



# Macroeconomic Implications of Demographic Changes in Bulgaria

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Ventsislav Ivanov  
Desislava Cvetkova  
Andrey Vassilev

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# Outline

- Research motivation
  
- The impact of demographic changes on:
  - ❖ Potential output;
  - ❖ Inflation;
  - ❖ Fiscal sustainability;

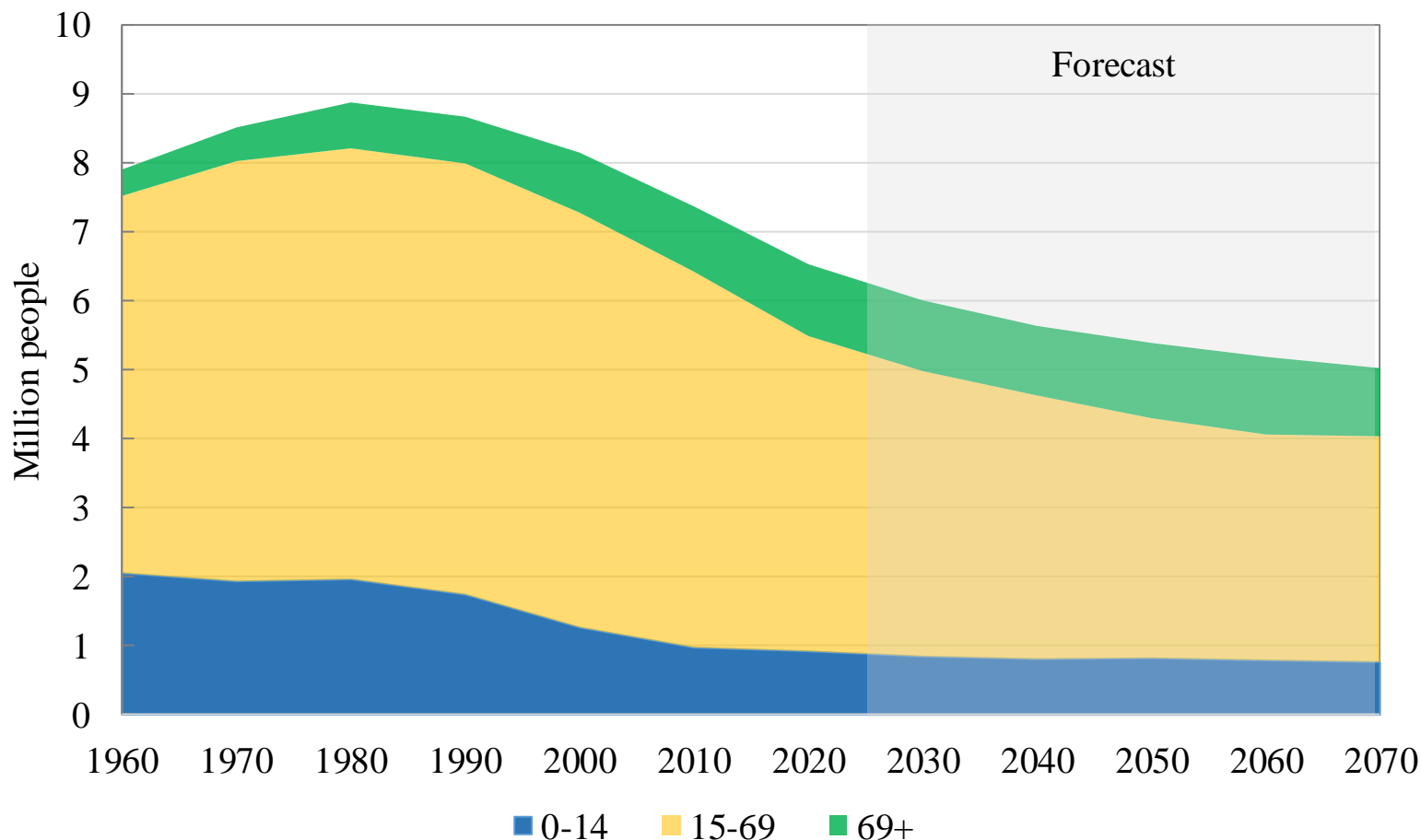


# Research motivation

- According to NSI's projections the overall size of Bulgarian population is expected to decrease by about 22% from 6.4 million people in 2022 to 5.0 million in 2070.
- Bulgaria is one of the fastest-ageing economies in the EU.
- Population aging is associated with decreasing productivity levels, lower savings, and higher government spending.
- Negative demographic trends are expected to affect economic growth, price processes and the sustainability of public finances in the long-term period.



# Demographic transition in Bulgaria



Note: The reported data covered the period 1960 – 2020 inclusive

Source: Eurostat, NSI



# The Impact of Demographic Changes on Potential Output

# Model specification



- **The BNB's multivariate unobserved components model** - combines a Cobb-Douglas production function with constant returns to scale with behavioural equations of the Phillips curve and Okun's law.

- Production function approach:

$$Y = L^{\alpha} * K^{(1-\alpha)} * TFP$$

- Augmented production function approach:

$$Y = (HC * L)^{\alpha} * K^{(1-\alpha)} * TFP$$

- Human capital index (HC)

$$HC(t) = \sum_{g,i,j} w_{g,i,j} * n_{g,i,j}(t)$$

w – the weight given by the earnings ratio for the last available year;

n – the proportion of individuals;

