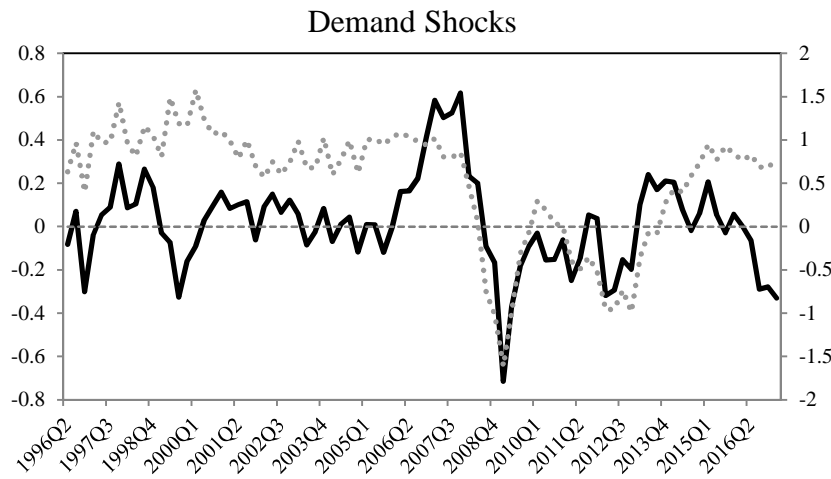
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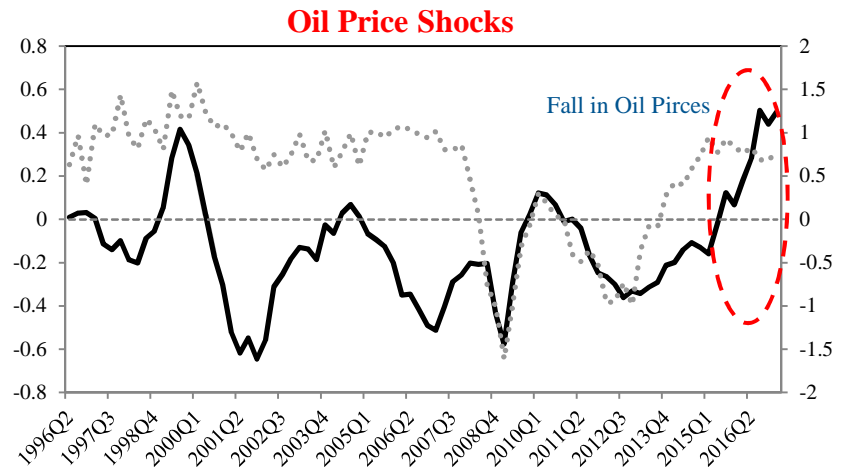
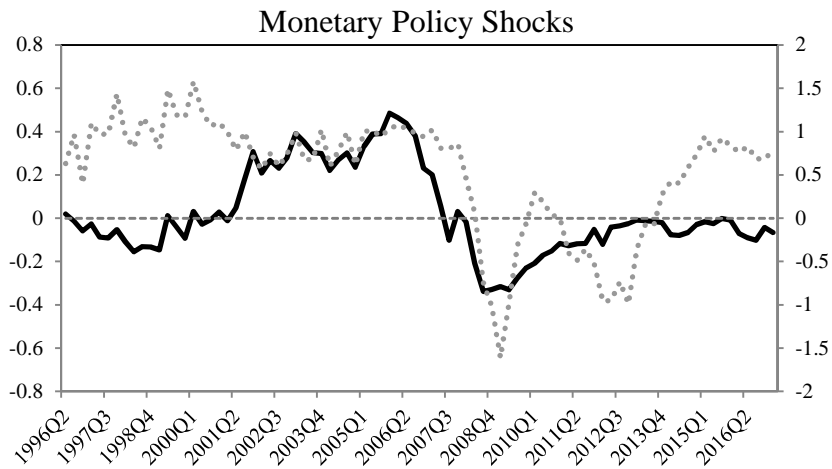
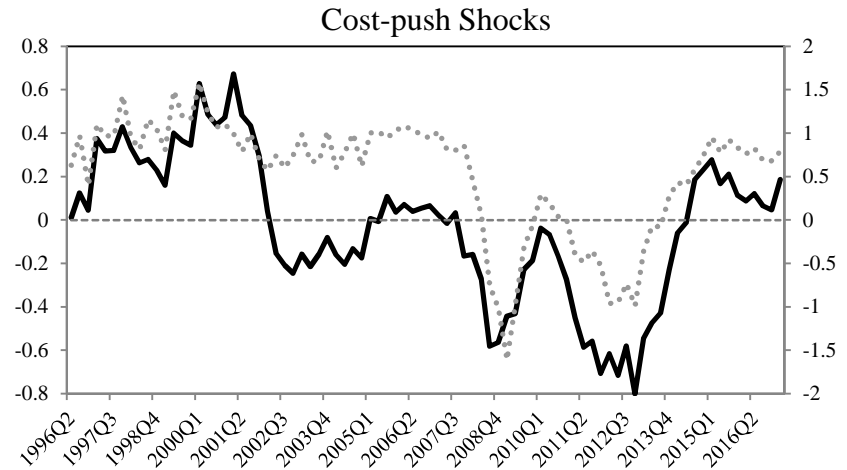
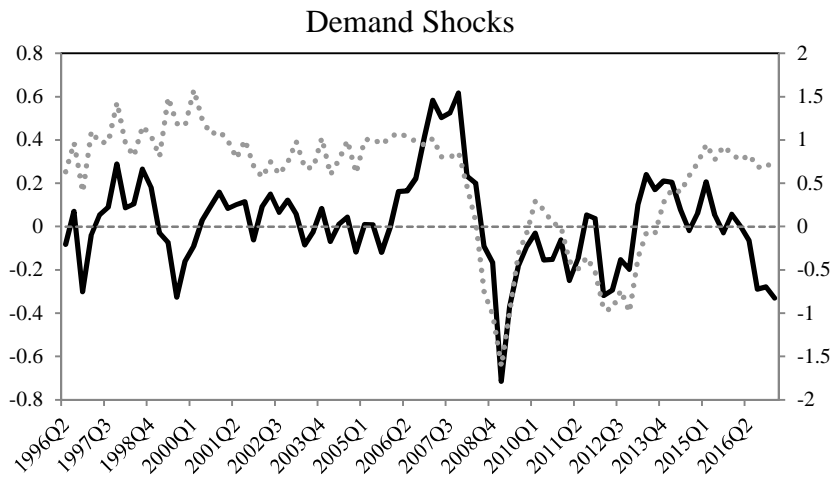
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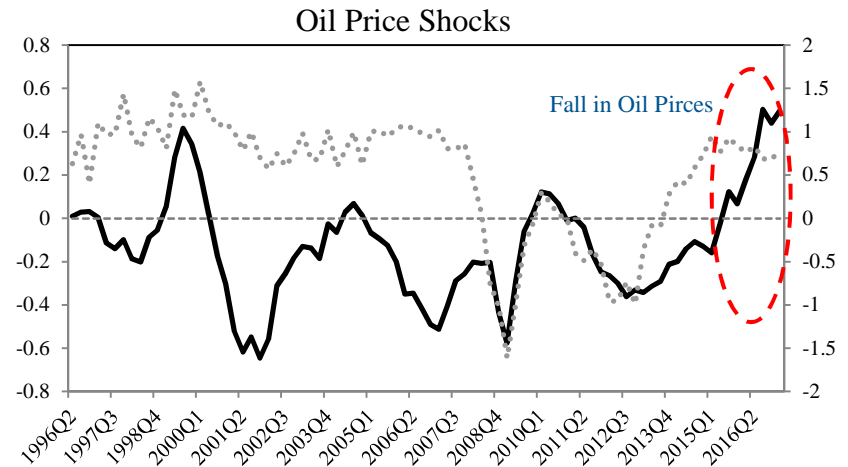
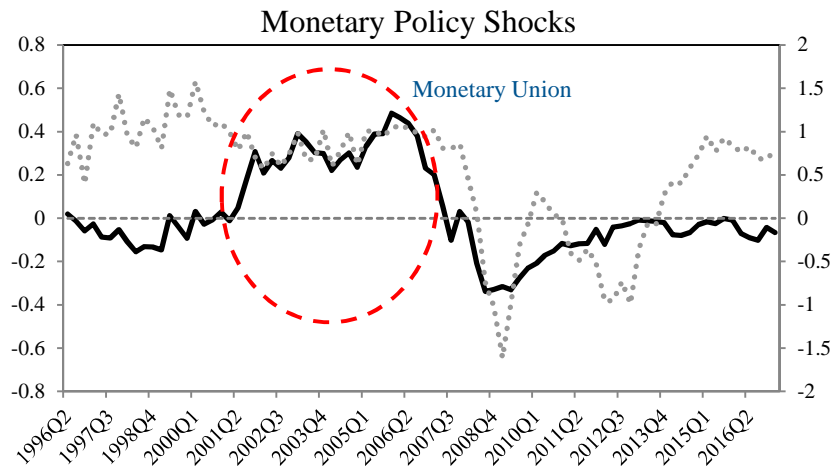
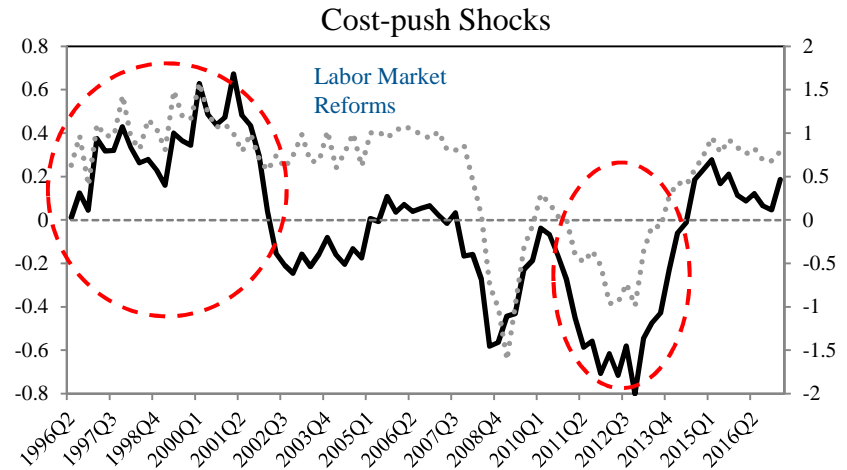
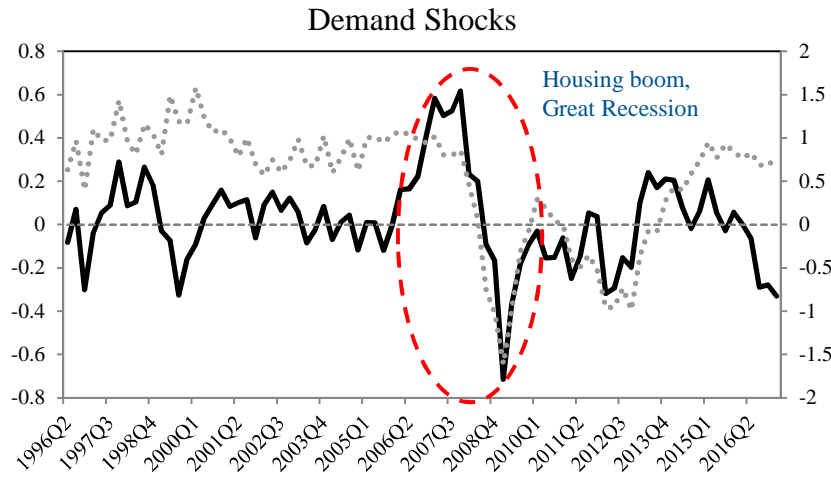
GDP Historical Decomposition: Benchmark Model



