

Demographics and the Macroeconomy

Bank of Finland and CEPR conference

On secular stagnation and low interest rates: demography matters

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Motivation

- Advanced economies are in a **low interest rate environment** (LIRE).
- On going debate on **causes** in academia and policy institutions.
- Key questions
 - *What brought economies into LIRE?*
 - *Will LIRE persist or will it revert?*
- This paper **does not** aim at assessing the relevance of all the factors put forward in the literature, but rather at focusing on **demographic developments**. In particular on **the role of dependency ratios**.

Motivation

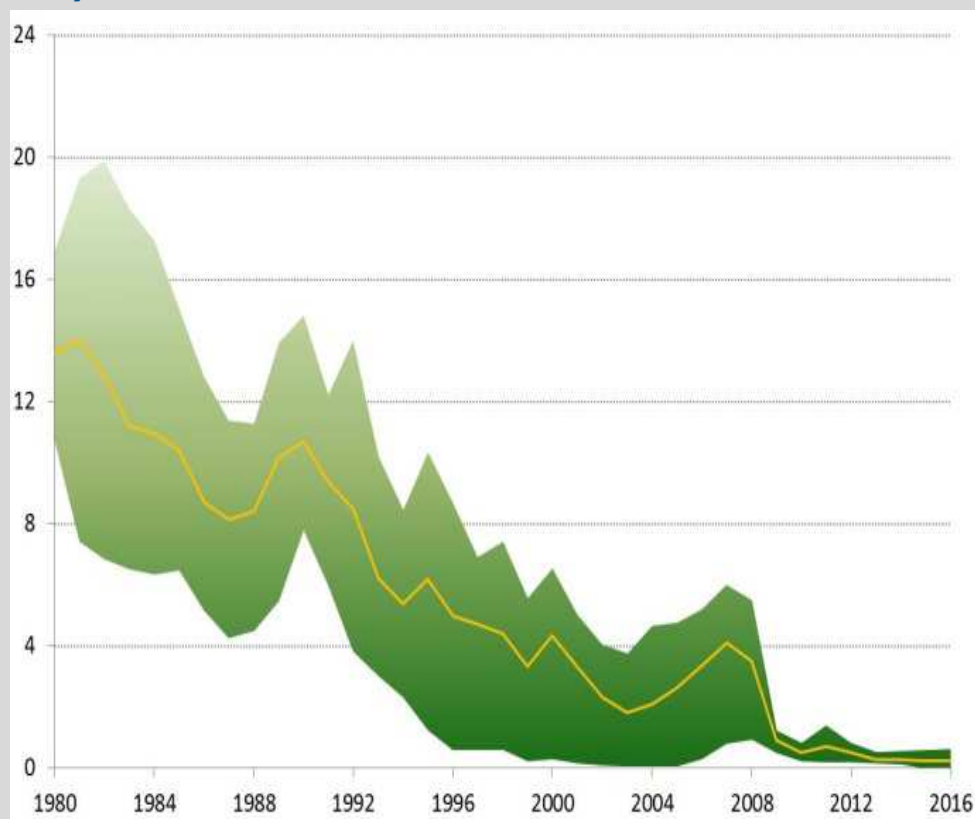
*Why focusing on **dependency ratios**?*

- **high persistence** of **dependency ratios** makes them particularly relevant from a **monetary policy and financial stability perspective**;
- **under certain conditions** the evolution of **dependency ratios** can be rationalized in terms of **past developments** in
 - **life expectancy** and
 - **fertility rates**.
- **Euro area countries** are projected to experience further **increases in dependence ratios** in the next decade by the United Nations (UN, 2015)
 - **fertility** in all euro area countries is below the level required for full replacement of the population in the long run;
 - **population aged 60 or over** is the fastest growing.

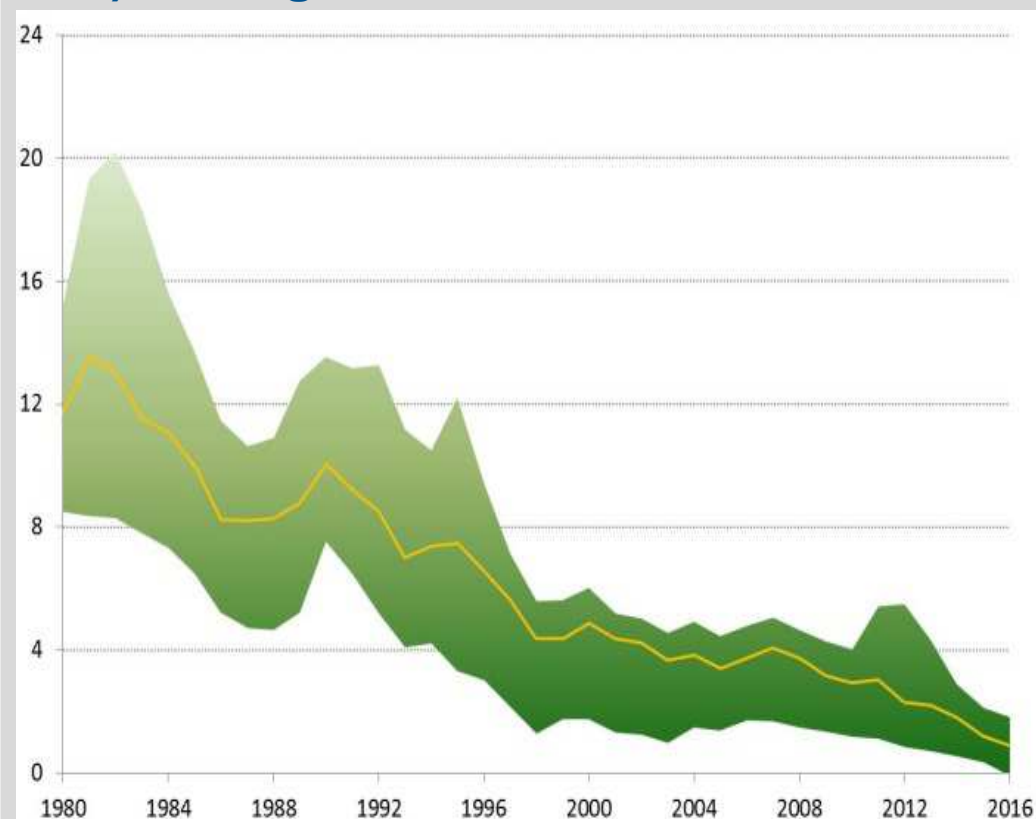
Low interest rates environment (LIRE)

The current macroeconomic environment is characterized by **exceptionally low nominal interest rates...**

a) Short-term nominal interest rates



b) Long-term nominal interest rates



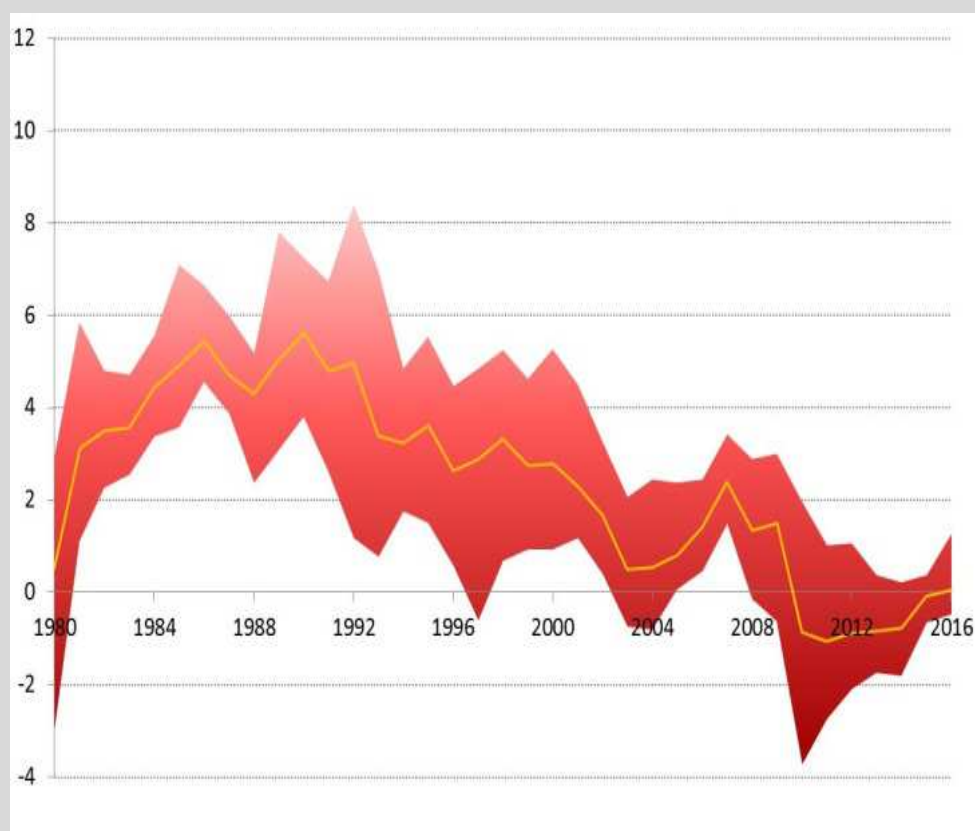
Source: European Commission and Reuters. Min and Max nominal interest rates in : **Germany, France, UK, Italy, Japan, US** and, since 1999, **the Euro area**; the yellow line is the average nominal interest rate. Long-term interest rates are yields on 10-year government bonds (or on the closest maturity); Short-term interest rates are yields on 3-month deposits, or Treasury bills