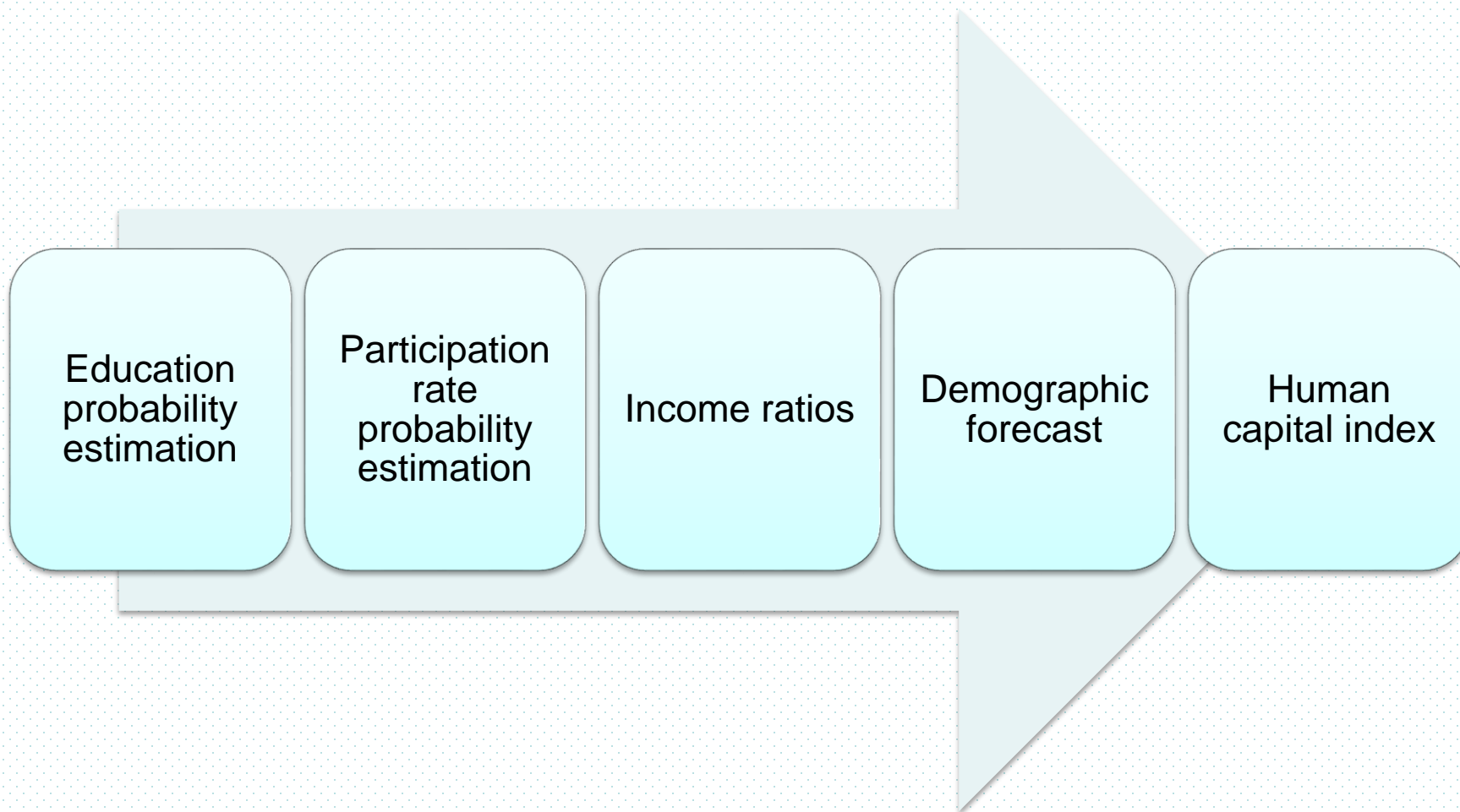
g – gender;

i – educational attainment level;

j – age group;



# Human capital index estimates





# Human capital index estimates

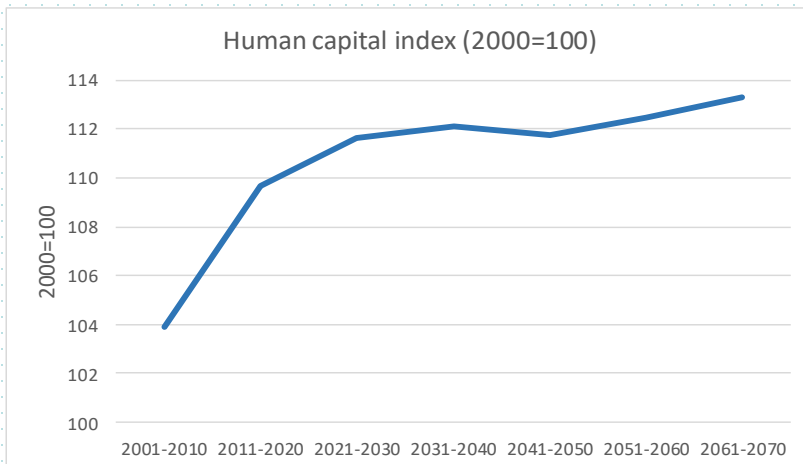
➤ Our approach for measuring educational level and participation rates over the forecast horizon is based on machine learning techniques - define 5 learning algorithms based on LFS micro data:

- Logistic Regression;
- Random Forest;
- Gradient Boosting;
- KNeighbors (K-Nearest Neighbors)
- Linear SVC (Support Vector Classification)

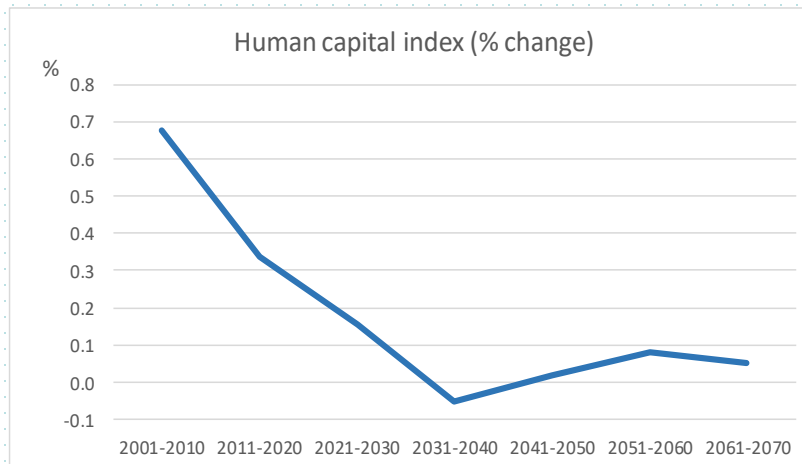
➤ Earning ratio is based on EU-SILC micro data :