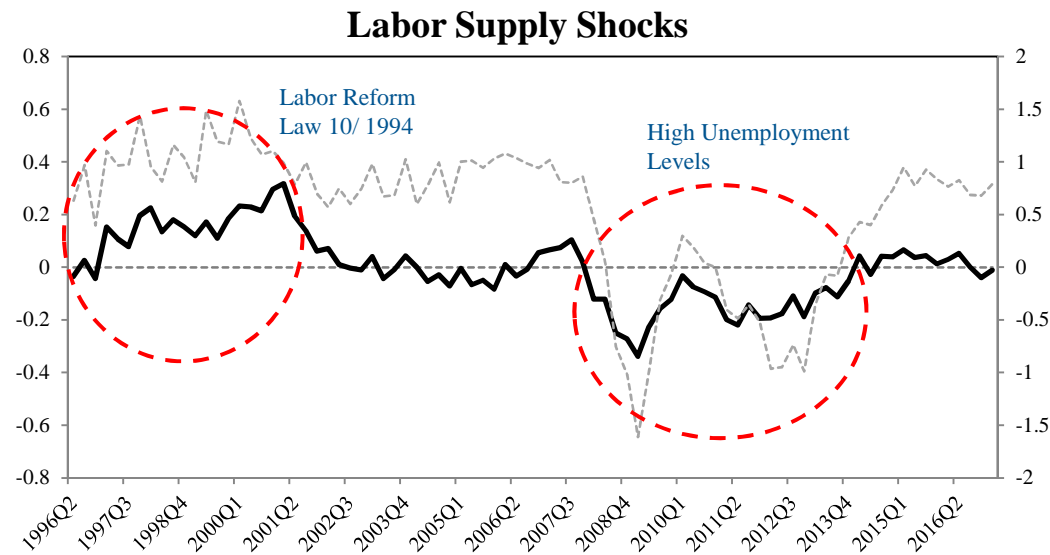
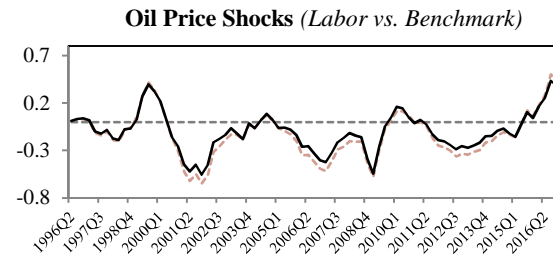
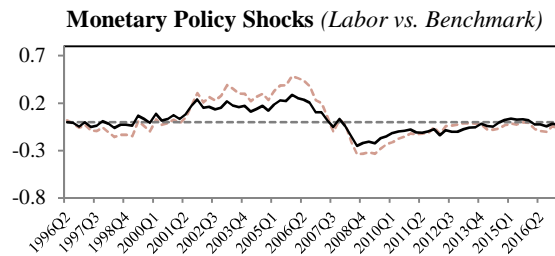
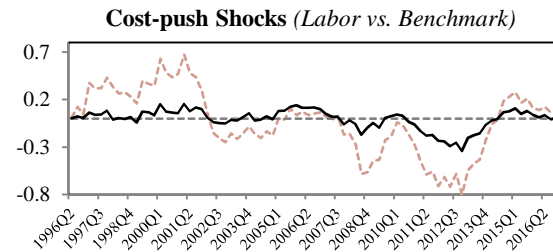
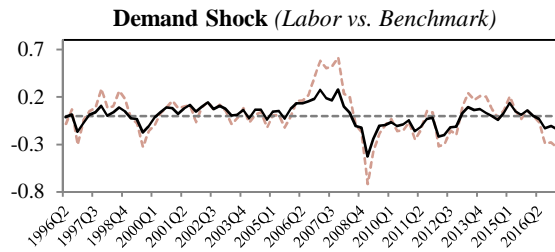
GDP Historical Decomposition: Benchmark Model



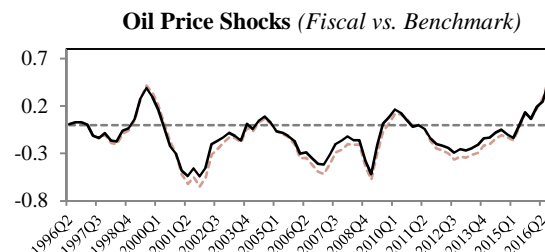
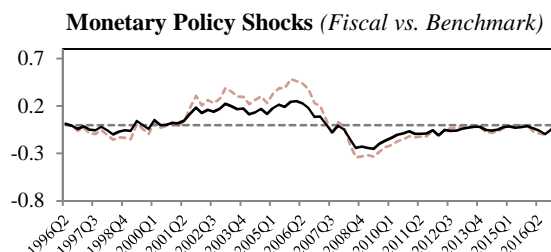
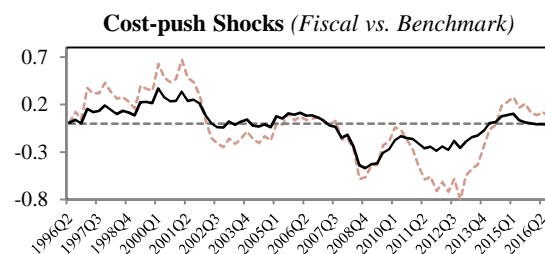
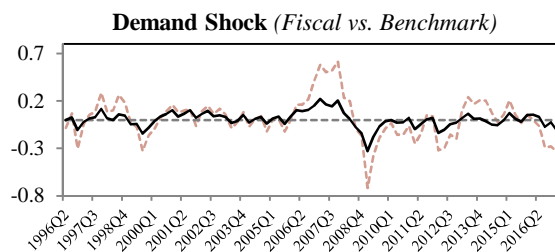
GDP Historical Decomposition: Benchmark Model



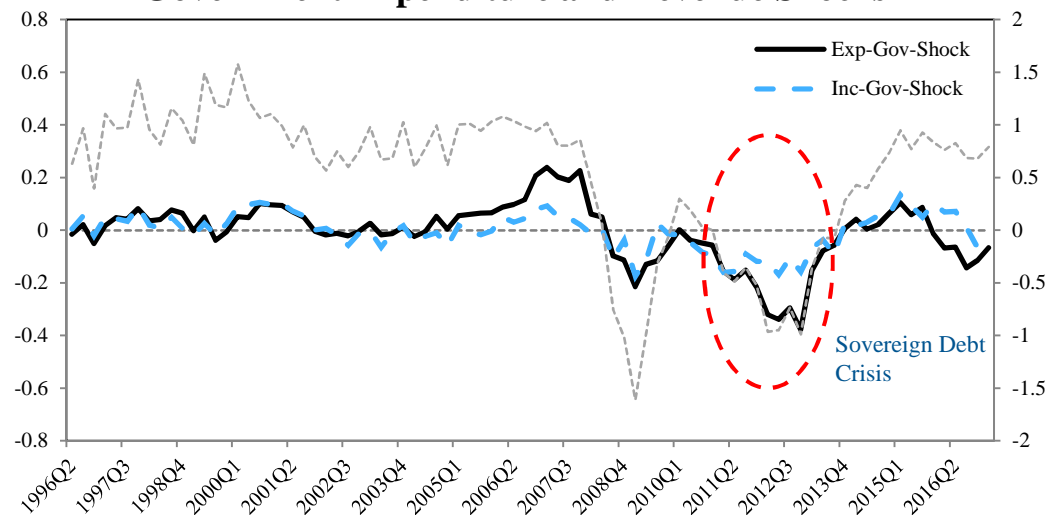
GDP Historical Decomposition: Labor Model