Low interest rates environment (LIRE)

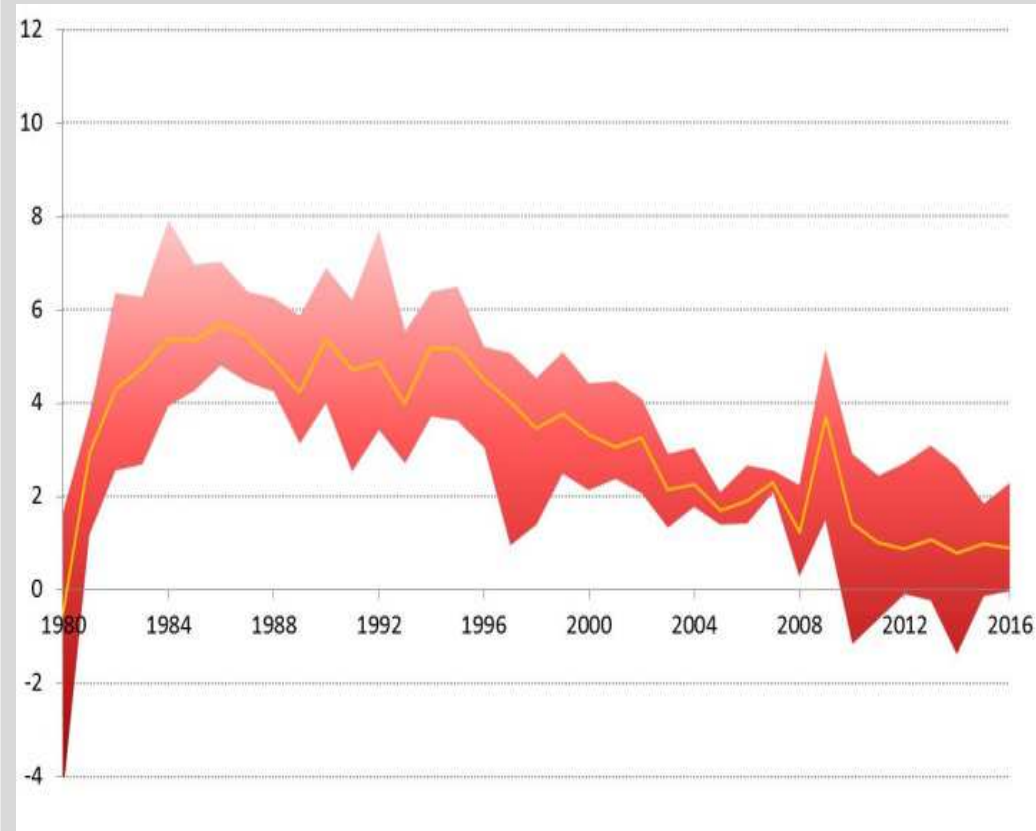
Nominal interest rates can be **decomposed** into three components:

$$i_{j,t}^L = \underbrace{r_{RF,t}^L}_{\text{real interest rate}} + E_t \pi_{t+L} + r p_{j,t}^L$$

a) Short-term real interest rates



b) Long-term real interest rates



Source: European Commission and Reuters. Min and Max nominal interest rates in: **Germany, France, UK, Italy, Japan, US** and, since 1999, the **Euro area**; the yellow line is the average nominal interest rate. Long-term interest rates are yields on 10-year government bonds (or on the closest maturity); Short-term interest rates are yields on 3-month deposits, or Treasury bills

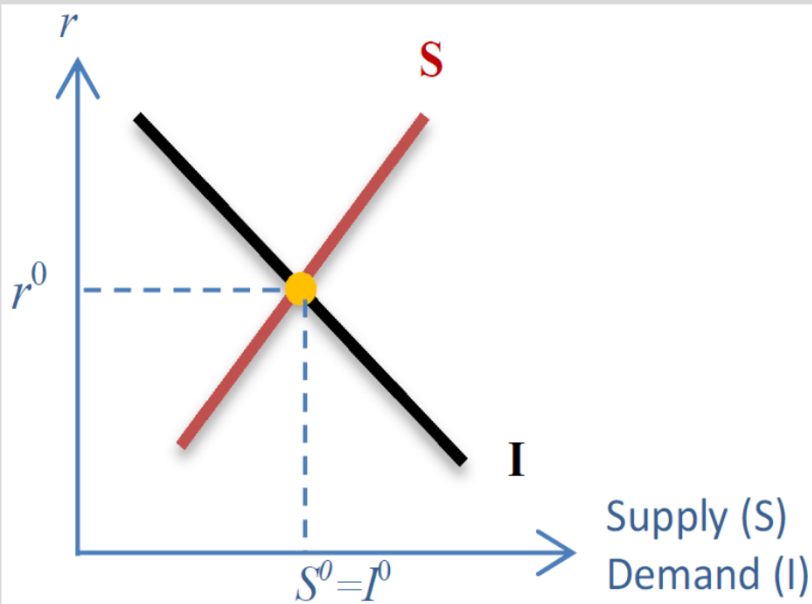
Real interest rates: The explanations

The drivers of real interest rates

- Two main explanations: (i) “**real/structural**” (Gordon, Summers, ...); (ii) “**cyclical/financial**” (Borio, Rogoff, ...):
 - **both explanations** look at the **1980-2016** period,
 - **explanations** are **not necessarily conflicting**,
 - **downward trend** in interest rates does **not mean** that there are **no cyclical fluctuations** around trend
 - **uncertainty** about the **relevance** of these factors and their **persistence** may contribute to the low level of interest rates.

Real interest rates: The explanations

The real/structural explanation



Real interest rate in equilibrium matches demand and supply of (real) funds

- **Supply**: optimal consumption-savings by households (lenders).

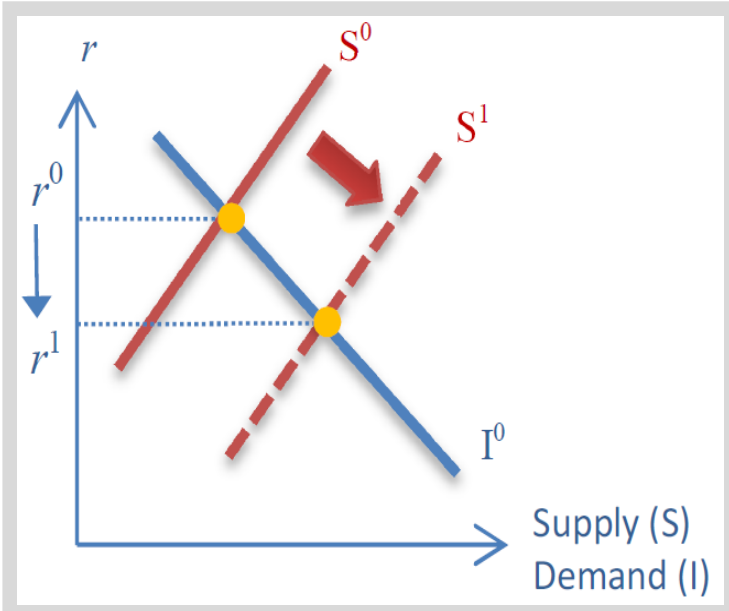
Elasticity of supply depends on households' intertemporal preferences, financial wealth and discounted future income, demographic trends.

- **Demand**: optimal consumption-savings by households (borrowers) + investment that maximizes a firm' profits, given technology

Elasticity of demand depends on households' intertemporal preferences, financial wealth and discounted future income + production technology + demographic trends.