- $$\text{Income ratio}_x = \frac{\text{income}_{age(x) \text{ sex}(y) \text{ educ}(z)}}{\text{income}_{age(17-22) \text{ sex}(female) \text{ educ}(low)}}$$

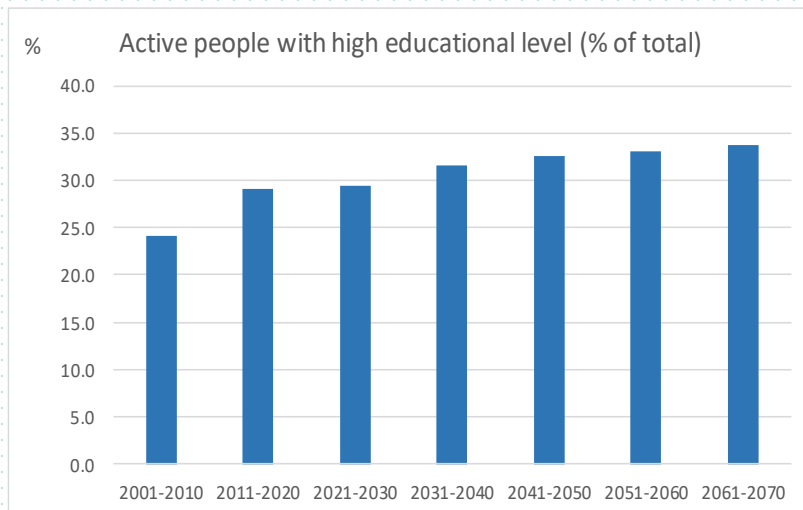
# Human capital estimates



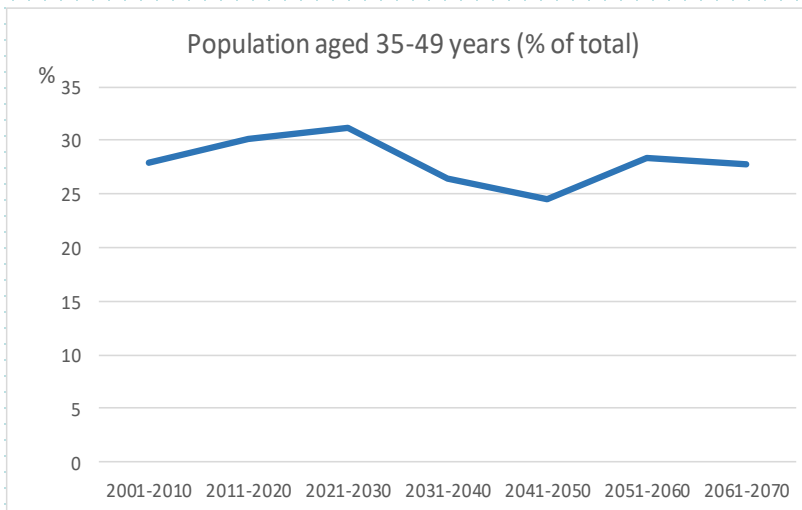
Source: Own estimation



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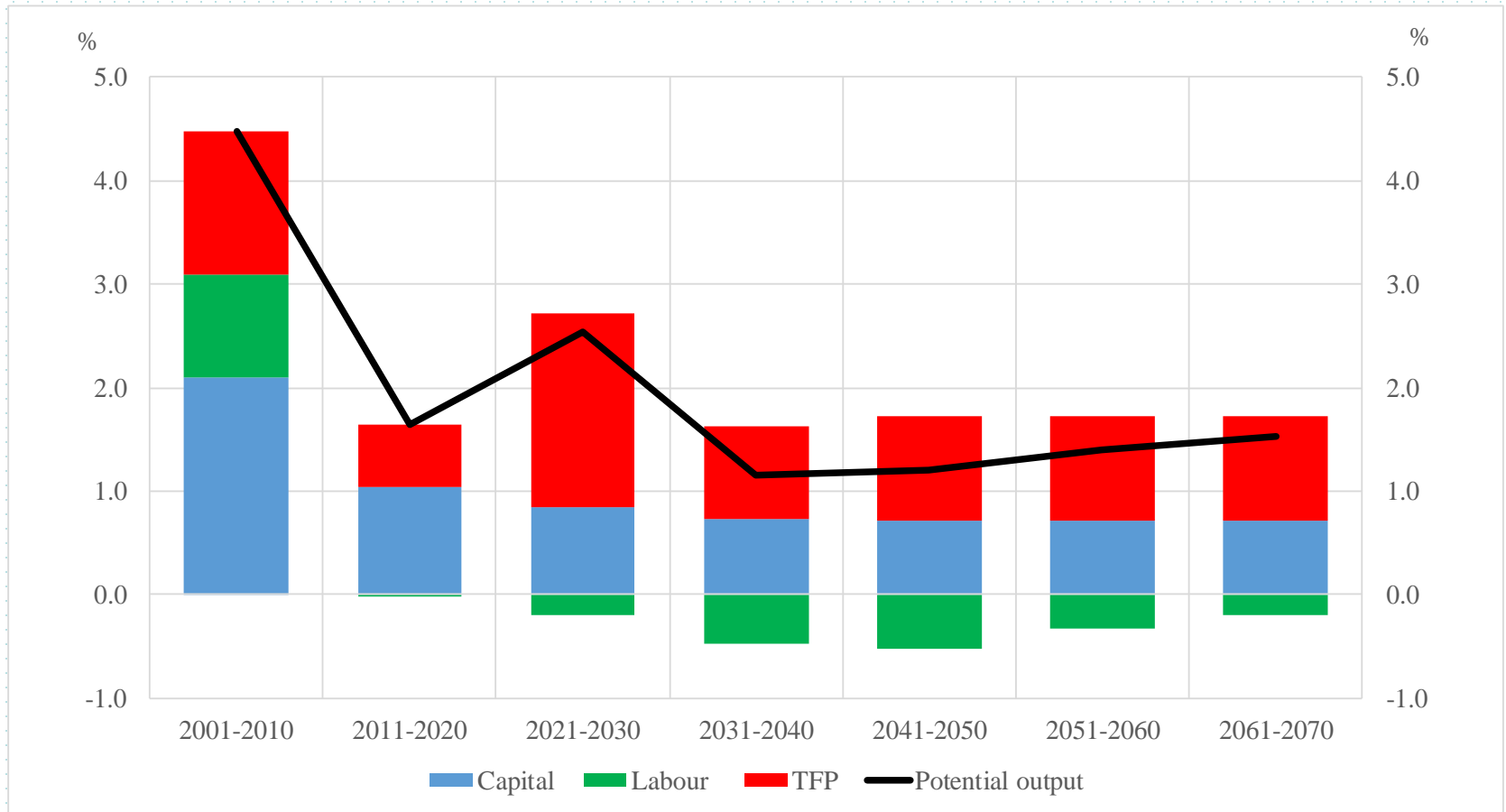