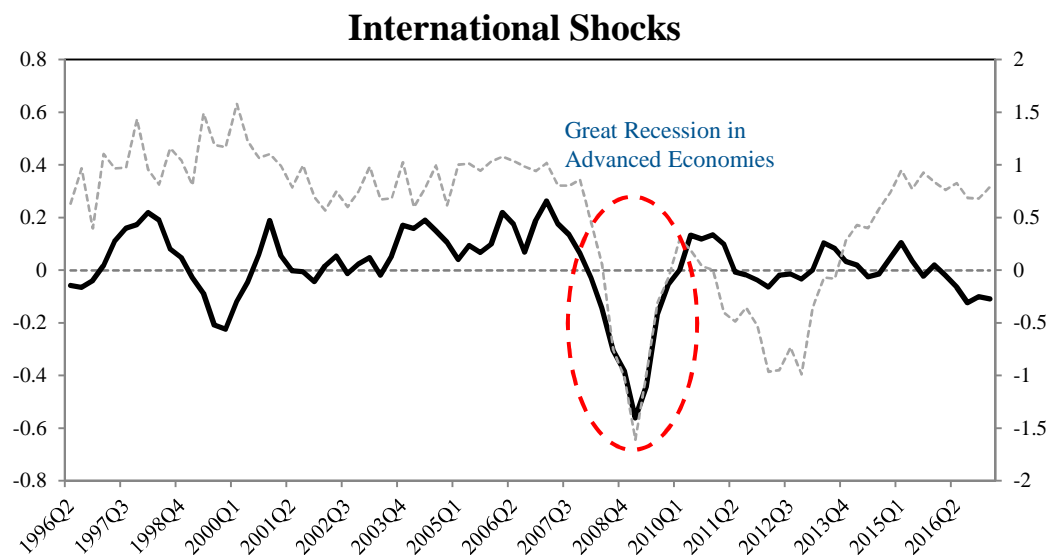
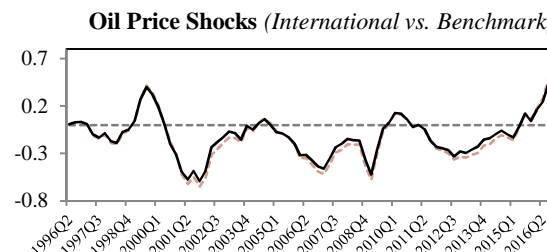
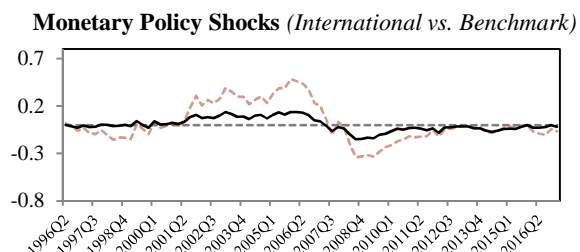
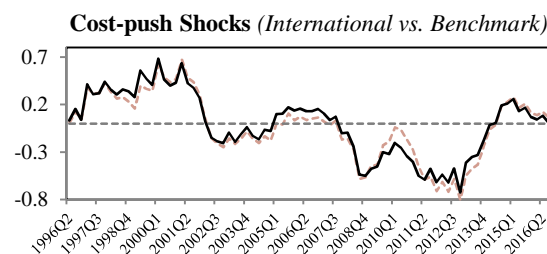
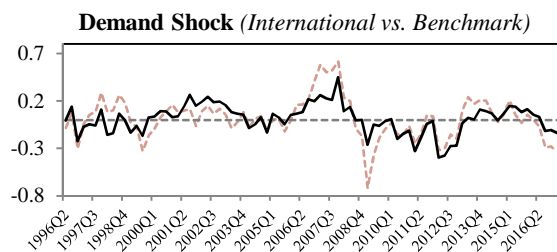
GDP Historical Decomposition: Fiscal Model



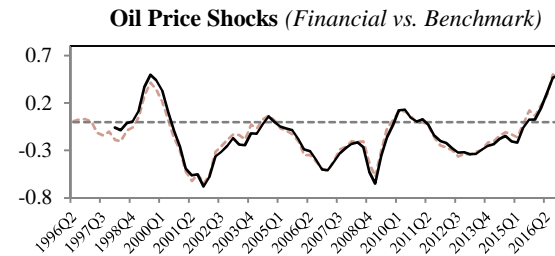
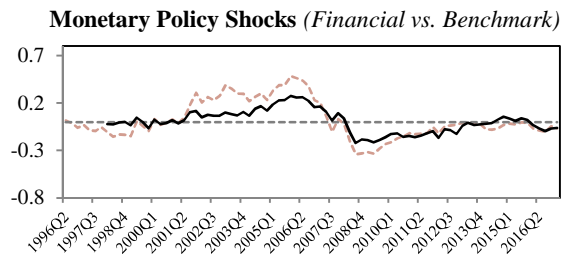
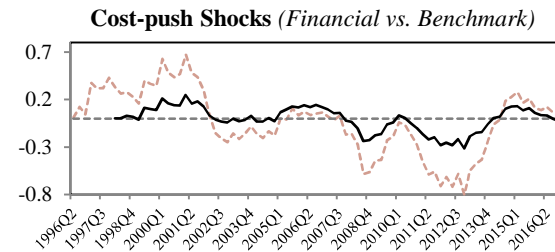
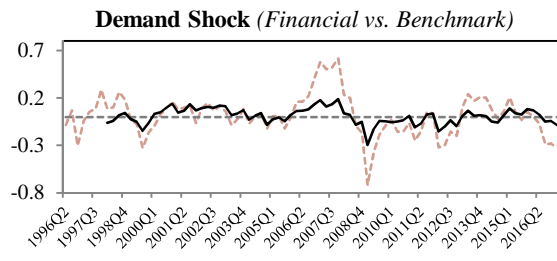
Government Expenditure and Revenue Shocks



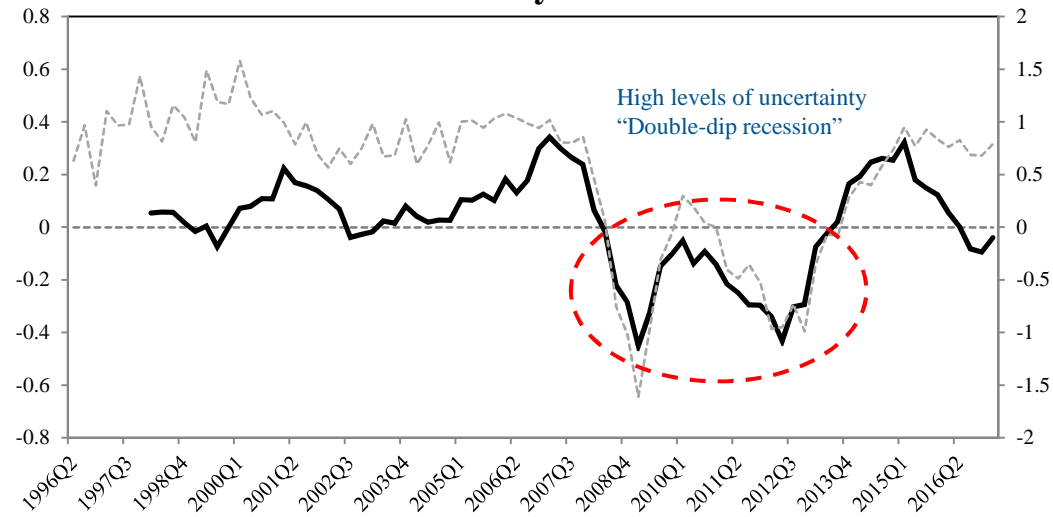
GDP Historical Decomposition: International Model