Real interest rates: The “financial/cyclical” view

1st Phase: credit expansion

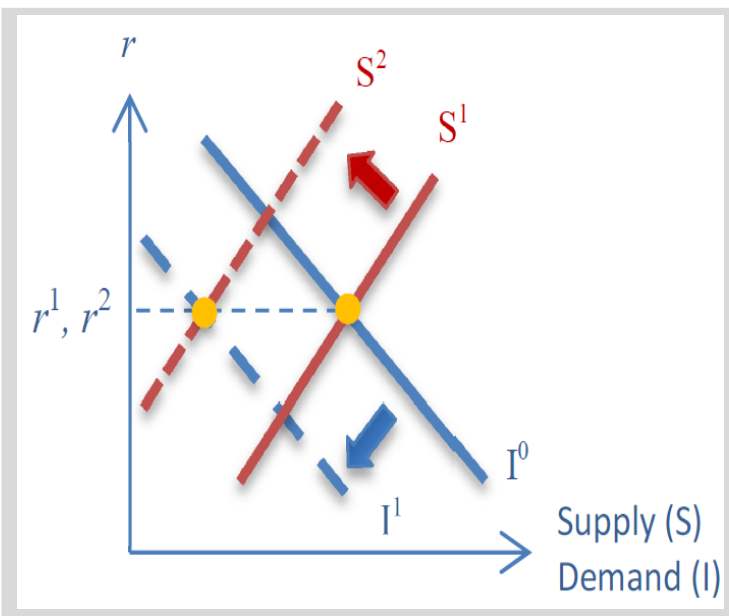


1st phase - credit expansion

Steady economic growth and low volatility encourage

- financial deregulation,
 - excessively expansionary MP,
 - overly optimistic expectations of future returns,
- which determine a large **increase** in the **supply of funds**: **real interest rates decrease** and **debt increases** excessively.

2nd Phase: financial crisis



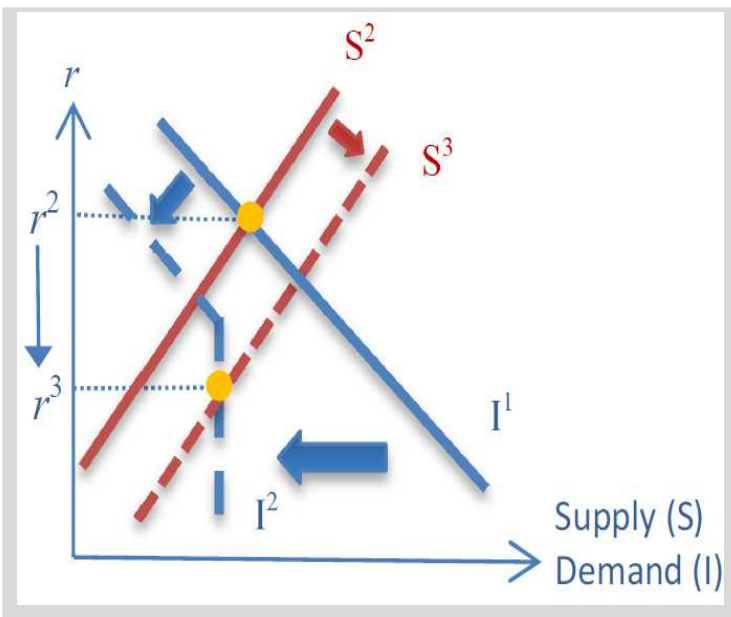
2nd phase - financial crisis

The **financial shock** hits the economy; the **supply and demand of funds decrease**.

The overall effect on **real interest rates** is **uncertain**, depending on relative effects on demand and supply; **credit reduces**.

Real interest rates: The “financial/cyclical” view

3rd Phase: slow recovery

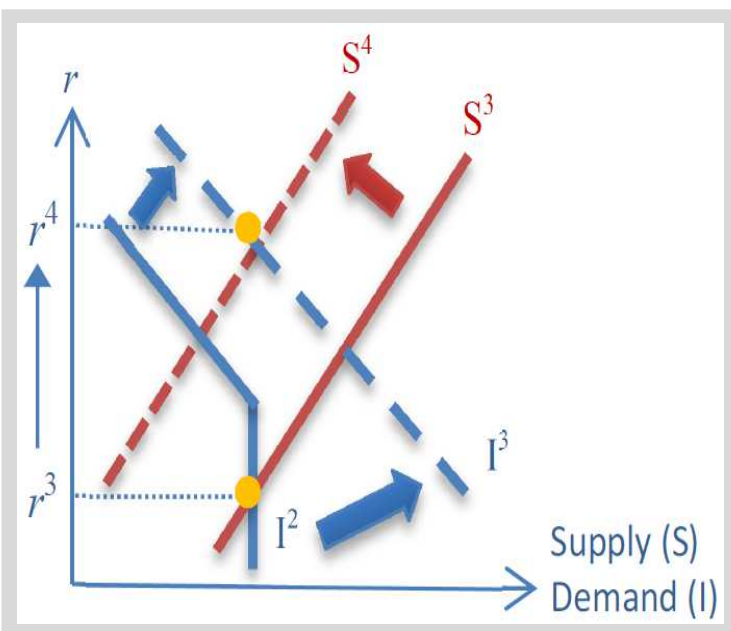


3rd phase – slow recovery

Expansionary **monetary policies** increase supply of **funds**, reducing real interest rates.

However, **deleveraging** and **uncertainty** about future income **dampen** investment and consumption, inducing a further **reduction** of real interest rates.

4th Phase: back to normal



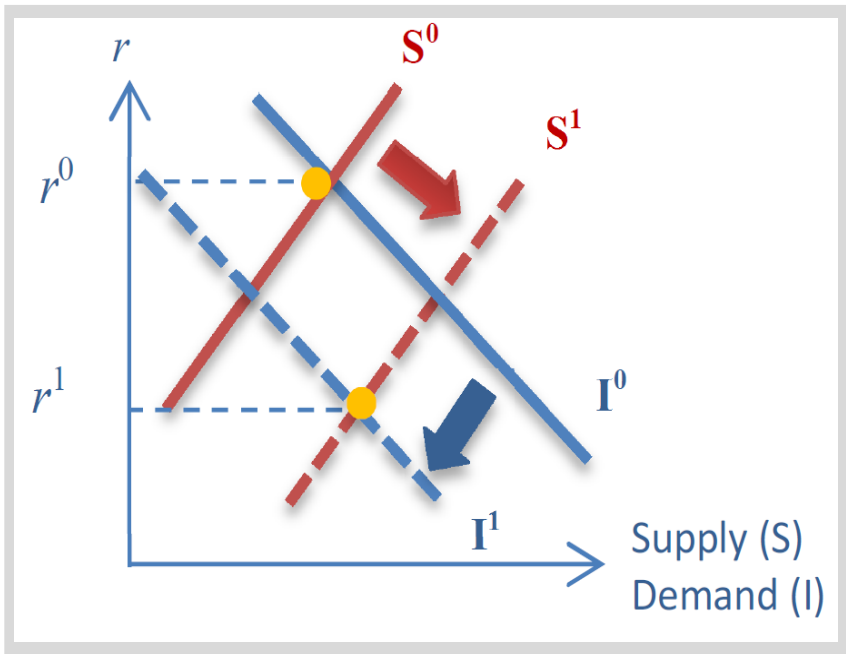
4th phase – back to normal

Interest rates remain low for an extensive period of time, but return “**back to normal**”, as the **deleveraging process ends**, **uncertainty reduces** and **expansionary monetary policies** are phased out.

But deleveraging process, tight credit conditions, uncertainty may have **long-lasting effects** on growth and real interest rates (**Hysteresis effects**).

Real interest rates: The “financial/cyclical” view

The real/structural explanation



Persistent imbalance resulting from an **increasing supply** and a **decreasing demand** of funds.