Source: Eurostat, own estimation



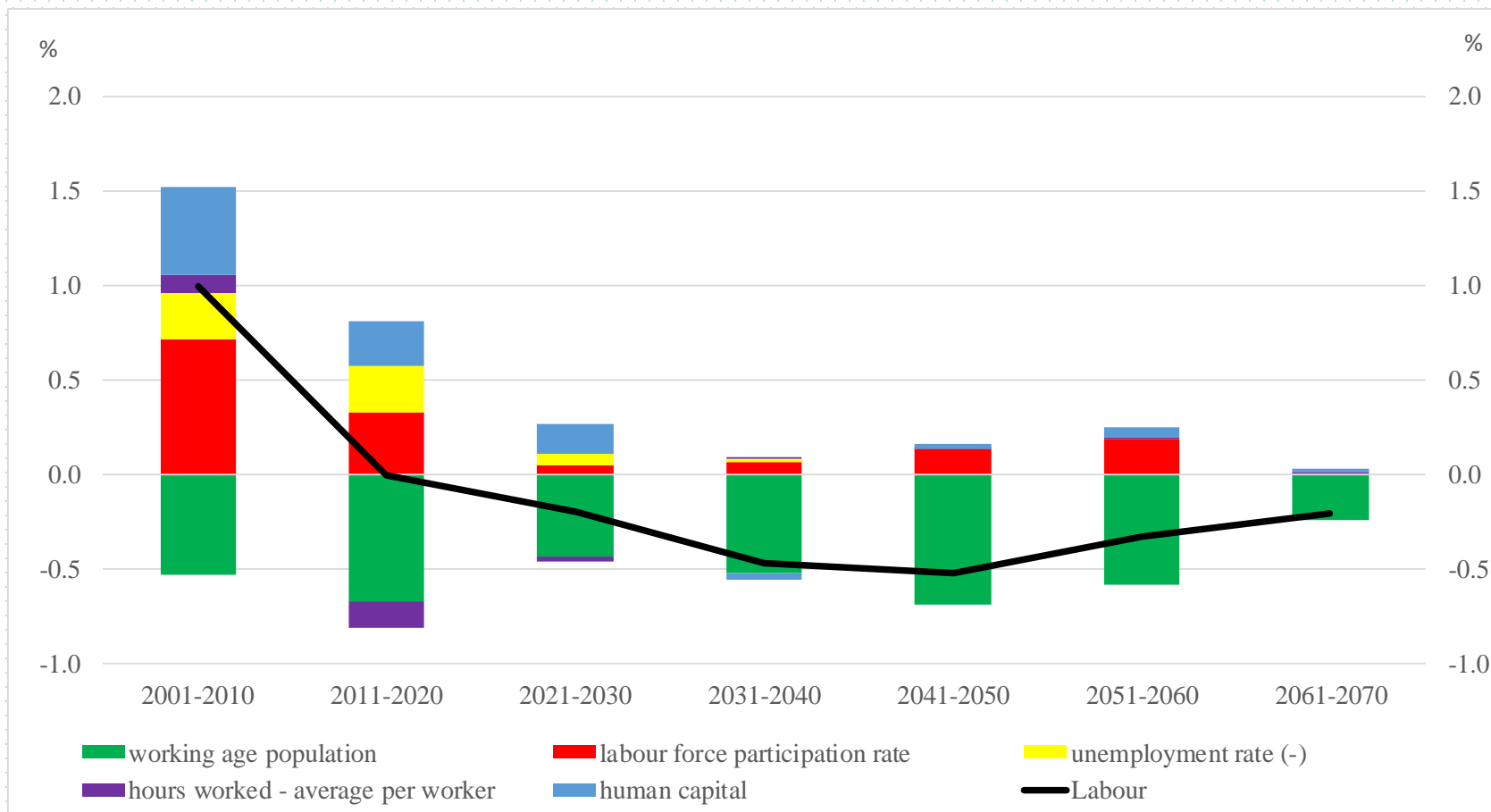
Source: Eurostat

# Average contributions to potential output growth



Source: Own estimations.

# Average contributions to labour input growth



Source: Own estimations.



# The Impact of Demographic Changes on Inflation



# The Impact on Inflation

- Two scenarios for VAR model for core inflation (with and without aging effects)
- explanatory variables:

*on the supply side: real wage*

If there is perfect competition on the labour and capital market, thus the marginal product of the two production factors are equal to their prices.