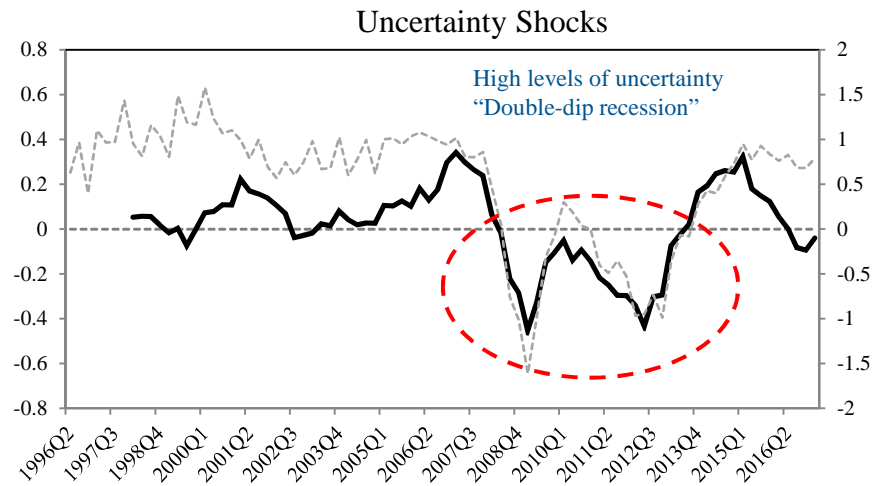
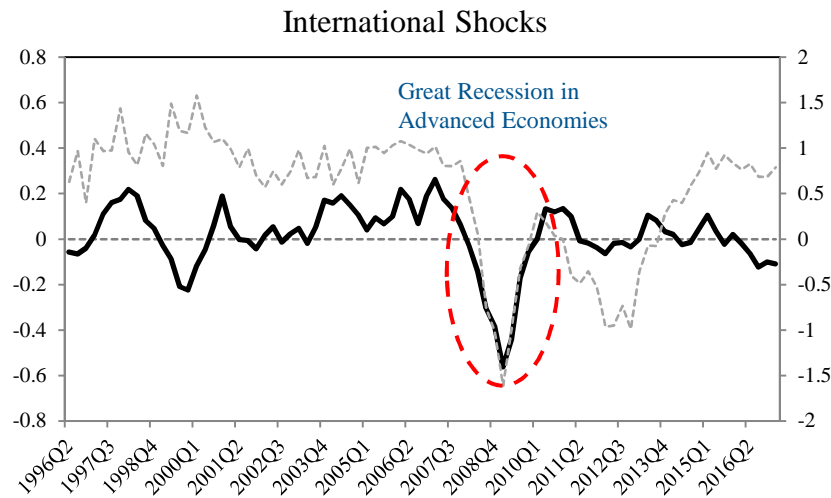
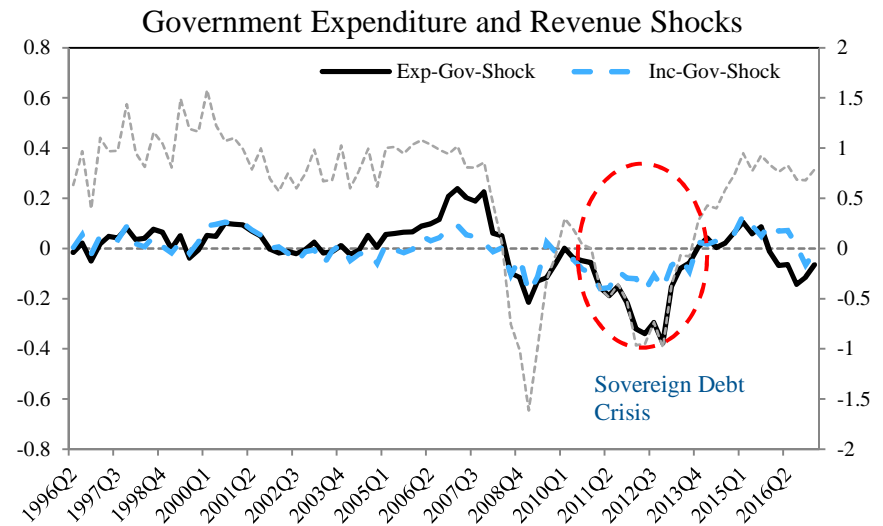
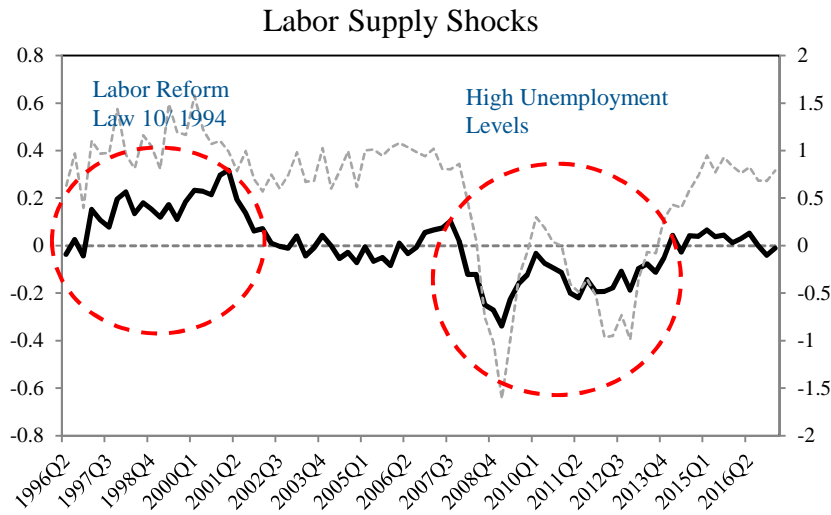
GDP Historical Decomposition: Financial Model



Uncertainty Shocks



GDP Historical Decomposition: Models by Block



Esquema



1. Suite of Models

2. Estimation Algorithms

3. Results

3.1. Structural Analysis

3.2. Forecasts

Forecasts: conditional and unconditional variables



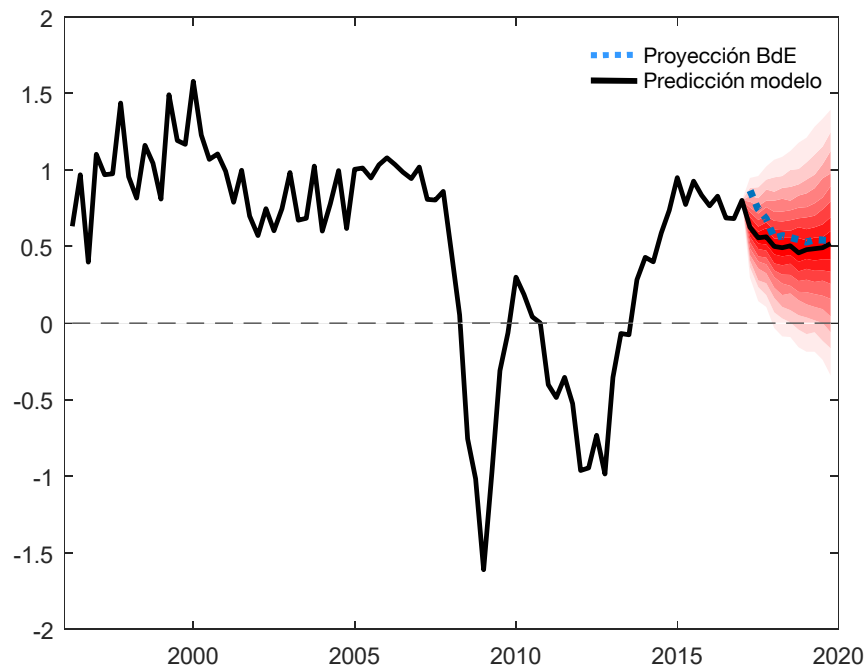
	BENCHMARK	FISCAL	LABOR	INTERNATIONAL	FINANCIAL	ONE-FITS-ALL
REAL GDP	*	*	*	*	*	*
CORE INFLATION	*	*	*	*	*	*
INTEREST RATE	X	X	X	X	X	X
GOVERNMENT EXPENDITURE		X				X
GOVERNMENT REVENUE		X				X
UNEMPLOYMENT RATE			*			*
WAGE			*			*
GLOBAL DEMAND				X		X
EXCHANGE RATE				X		X
STOCK RETURNS					X	X
UNCERTAINTY					*	*
OIL PRICE	X	X	X	X	X	X

Nota. * denotes unconditional variables and X denotes conditional variables

Forecasts: Benchmark Model



Growth Rate of Real GDP

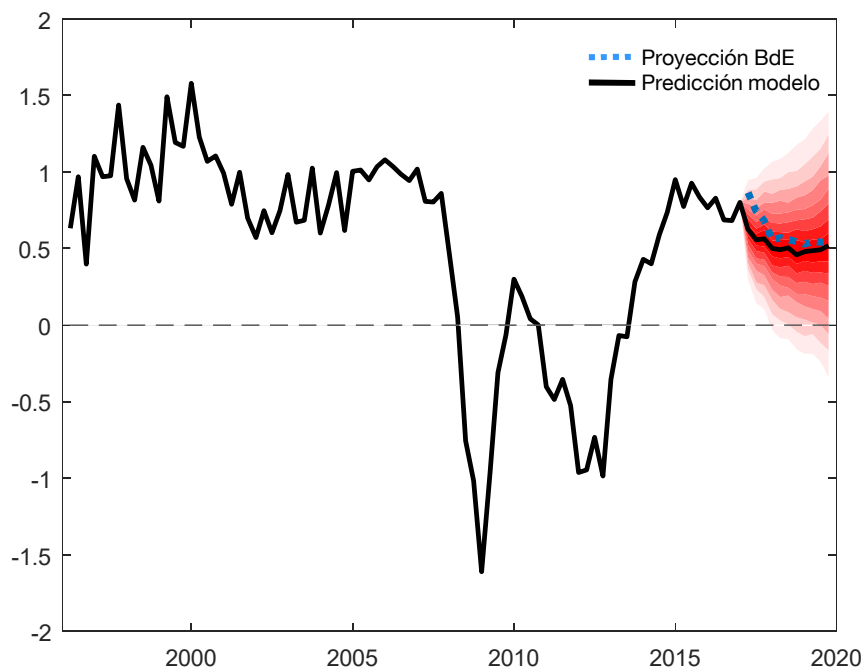


- The forecasts of GDP from the *Benchmark* model tend to be slightly lower than the BdE projections