Demand and supply factors include:

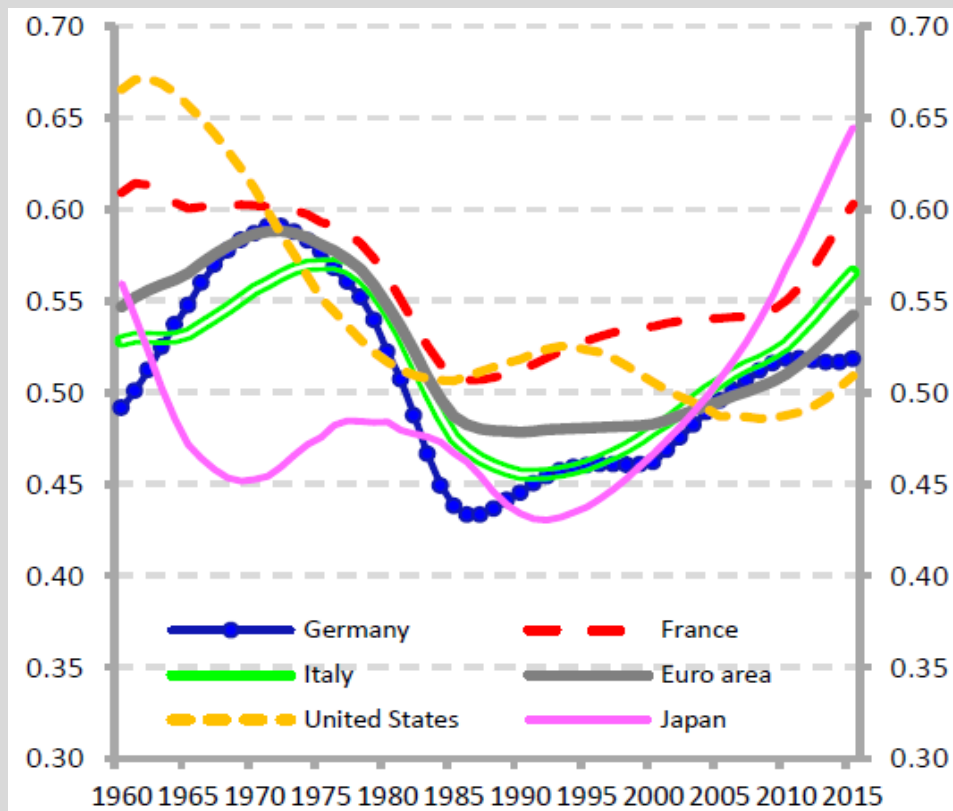
- adverse **demographic** developments
- lower pace of **technological innovation**
- falling relative **price of investment** goods
- **scarcity of safe assets** in emerging economies
- increases in wealth and income **inequality**

Excessive savings act as a drag on **growth** and **inflation**, and push **real rates** down.

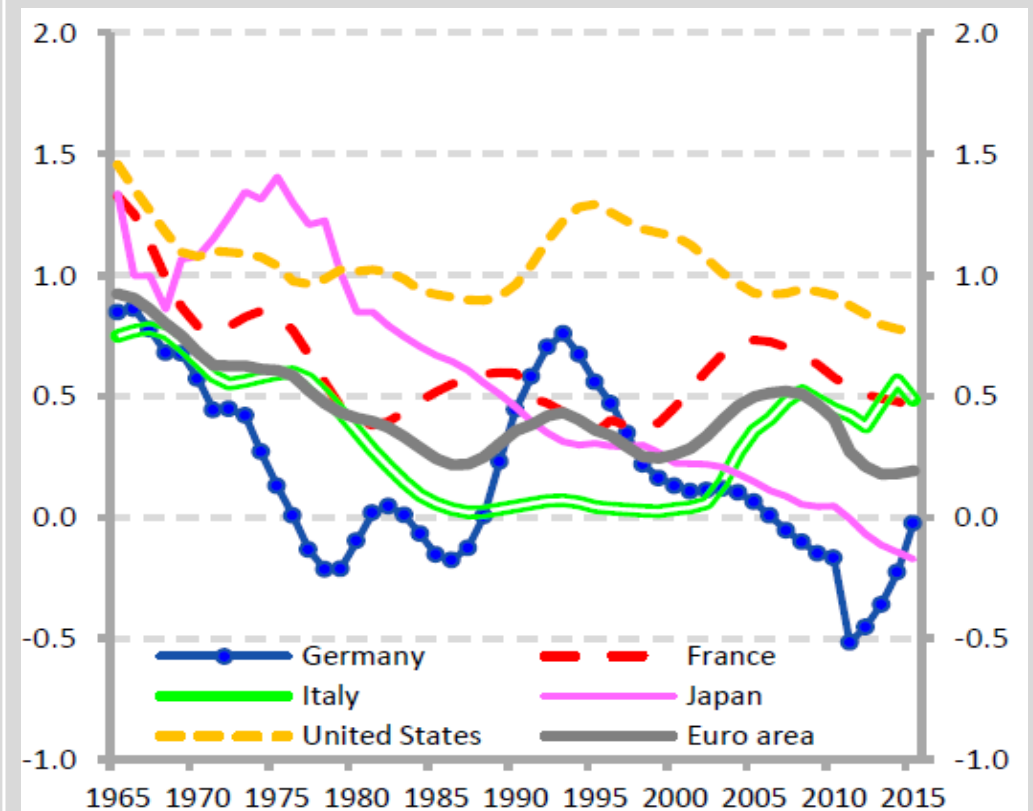
Looking forward, interest rates may remain “low for long”.

Demographics: Empirical evidence

a) Dependency ratio



b) Population growth



Source: World Bank Open Data, <http://data.worldbank.org/>.

Demographics and real interest rates: the channels

Demographics affect both **demand** and **supply** side of the economy. **Three channels** through which **demographics** influence real interest rate:

1. Longer longevity (Acemoglu et al 2007; Backus et al, 2014): for a given retirement age, an **increase in life expectancy**
 - **lengthens the retirement period** and
 - generates **higher incentives to save** throughout the life cycle and
 - a **downward pressure on real interest rates**

“When the ratio of the working-age population to the total population is expected to decline in the process of population aging, the number of wage earners relative to the number of persons who consume is expected to decrease. Households then consumes less and saves more in order to smooth out the level of per-capita consumption into the future.” Ikeda & Saito, 2014

Demographics and real interest rates: the channels

2. Lower population growth: a drop in **population growth** produces two opposite effects on real interest rates

2.1 Supply effect (Aksoy et al., 2015):

- higher **capital–labor ratio**, which
- depresses the **marginal product of capital** and therefore
- it reduces the **investment demand** and the equilibrium **real interest rate**
- These may be further **reduced** in presence of **collateral constraints**

“a decline in the working-age population ratio works like a fall in TFP; this reduces the marginal products of capital (and land), and the demand for capital (and land) by the firm decreases” Ikeda & Saito, 2014

Demographics and real interest rates: the channels

2.2 Demand effect (Favero and Galasso, 2015; Carvalho et al 2016):

- it drives up the **dependency ratio**
- and, since retirees have a **lower marginal propensity to save**, this change in the composition of the population is akin to a “**demand shock**” that
- pushes up **aggregate consumption**, and
- puts upward pressure on equilibrium **real interest rates**

Demographics and real interest rates: Which effect dominates?

Which effect dominates? An empirical issue

- Bloom et al. (2003) find, empirically, that the dominant effect of *increased life expectancy* is higher savings rates and, therefore, **lower real interest rates**.
- Aksoy et al. (2016), quantify impact of demographics: *ageing* leads to **subdued output growth, higher savings and lower interest rates**.
- Carvalho et al. (2016) life-cycle model: *demographic trends* between 1990 and 2014 in developed economies **reduced**, ceteris paribus, the equilibrium **interest rate** by 1.5 percentage points.
- Favero and Galasso (2016) show that *demographic* based projections deliver for next 20 years a **lower** long-run **potential growth** rate but a **reversion of real interest rates** to historical means

Methodology and data

- Restricted **panel VAR-X**

$$Y_t^i = \alpha_i + A(L)Y_{t-1}^i + \gamma(L)D_t^i + \varepsilon_t^i$$

- Y_t^i : potential output, real GDP, TFP, investment, consumption growth; GDP deflator, investment and consumption (deflator) inflation, unemployment rate, real short- and long-term rates
- D_t^i : demographic variables (population growth and **dependency ratio**)
- Annual data, 1990-2016, all **euro-area countries**
- Source: AMECO, European Commission