*We assume, that real wage is equal to productivity, then:*

$$w_t = \frac{\partial Y_t}{\partial L_t} = \frac{\partial (A_t K_t^{1-\alpha} L_t^\alpha)}{\partial L_t} \quad w_t = \alpha A_t K_t^{1-\alpha} L_t^{\alpha-1},$$

*where L account for ageing and human capital effects. Now we can estimate two scenarios for real wage, with and without aging effect.*

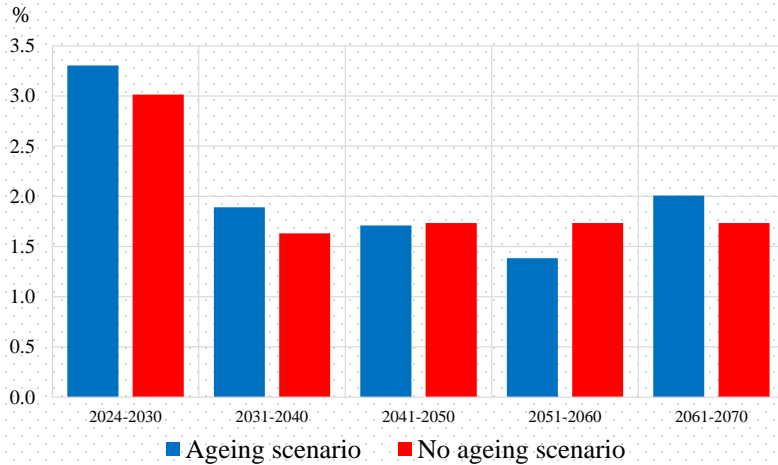
*on the demand side: consumption*

$$\begin{aligned} & \text{consumption}_t \\ &= \Sigma(\text{propensity to consume by age group}) * \Sigma(\text{wage by age group}_t) \\ & \quad * \Sigma(\text{population group by age group})_t \end{aligned}$$

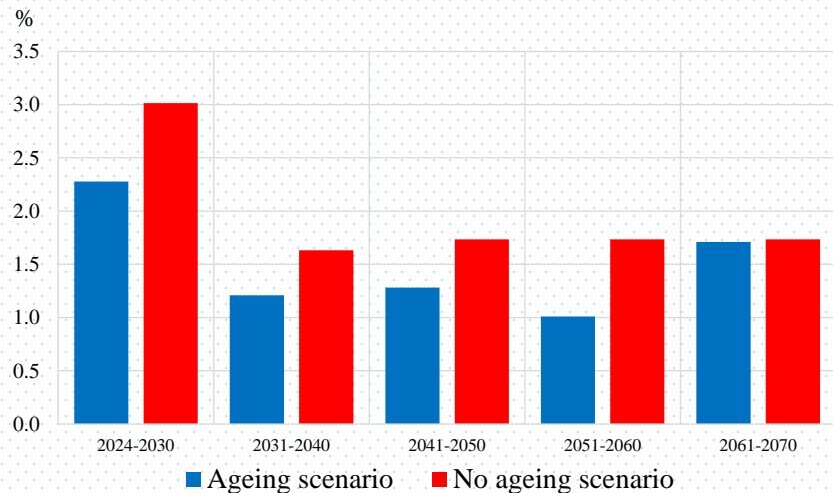
# Wage and consumption forecast



## Real Wage



## Real Consumption



Source: Own estimations.

# The impact on inflation

## ➤ BVAR

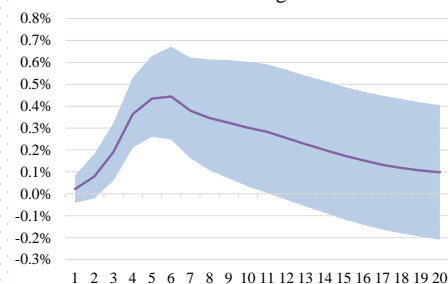
### ➤ Key Features:

- *Combines prior beliefs with observed data.*
- *Addresses overfitting, especially in small samples*
- *Suitable for forecasting and structural analysis*

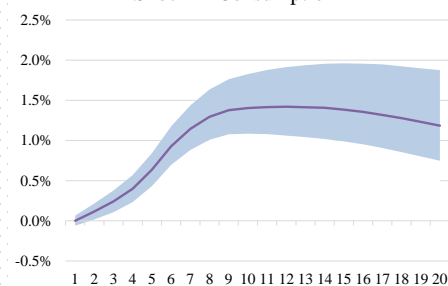
### ➤ Data

- *Period: 2000Q1 – 2023Q4*
- *Transformation: ln (levels), seasonally adjusted*
- *Variables*
  - *Endogenous: Real private consumption, Wage deflated with HICP, Core Inflation index*
  - *Exogenous: Oil price*

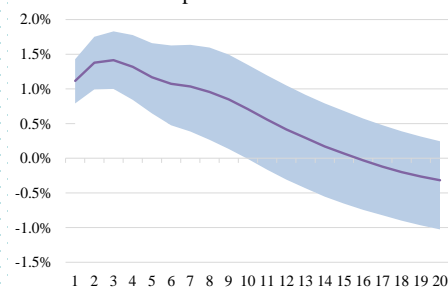
Impulse Response of Inflation to a Shock in Wages