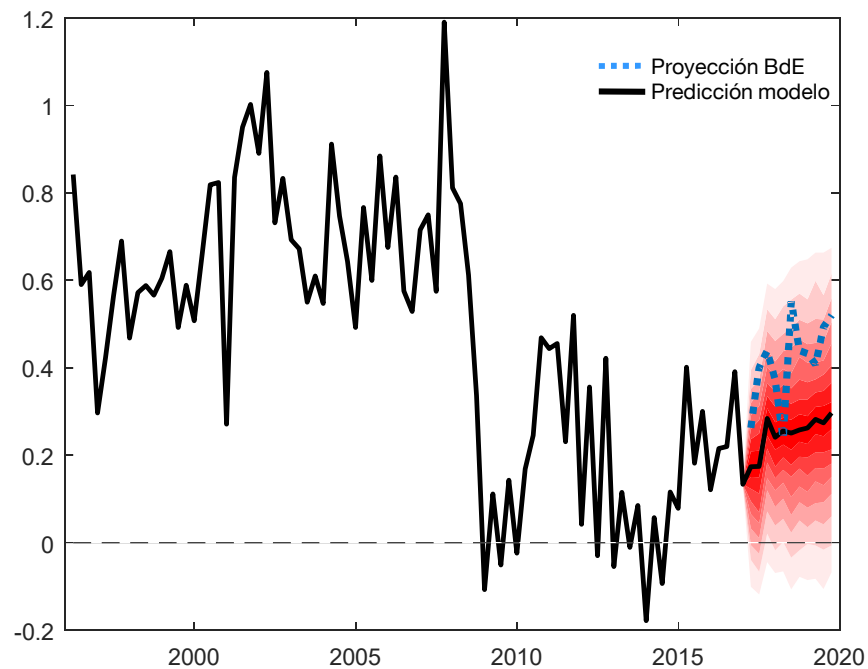
Forecasts: Benchmark Model



Growth Rate of Real GDP

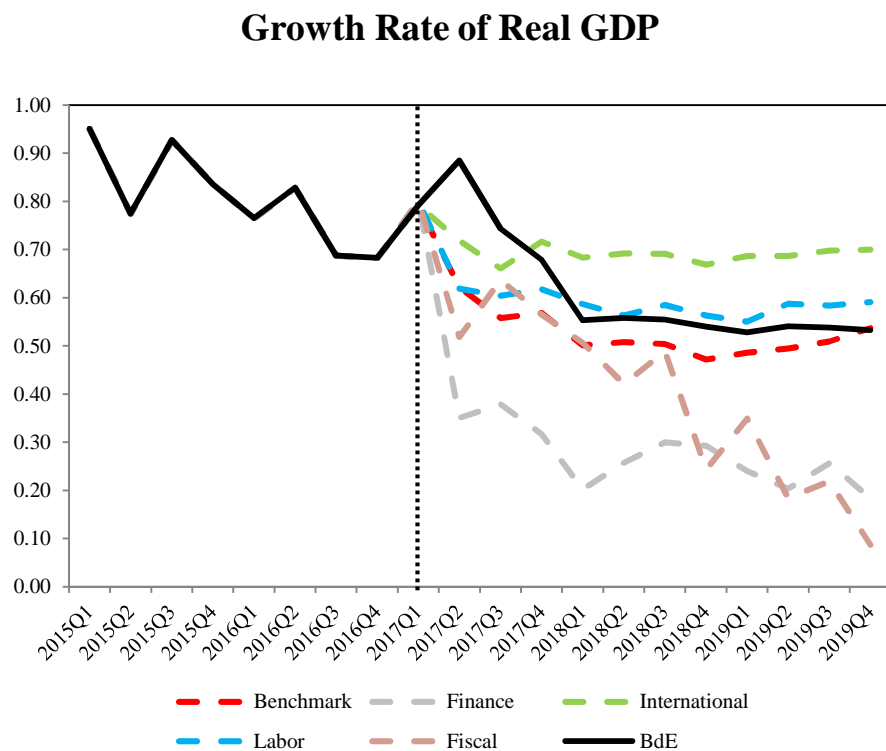


Core Inflation Rate



- The forecasts of GDP from the *Benchmark* model tend to be slightly lower than the BdE projections
- The forecasts of inflation from the *Benchmark* model tend to be significantly lower than the BdE projections

Forecasts: Models by Block

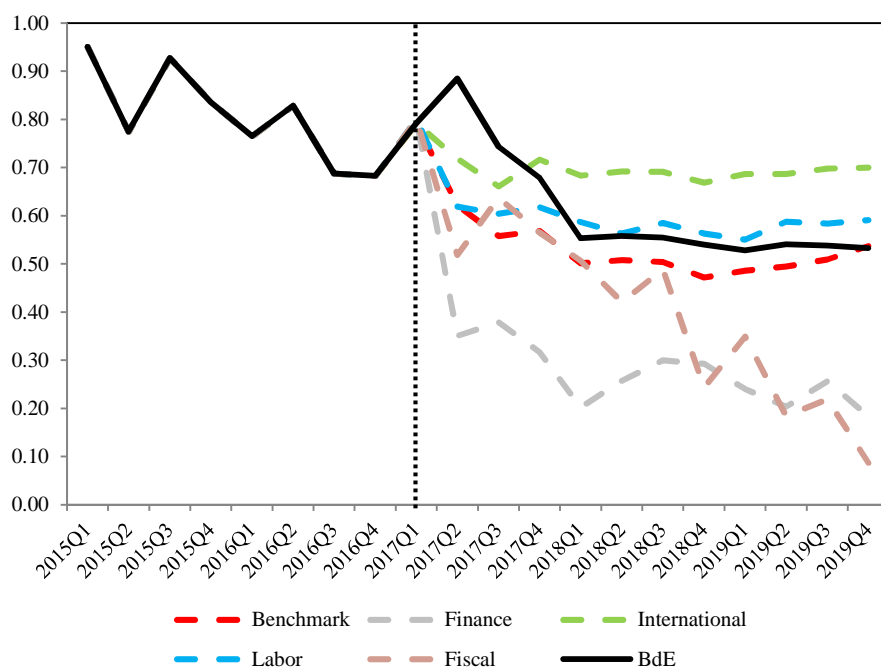


- The forecasts of GDP from most of the models by blocks are aligned with the BdE projections. Although, there is certain heterogeneity.

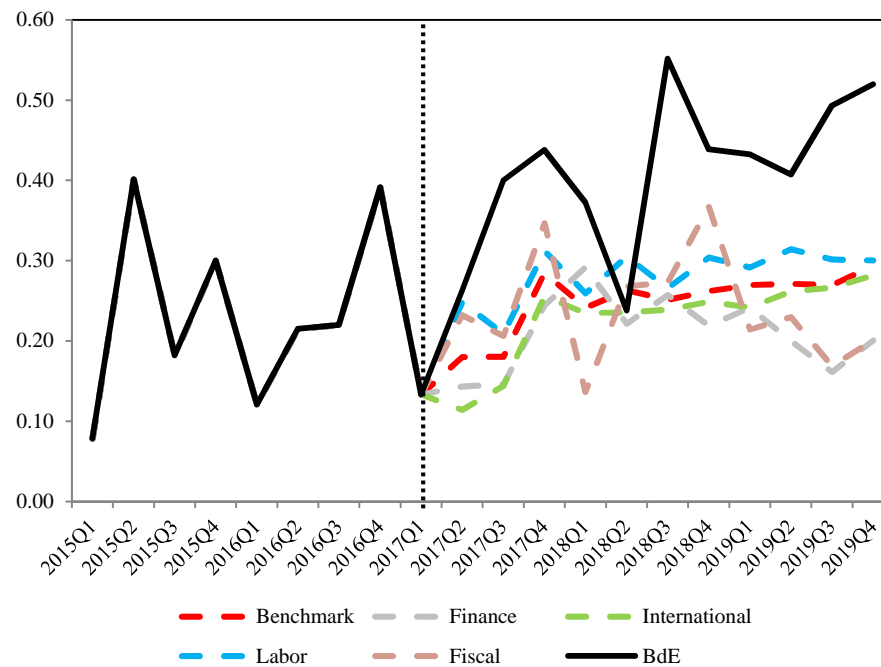
Forecasts: Models by Block



Growth Rate of Real GDP



Core Inflation Rate

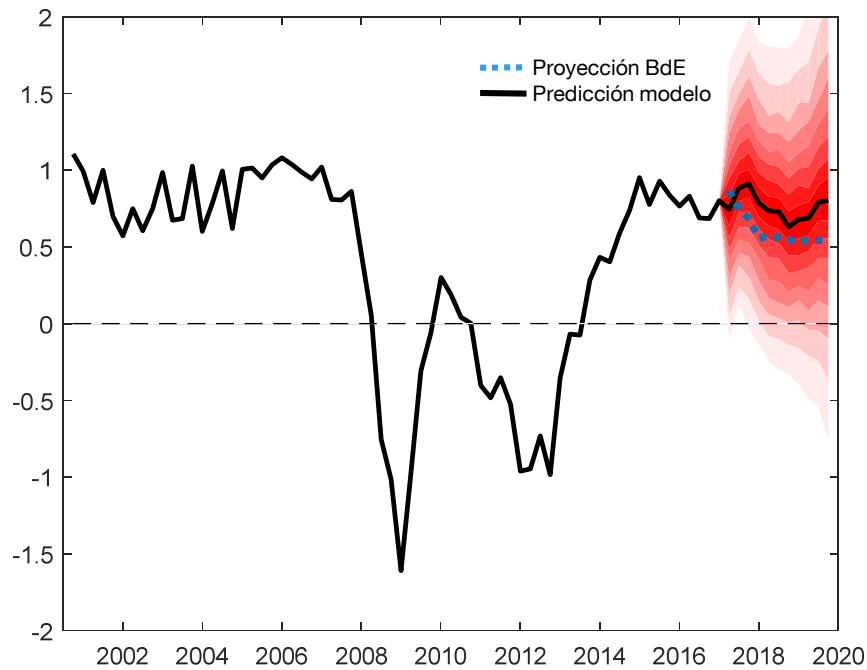


- The forecasts of GDP from most of the models by blocks are aligned with the BdE projections. Although, there is certain heterogeneity.
- For the case of inflation, the forecasts of all the models by blocks point to a significantly lower inflation than the BdE projections.