Estimation

	Potential output growth	TFP growth	Real GDP growth	GDP deflator Inflation	Real long-term interest	Real short-term interest	Unemployment rate change	Investment growth	Private consumption growth	Private consumption deflator inflation
Potential output growth (-1)	0.88 **	0.13	0.37 **	-0.03	0.39 **	0.23	0.18 **			
TFP growth (-1)	0.10 **	-0.01	0.24	0.00	-0.08	-0.10		0.40 **	0.18 **	0.04
Real GDP growth (-1)			0.00	0.10**	-0.27	0.18	-0.39 **			
GDP deflator inflation (-1)	-0.05		-0.20	0.61 **						
Change in unemploy. rate		-0.25 **								
Real long-term i-rate		-0.09**					0.22 **			
Real long-term i-rate (-1)	0.02 *	0.15 **	0.06 **	0.01	0.64 **	-0.03	-0.21 **	0.04	0.01	0.01
Real short-term i-rate		0.06 *					-0.13 **			
Real short-term i-rate (-1)	-0.01	-0.07 **	-0.07 **	0.01	0.11	0.74**	0.17 **	-0.09 **	-0.01	-0.00
Population growth	-0.00	-0.12	-0.01	0.05 **	-0.25 **	-0.25 **		-0.01	0.07	0.04 *
Change in dependency ratio	-0.08 **	-0.02	-0.21 **	-0.04 **	0.00	-0.19 *	0.28 **	-0.22 **	-0.27 **	-0.07 **
R^2	<i>0.94</i>	<i>0.40</i>	<i>0.40</i>	<i>0.81</i>	<i>0.63</i>	<i>0.69</i>	<i>0.49</i>	<i>0.29</i>	<i>0.46</i>	<i>0.63</i>
$Adj. R^2$	<i>0.93</i>	<i>0.35</i>	<i>0.36</i>	<i>0.79</i>	<i>0.61</i>	<i>0.67</i>	<i>0.45</i>	<i>0.24</i>	<i>0.42</i>	<i>0.60</i>
SE of regression	<i>0.35</i>	<i>0.74</i>	<i>0.80</i>	<i>0.33</i>	<i>2.45</i>	<i>2.30</i>	<i>0.89</i>	<i>0.87</i>	<i>0.69</i>	<i>0.44</i>
Durbin Watson	<i>1.53</i>	<i>1.84</i>	<i>1.91</i>	<i>2.09</i>	<i>1.93</i>	<i>2.02</i>	<i>1.89</i>	<i>1.83</i>	<i>1.96</i>	<i>2.15</i>
N. observations	<i>396</i>	<i>395</i>	<i>396</i>	<i>396</i>	<i>395</i>	<i>396</i>	<i>395</i>	<i>396</i>	<i>396</i>	<i>396</i>

Estimation

Dependency ratios significantly affect main macroeconomic variables

- **Direct negative impact:** potential output, real GDP, investment and consumption growth
- **Direct negative impact:** real short-term interest rates; consumption and GDP inflation
- **Direct positive impact:** unemployment
- **Indirect negative effect:** TFP growth and long-term real interest rates

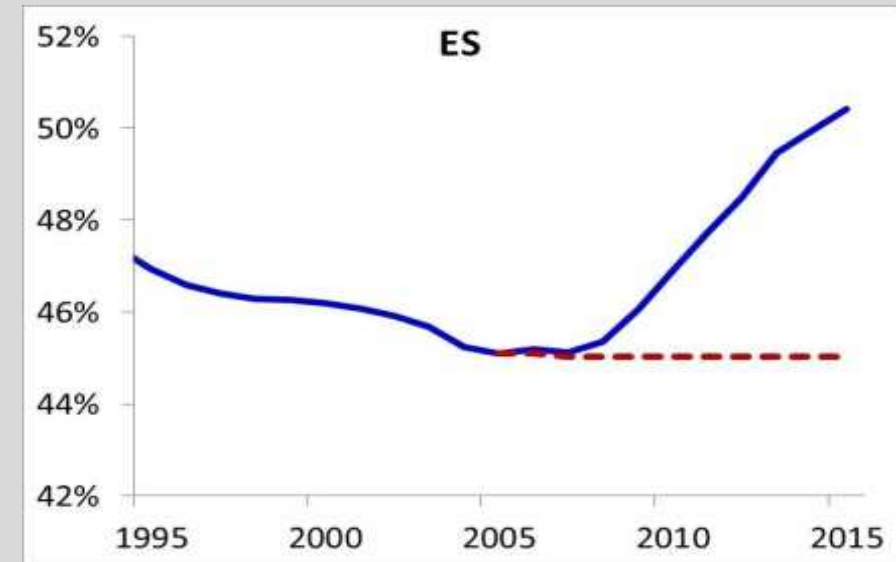
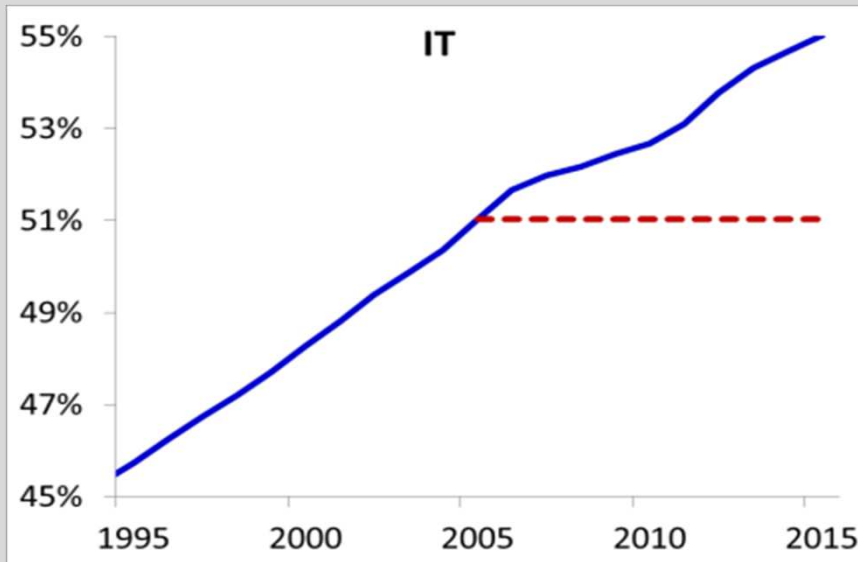
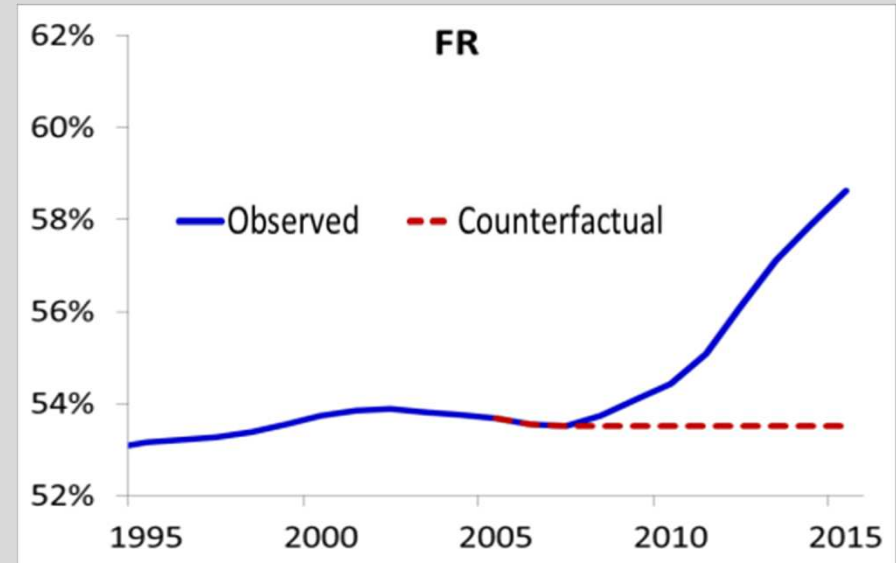
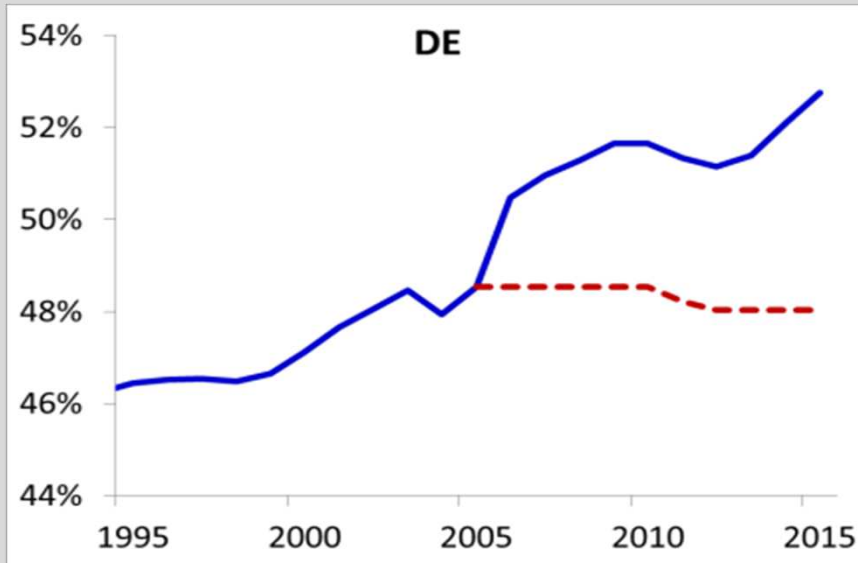
Scenario analysis

Two exercises:

- **Backward: counterfactual analysis** → role of demographics in driving down and keeping real rates low between 2006 and 2015.
- **Forward: out-of-sample long-term projections** → will real rates remain low because of adverse demographic developments over the next ten years?