Impulse Response of Inflation to a Shock in Consumption

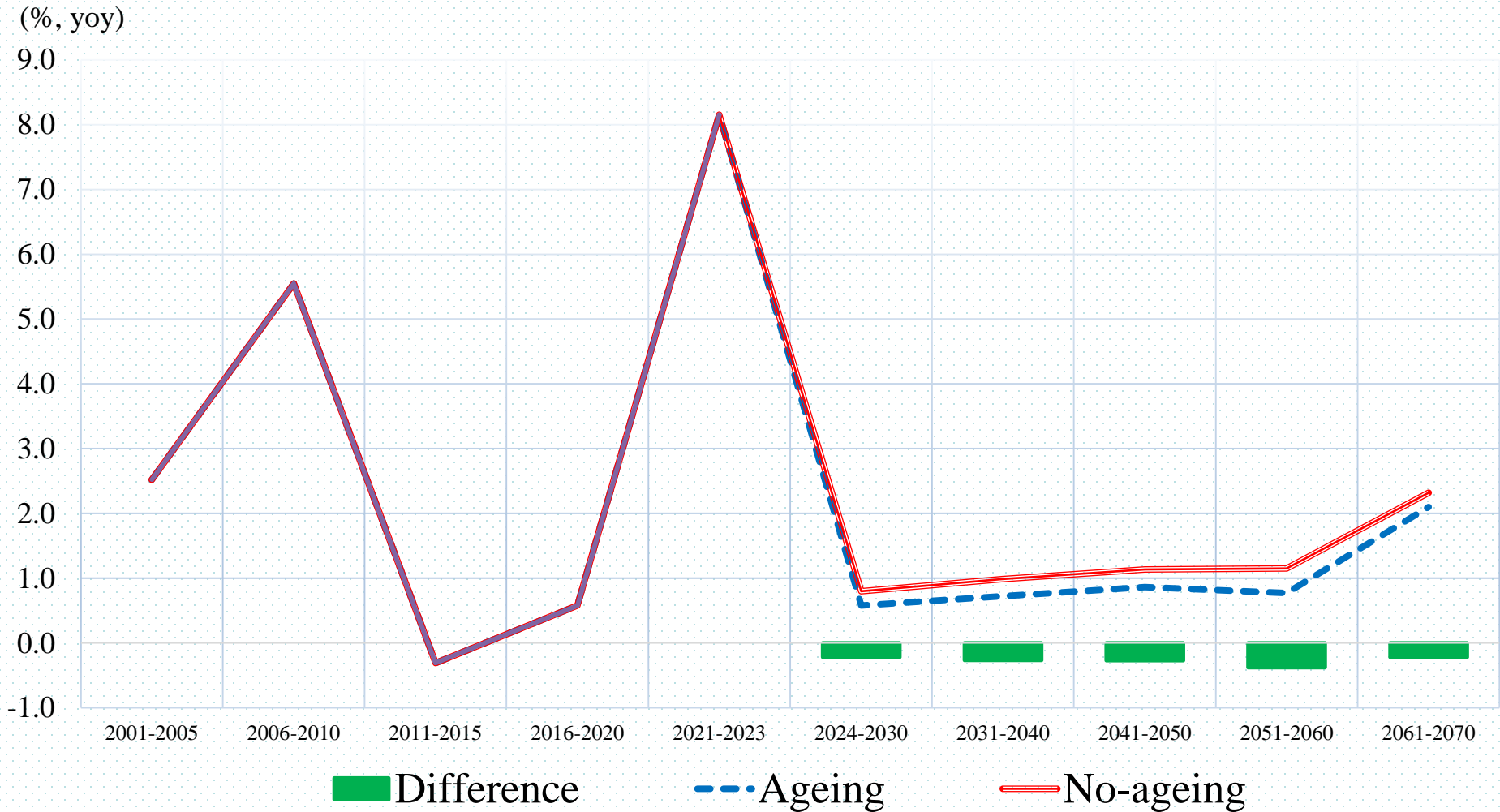


Impulse Response of Inflation to a Oil price Shock





# Core inflation – Conditional forecast



Source: Own estimations.



# The Impact of Demographic Changes on Fiscal Sustainability

# The impact on fiscal sustainability



If the government's debt reach too high levels (does not stabilize) by the end of the period, this indicates the unsustainability of the current policy.

$$D_t = \left[ \frac{1 + i_t}{1 + g_t} \right] D_{t-1} - PB_t + SF_t$$

In terms of simplicity we focus only on Primary Balance dynamic:

- *Revenues*
  - *Personal income tax*
  - *Net social contribution*
  - *VAT*
- *Expenditures*
  - *Pensions*
  - *Healthcare*
  - *Wages*
- For all others budget balance items we assume fixed share as a % of GDP on an 2007 – 2019 average levels.

# Budget Items Forecast



## Budget Revenues

Budget component	Macro base	Elasticity	Other considerations
Personal income tax	Compensation of employees	1	
Value added tax	Private consumption	1	
Social security contributions	Compensation of employees	0.75	Self-employed, Pensioners and Students contributions

## Budget Expenditures

- Compensation of employees in public sector =  $Wages (PS) * Employees (PS)$
- Healthcare expenditures =  $Share of Health exp. by age groups * Wage growth * Population by age groups$
- Pensions expenditures =  $Number of pensions * Average Pension$