Forecasts: One-Fits-All Model (“Agnostic” priors)



Growth Rate of Real GDP

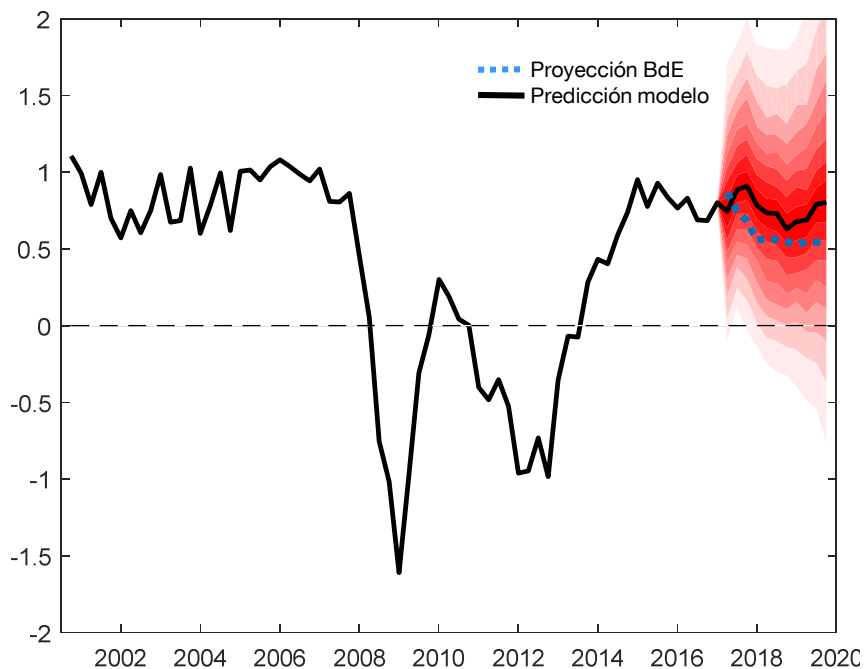


- Once it is conditioned on all the assumptions, the *One-Fits-All* model produces forecasts that are more optimistic than the projections of the BdE

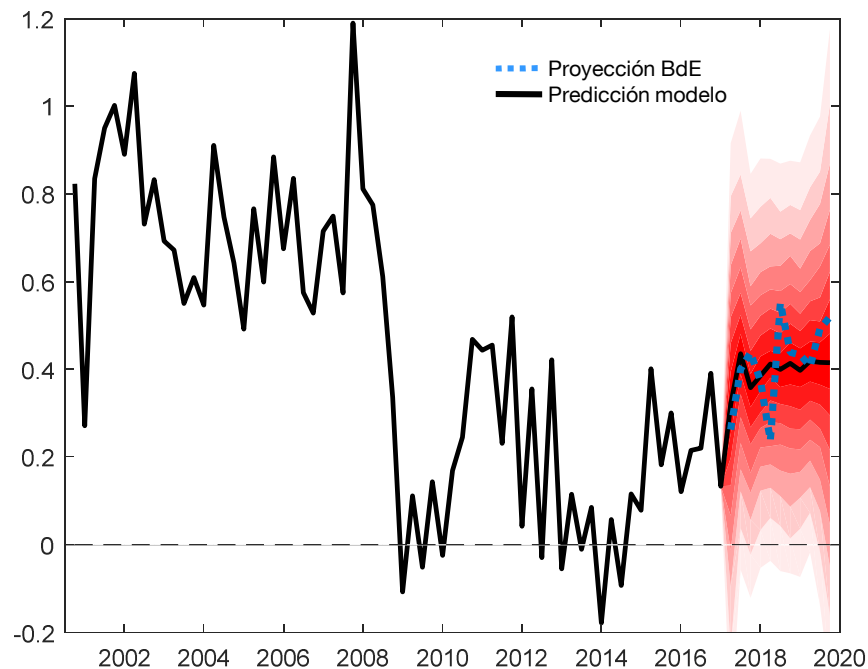
Forecasts: One-Fits-All Model (“Agnostic” priors)



Growth Rate of Real GDP



Core Inflation Rate

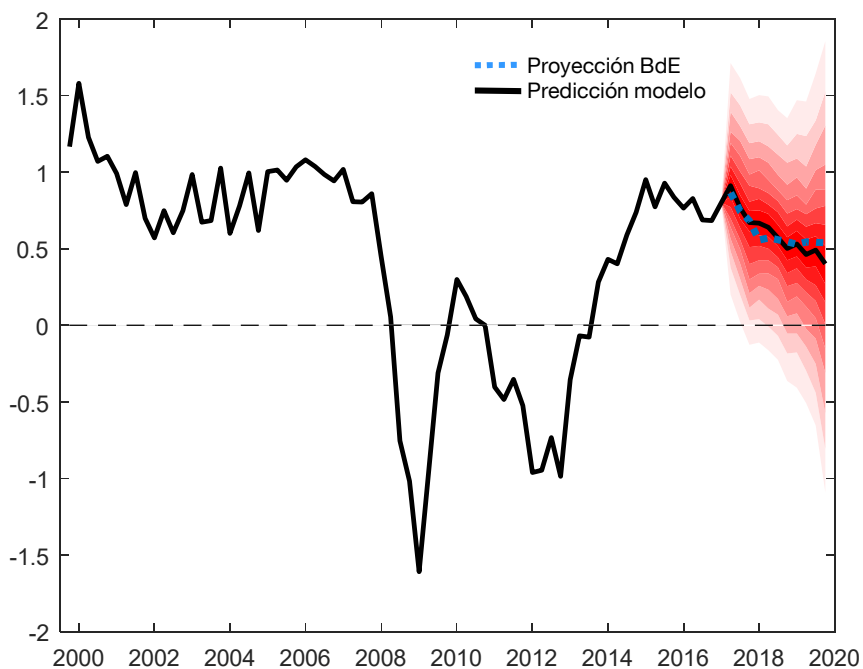


- Once it is conditioned on all the assumptions, the *One-Fits-All* model produces forecasts that are more optimistic than the projections of the BdE
- The forecasts of inflation from the *One-Fits-All* model follow a similar path to the BdE projections

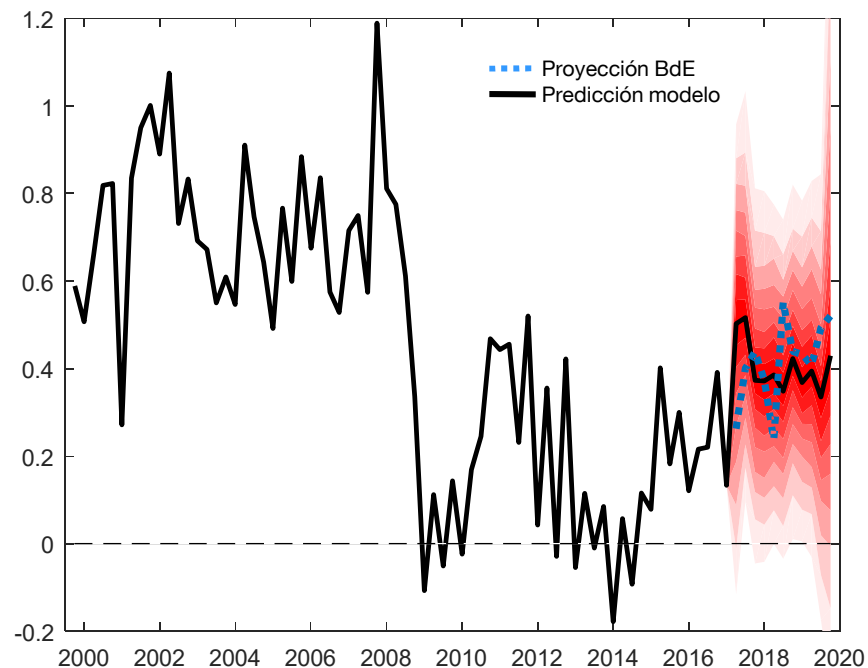
Forecasts: One-Fits-All Model (“Mimic” priors)



Growth Rate of Real GDP



Core Inflation Rate

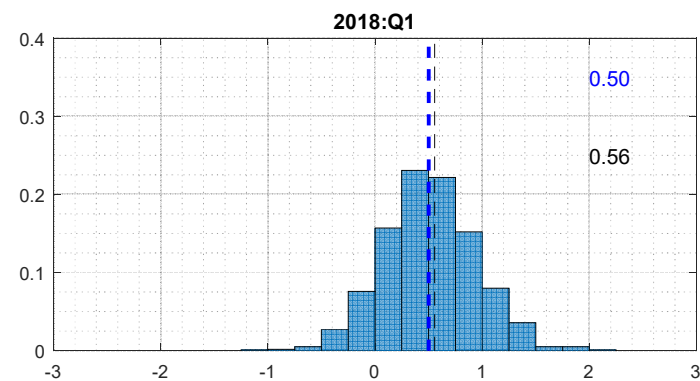
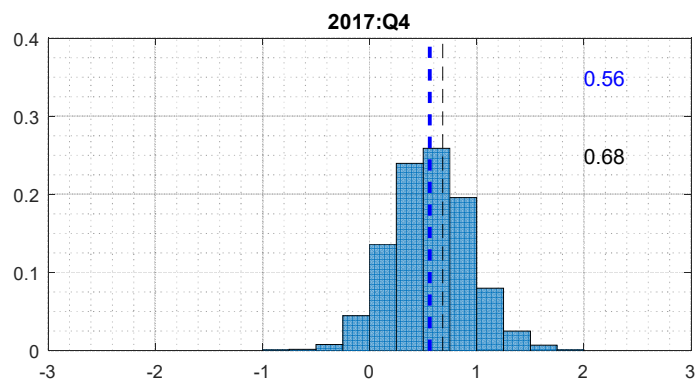
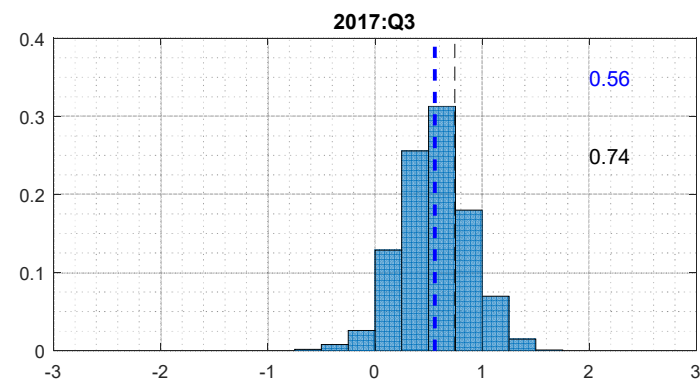
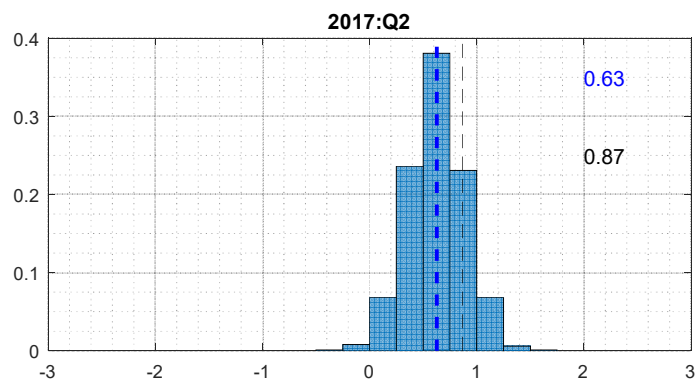