Counterfactual analysis: 2006-2015

Historical counterfactual assumptions for dependency ratios: selected countries



Note: The figures show the historical evolution of the dependency ratio (blue) over the 1995-2015 period together with the projection conditional on a more favorable evolution of demographics between 2006 and 2015 (red dashed).

Counterfactual analysis: 2006-2015

In the euro area, if **dependency ratios had remained flat**, in the period 2006-2015, on average

- **potential output, real GDP growth and investments** would have been **higher by 0.3, 0.5 and 1.0 p.p.**, respectively;
- **real short-term rates** would have been **higher by 0.5 p.p.**

Historical counterfactual: more favorable dependency ratios, 2005-16 – Euro area

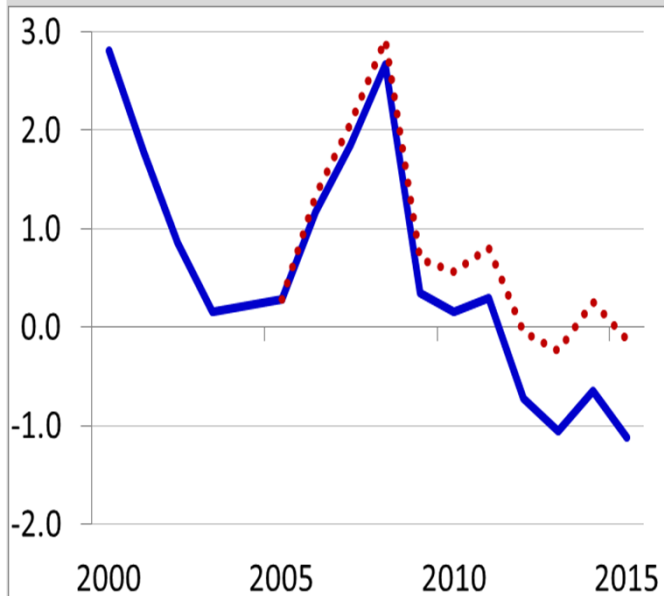
Scenario		Population growth	Dependency ratio	Real long-term interest rates	Real short-term interest rates	TFP	Potential output	Real GDP	Real investment	Real priv. consumption	GDP deflator	Priv. cons. deflator	Unemployment rates
2006-15	Obs.	0.35%	51.8%	2.0%	0.3%	0.1%	0.9%	0.7%	-0.2%	0.5%	1.4%	1.4%	9.2%
	Counterf.	0.35%	49.5%	2.1%	0.8%	0.3%	1.2%	1.3%	0.8%	1.1%	1.7%	1.8%	8.5%
	Diff. in p.p.	0.0	-2.3	0.1	0.5	0.2	0.3	0.5	1.0	0.6	0.4	0.4	-0.7

NOTE: the table reports the averages of the selected variables over the period 2006-15 together with the counterfactual dynamic projections conditional on the assumption that dependency ratios would have evolved more favorably. Nominal GDP-weighted aggregates.