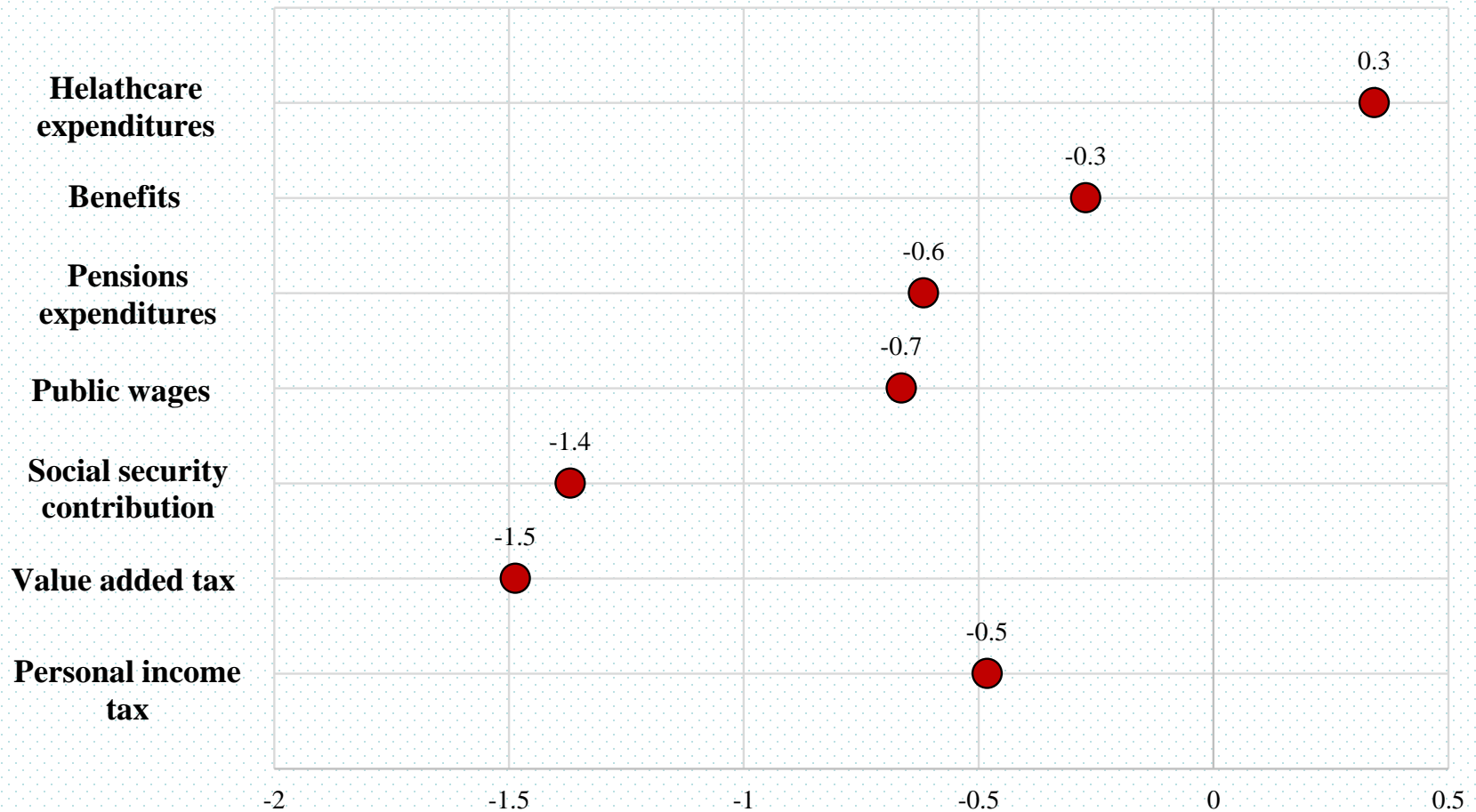
# Pensions Expenditures

- Number of pensioners by pension categories – NSSI assumptions
  
- Average pension by pension categories – Swiss rule
  - Old-age pensions - Assumption of the gradual reduction of the average pension as a result of the mechanical transition of insured individuals from pillar 1 to pillar 2 of the pension system (NSSI)
  - Disability pensions – Assumption for the number of disability pensions as a result of the 2023 administrative reform (NSSI)

# Results



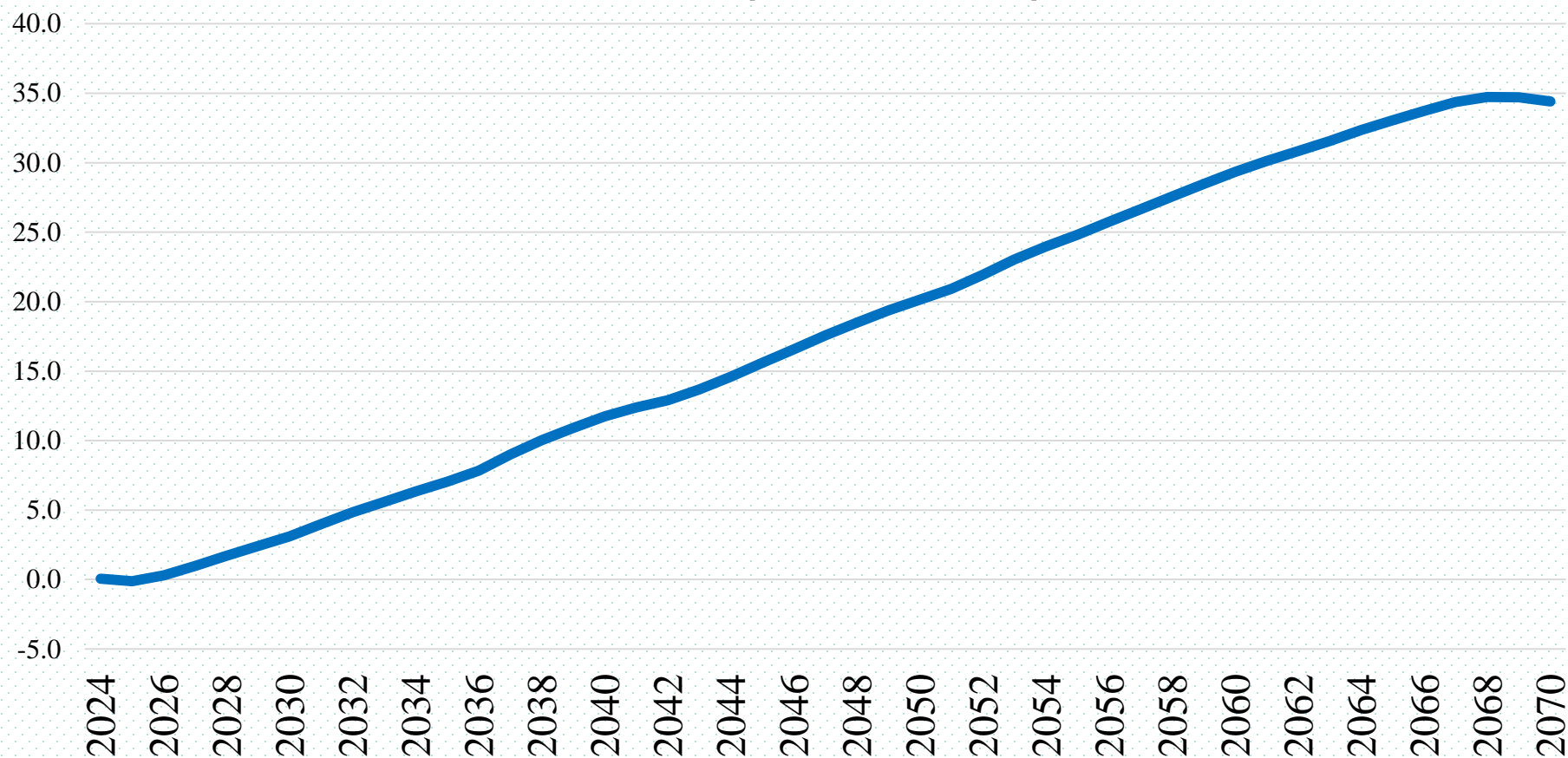
## Selected budget revenues and expenditures in 2070: Ageing scenario – Non-ageing scenario (as % of GDP)



Source: Own estimations.