- Once the model uses “mimic” priors and conditions on all the assumptions, the forecasts of GDP from the *One-Fits-All* model are very similar to the projections of the BdE
- The forecasts of inflation from the *One-Fits-All* model also follow a similar path to the BdE projections

Forecast Uncertainty: Benchmark Model



Growth Rate of Real GDP

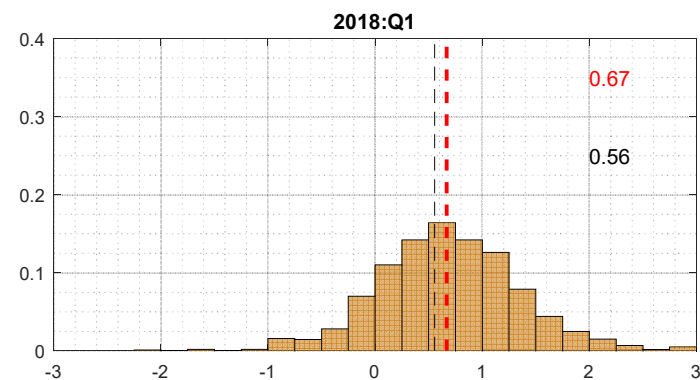
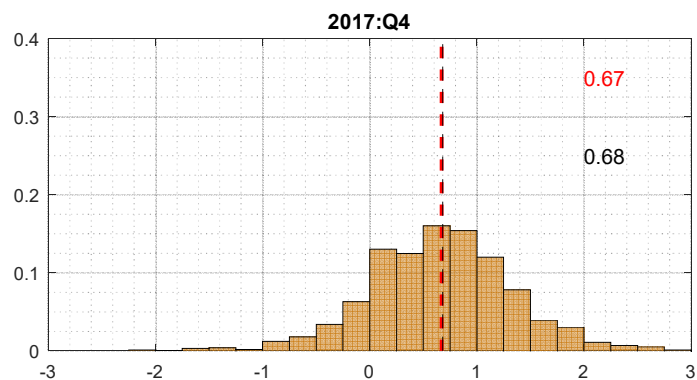
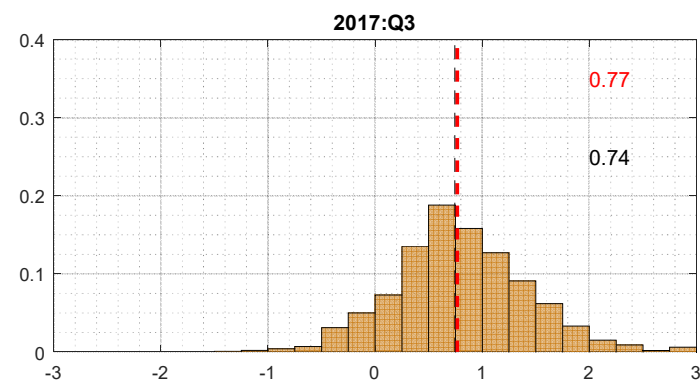
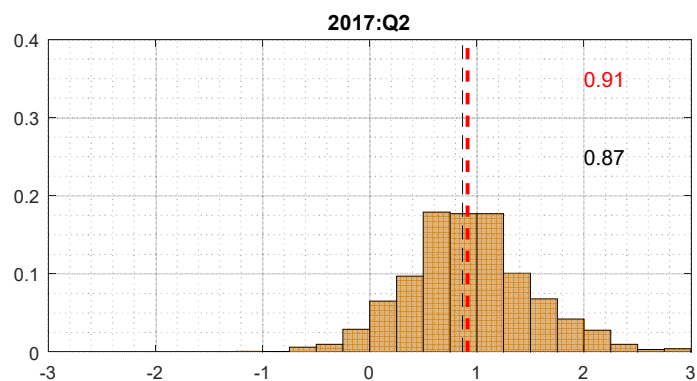


Nota. Numbers in blue indicate the forecasts from the *Benchmark* model, while numbers in black indicate the BdE projections

Forecast Uncertainty: One-Fits-All Model



Growth Rate of Real GDP

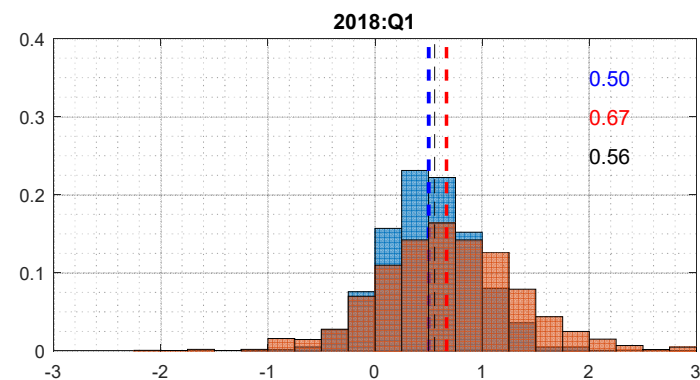
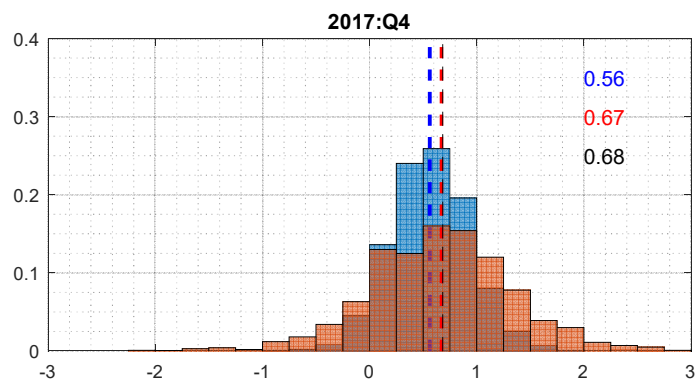
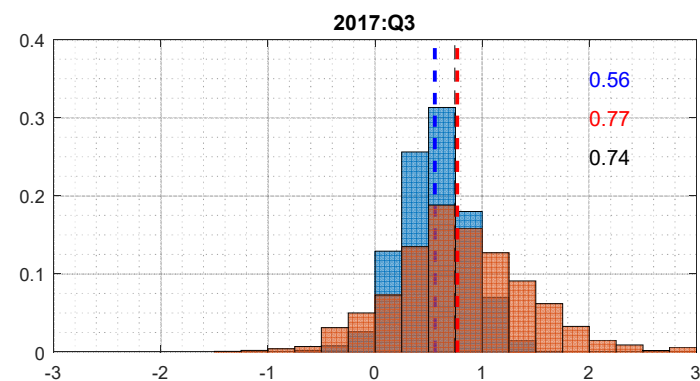
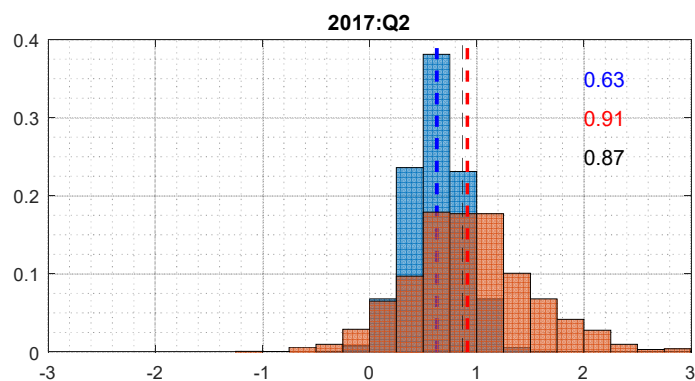


Nota. Numbers in red indicate the forecasts from the *One-Fits-All* model, while numbers in black indicate the BdE projections

Forecast Uncertainty: Benchmark vs. One-Fits-All Model



Growth Rate of Real GDP

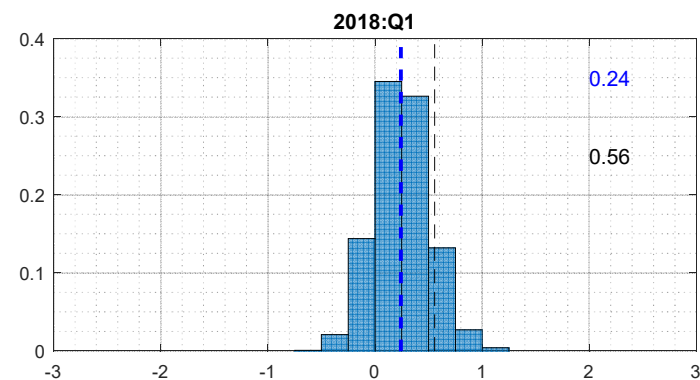
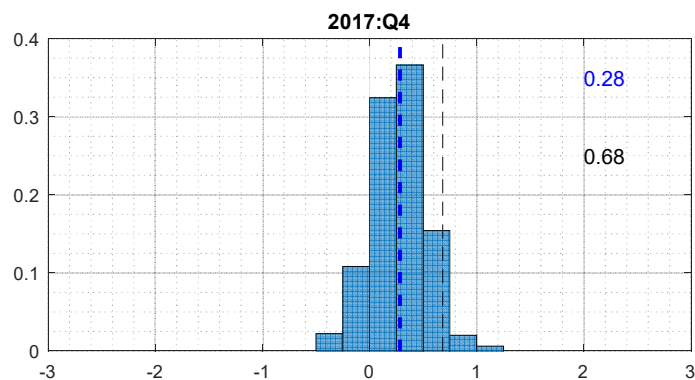
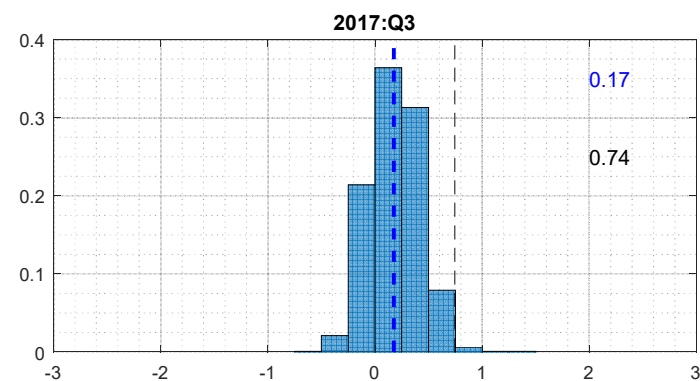
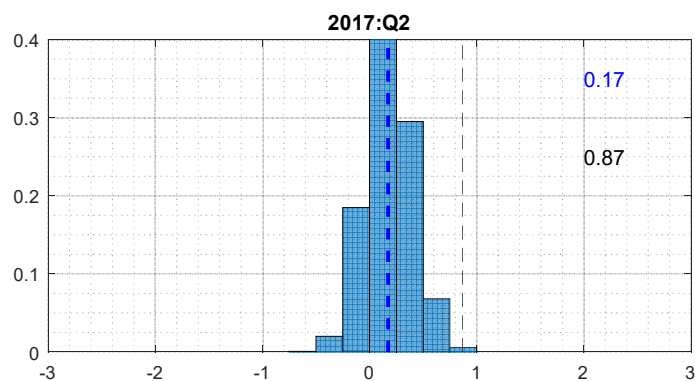