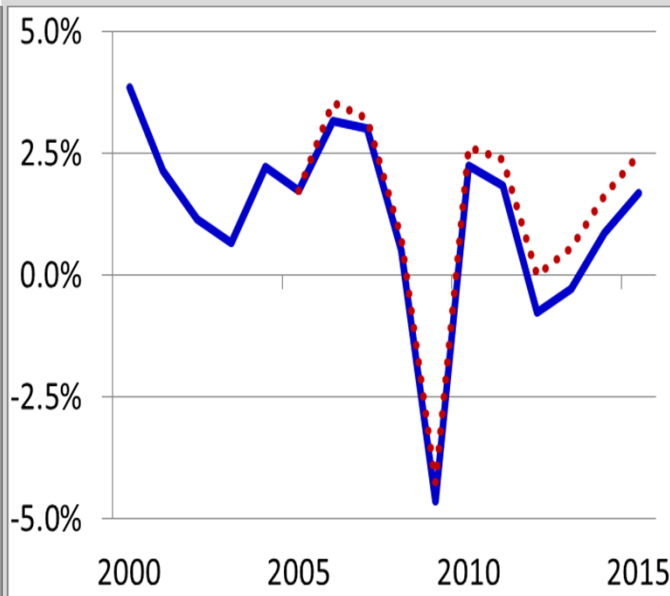
Counterfactual analysis: 2006-2015

Counterfactual projections for main variables (2005-2015): euro area

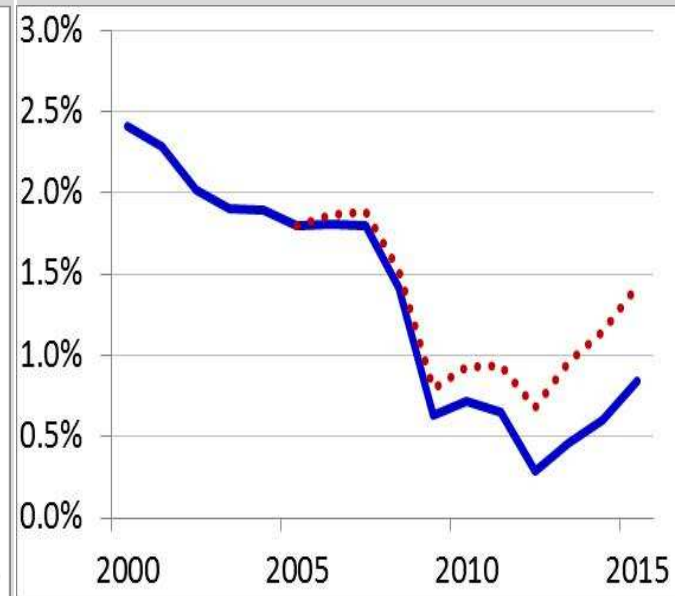
Short-term real interest



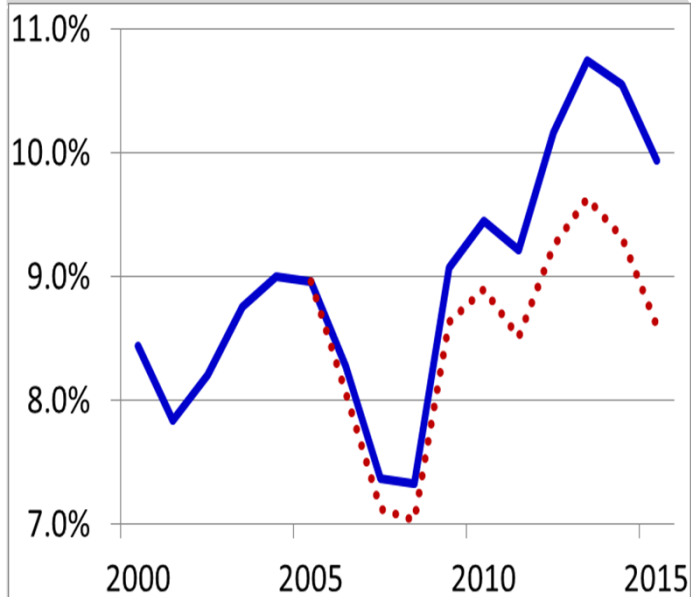
Real GDP growth



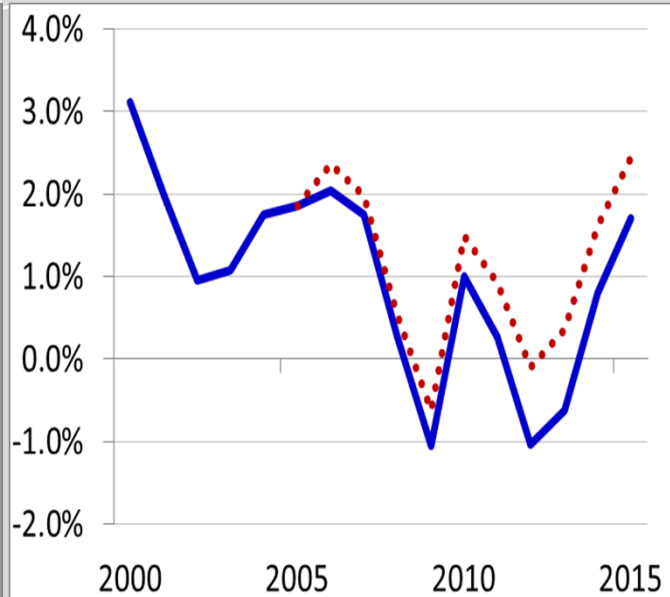
Potential output



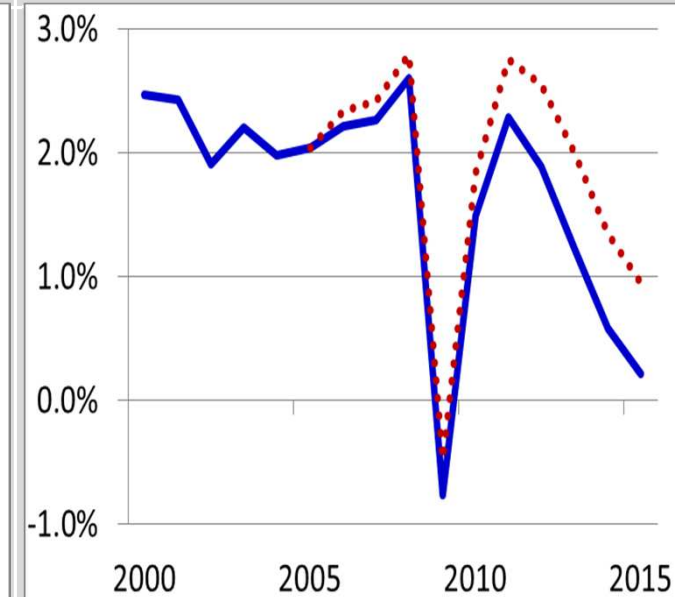
Unemployment



Consumption growth



Consumption deflator



Counterfactual analysis: 2006-2015

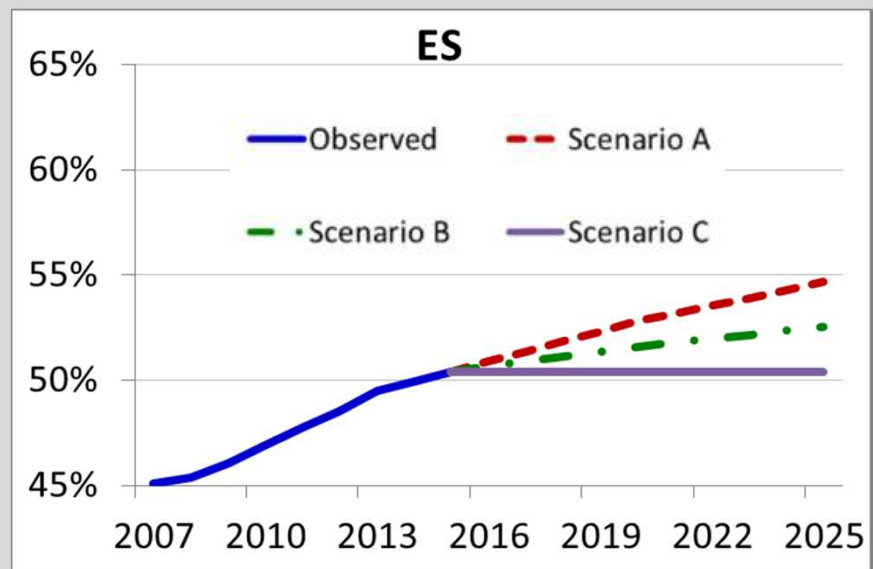
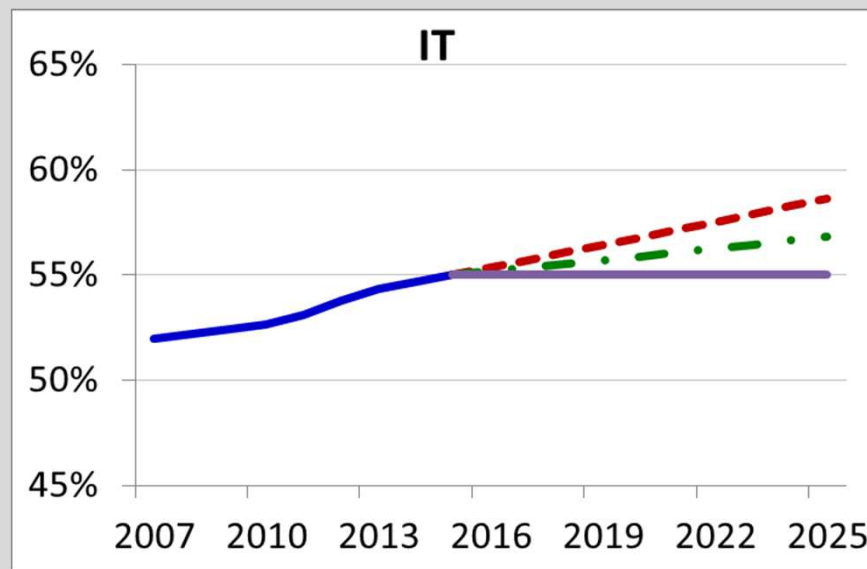
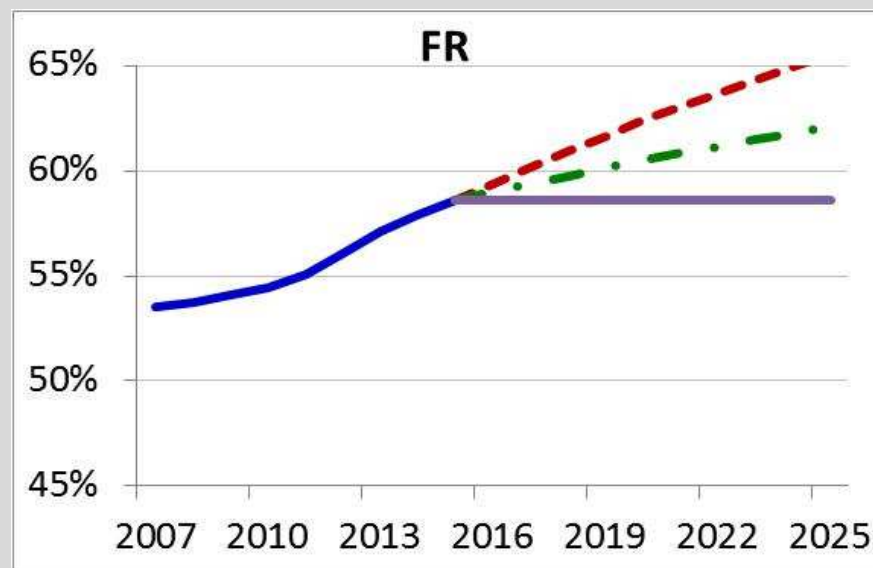
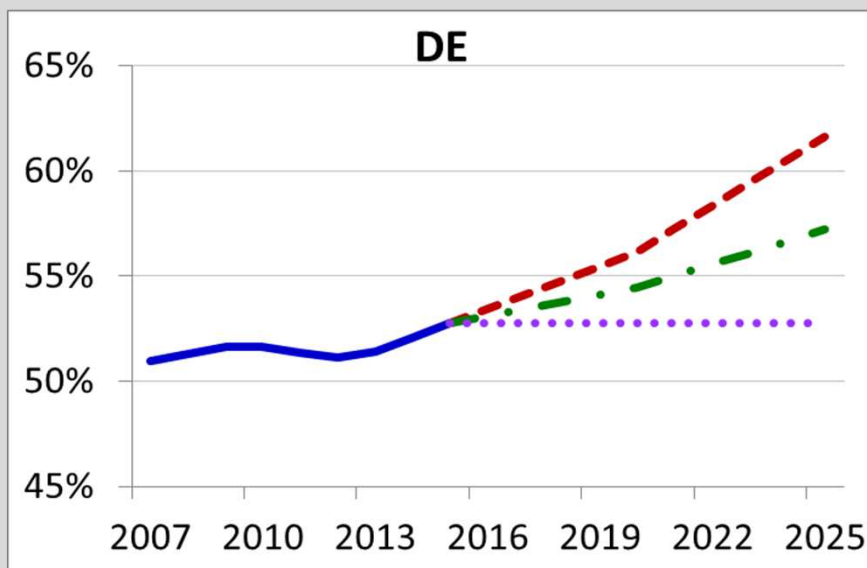
Significance estimates (p-values): counterfactual versus actual, 2006-2015