Nota. Numbers in blue (red) indicate the forecasts from the *Benchmark (One-Fits-All)* model, while numbers in black indicate the BdE projections

Forecast Uncertainty: Benchmark Model



Core Inflation Rate

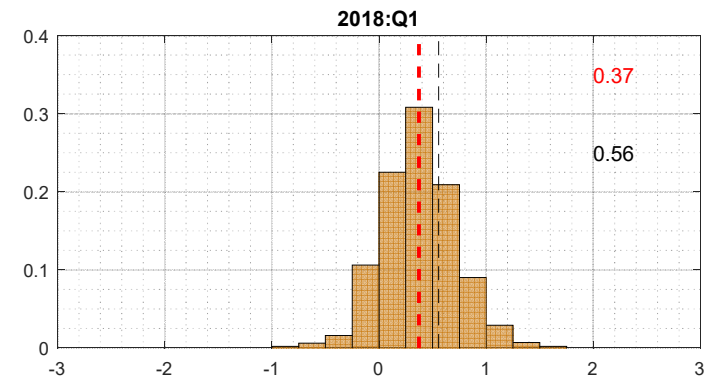
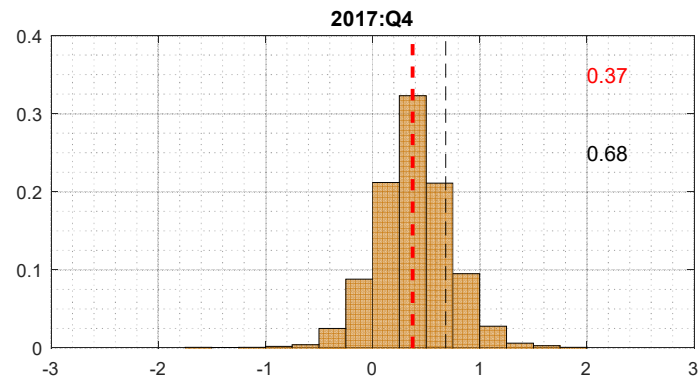
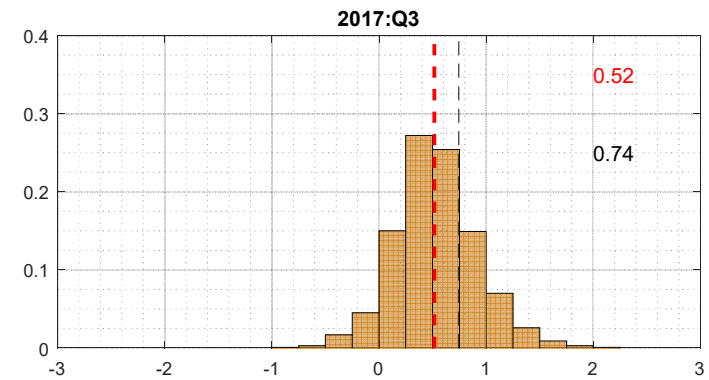
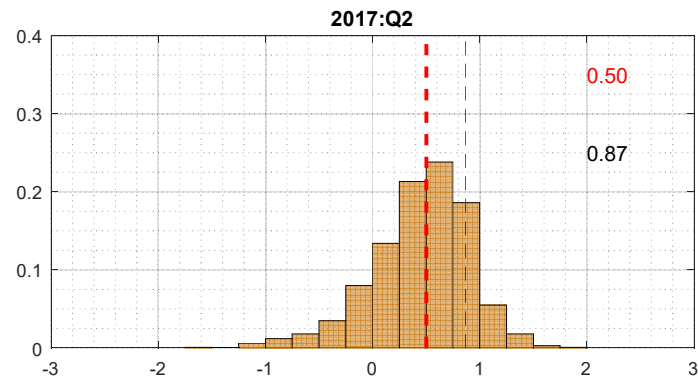


Nota. Numbers in blue indicate the forecasts from the *Benchmark* model, while numbers in black indicate the BdE projections

Forecast Uncertainty: One-Fits-All Model



Core Inflation Rate

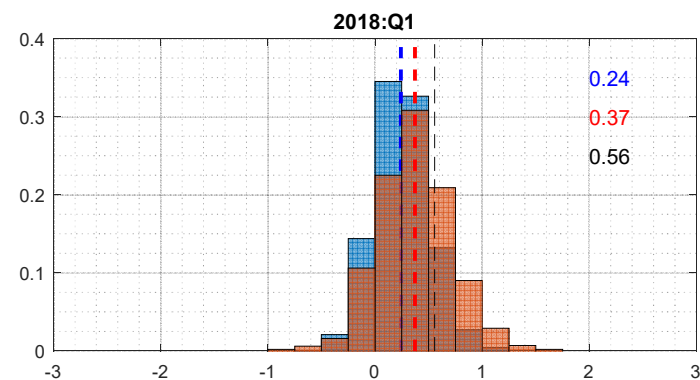
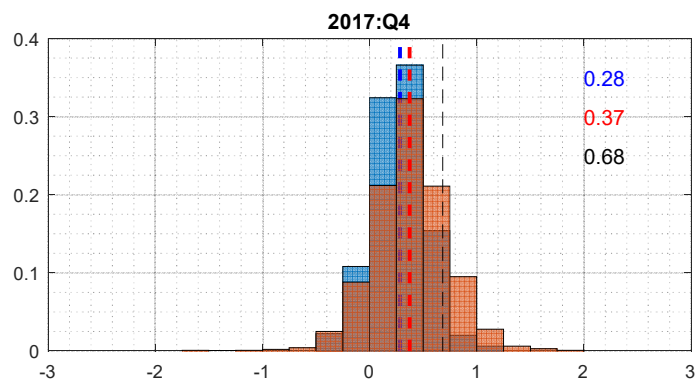
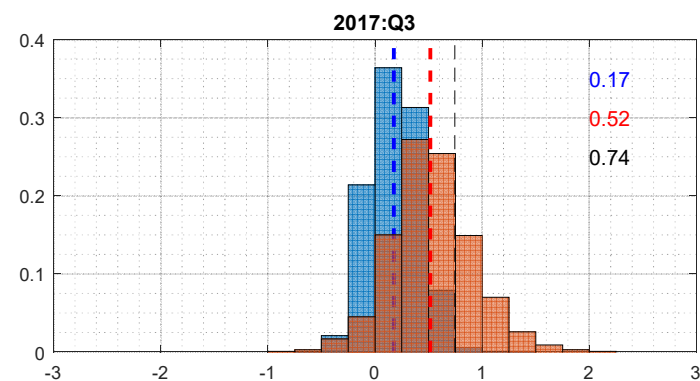
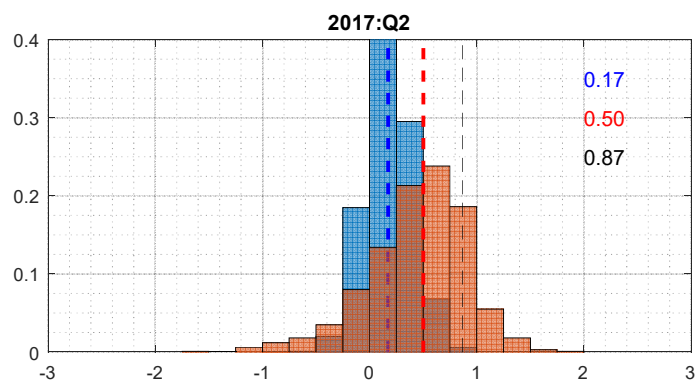


Nota. Numbers in red indicate the forecasts from the *One-Fits-All* model, while numbers in black indicate the BdE projections

Forecast Uncertainty: Benchmark vs. One-Fits-All Model



Core Inflation Rate



Nota. Numbers in blue (red) indicate the forecasts from the *Benchmark (One-Fits-All)* model, while numbers in black indicate the BdE projections

Conclusions



- **The proposed suite of models provide a narrative of the contribution of fundamental economic shocks that agrees with main historic events of the Spanish economy.**
- **The proposed SBVAR models are used to provide forecasts of output and inflation conditional on different scenarios about the development of key macroeconomic variables.**
- **The models provide conditional forecasts that are significantly aligned to the BdE projections**
- **Therefore, the suite could be incorporated to the toolkit of quantitative models that the Banco de España uses to perform forecasts.**



THANK YOU.