	AT	BE	DE	ES	FI	FR	EL	IE	IT	NL	PT
Potential output growth	16%	2%	15%	4%	3%	0%	6%	5%	7%	6%	7%
TFP growth	20%	16%	16%	1%	12%	7%	11%	13%	15%	13%	4%
Real long-term interest rates	24%	21%	19%	17%	20%	17%	22%	19%	19%	17%	20%
Real short-term interest rates	19%	11%	14%	9%	9%	6%	12%	12%	14%	7%	11%
Real GDP growth	17%	9%	8%	6%	5%	2%	6%	7%	11%	8%	1%
GDP deflator inflation	19%	9%	20%	8%	2%	0%	14%	8%	12%	7%	8%
Real investment growth	17%	11%	8%	10%	6%	6%	9%	9%	15%	9%	1%
Investment deflator inflation	17%	7%	18%	6%	3%	1%	8%	9%	5%	4%	1%
Real private consumption growth	12%	3%	5%	4%	2%	0%	5%	4%	8%	4%	0%
Private consumption deflator inflation	17%	7%	18%	3%	1%	0%	11%	3%	9%	5%	3%
Unemployment rate	26%	6%	13%	1%	0%	0%	2%	15%	9%	1%	4%

Note: lower levels imply larger significance in difference between the observed and the counterfactual average values.

Projections: 2016-2025

Scenarios for dependency ratios: selected countries



Note: For scenario A, the assumptions from the 2015 Ageing Report are adopted. In scenario B the dependency ratios move half way in between the EC projections and a flat path. Under scenario C, the ratios are assumed to remain flat at their 2015 levels.

Counterfactual analysis: 2006-2015

In the euro area, **if dependency ratios increase as foreseen by European Commission**, in the period 2016-2025, on average

- **potential output** and **real GDP** growth similar to financial crisis and much lower than in the 2000-2006 period
- **short-term real** interest rates close to zero

Historical counterfactual: more favorable dependency ratios, 2005-16 – Euro area

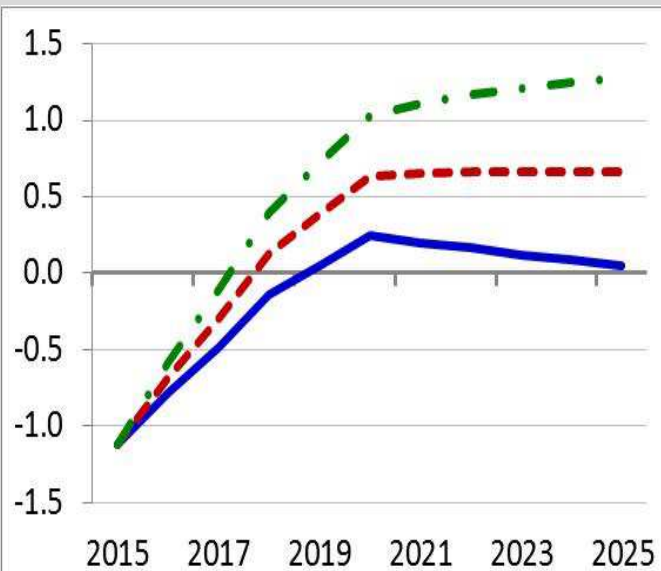
Scenario		Popu- lation growth	Depen- dency ratio (2025)	Real long- term interest rates (2025)	Real short- term interest rates (2025)	TFP	Potential output	Real GDP	GDP deflator	Real invest- ment	Invest- ment deflator	Real priv. consump- tion	Priv. cons. deflator	Unemploy- ment rates (2025)
2000-06		0.46%	49.5%	2.3%	1.1%	0.6%	2.0%	2.1%	2.0%	2.3%	1.9%	1.8%	2.2%	8.5%
2007-15		0.34%	52.0%	2.0%	0.2%	0.0%	0.8%	0.5%	1.3%	-0.8%	1.1%	0.3%	1.3%	9.3%
2015		0.43%	54.1%	0.1%	-1.1%	0.8%	0.8%	1.6%	1.3%	2.8%	0.7%	1.7%	0.2%	10.0%
2016-25	A	0.13%	60.7%	1.9%	0.1%	0.1%	0.6%	0.6%	1.0%	0.7%	0.9%	1.0%	1.1%	9.9%
	B	0.13%	57.4%	2.1%	0.7%	0.3%	0.8%	0.9%	1.2%	1.3%	1.2%	1.4%	1.4%	9.0%
	C	0.13%	54.1%	2.4%	1.3%	0.4%	1.0%	1.3%	1.4%	1.9%	1.5%	1.8%	1.7%	8.3%

NOTE: the table reports the averages of the selected variables over the period 2006-15 together with the counterfactual dynamic projections conditional on the assumption that dependency ratios would have evolved more favorably. Nominal GDP-weighted aggregates.

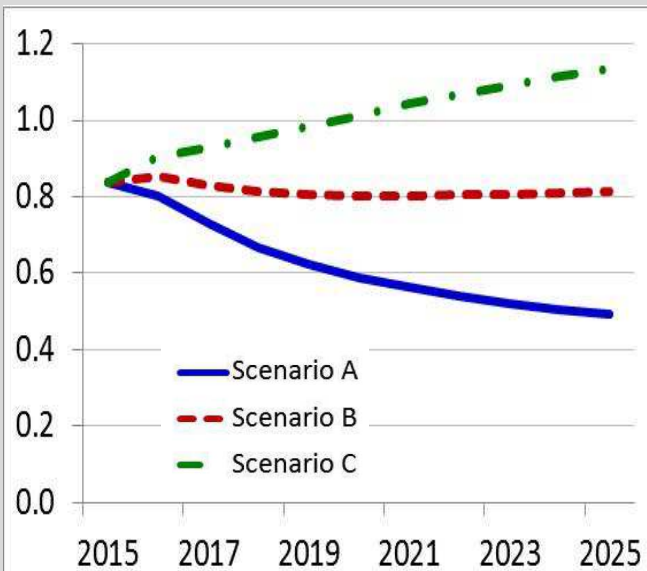
Projections: 2016-2025

Conditional projections (2016-2025) - Euro area

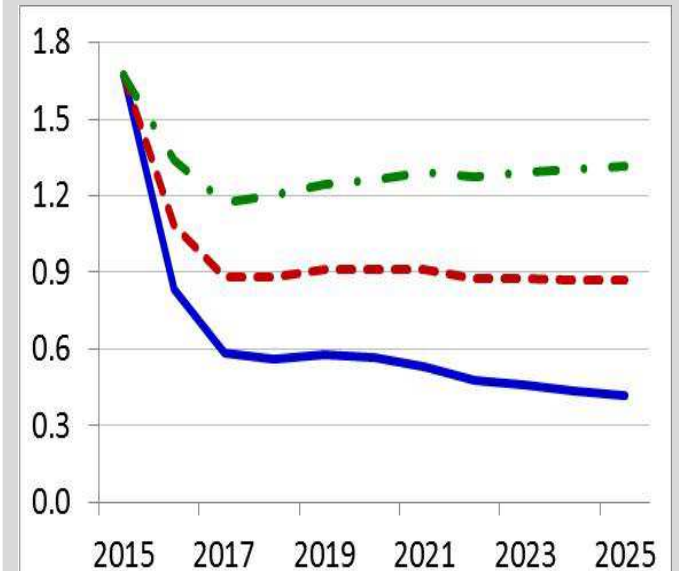
Short-term real interest



Potential output



Real GDP growth



Note: The charts show the trajectory of long-term interest rates under the historical evolution of the observed variables (blue); the projected path under scenario A (red dashed line), under scenario B (green dashed-dotted line) and under scenario c (violet dotted line).

Concluding Remarks

- **Real interest rates** have been decreasing since the mid-80s and have reached historical low levels after outbreak of global financial crisis.
- Open **debate on the drivers** and on **implications** for monetary policy and financial stability (ESRB report, 2016).
- Key message: **adverse demographic developments** have exerted, and may continue to exert **downward pressure** on **real interest rates** and **growth**.
- Directions for future research: implications of **age composition** of population for **macroeconomic and financial variables**, and more importantly, for monetary policy-making