## Government Debt Gap between Ageing scenario and Non-ageing scenario (as % of GDP)



Source: Own estimations.



# Conclusions

## ➤ Policy recommendations:

- increasing labour force participation
- promoting skill development
- ensuring the sustainability of public finances
- advancing structural reforms that raise productivity

## ➤ Limitations and further work:

- its reliance on historical relationships that may not reflect future technological or policy developments
- uncertainty stemming from assumptions about labour force participation and productivity
- Incorporating of general equilibrium models and fiscal reaction functions



Thank you for the attention!  
Q & A Session

# Other revenues and expenditures



	2007-2019
<b>Gov Revenue</b>	35.0
Corporate income tax	2.2
Personal income tax	3.0
Value added tax	9.0
Excises	5.0
Custom duties	0.2
Social security contributions	7.6
Other taxes	1.0
Non-tax revenue	4.6
Grants	2.4
<b>Gov Expenditures</b>	35.6
Government wages	6.2
Government social security contributions	1.5
Scholarships	0.1
Maintenance	4.6
Subsidies	1.9
Membership fees	0.1
Interest expenditure	0.7
Pensions	8.8
Benefits	5.5
- Health Care Benefits (transfers in kind)	3.0
- Unemployments benefits	0.4
- Other transfers in cash	2.2
Capital spending	5.1
Other expenditure	0.0
Contribution to the EU budget	1.0

# The impact on fiscal sustainability (3)



## ➤ Pension expenditures approach

$$\frac{\text{pension expenditure}}{\text{GDP}} = \frac{\text{dependency ratio}}{\text{population } 20-64} \times \frac{\text{coverage ratio}}{\text{population } 65+} \times \frac{\text{benefit ratio}}{\frac{\text{GDP}}{\text{hours worked } 20-74}} \times \frac{\text{labour market effect}}{\text{hours worked } 20-74}$$

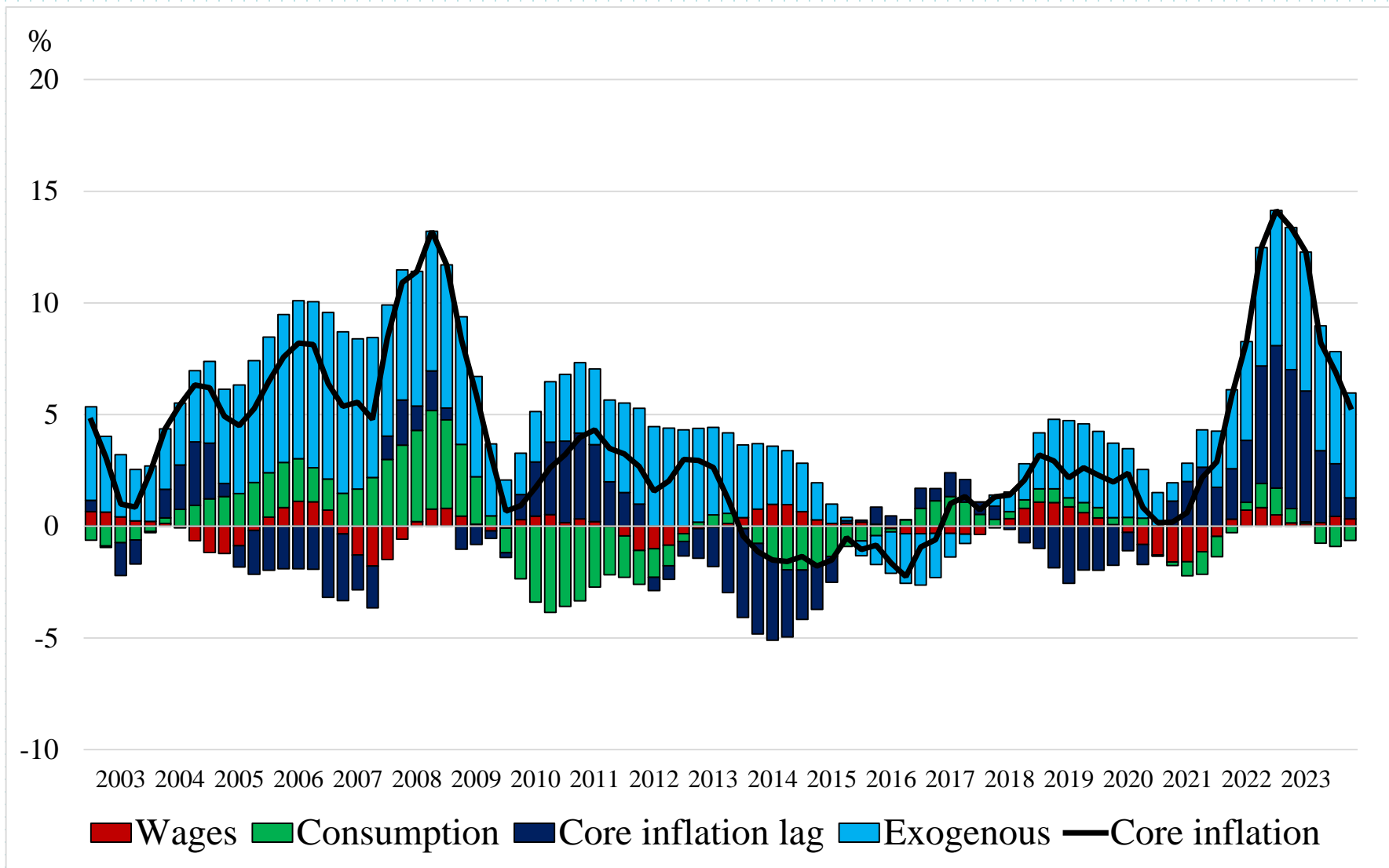
The equation is annotated with four terms above the fractions, each with a downward arrow pointing to its corresponding fraction:

- dependency ratio* points to  $\frac{\text{population } 65+}{\text{population } 20-64}$
- coverage ratio* points to  $\frac{\text{number of pensioners}}{\text{population } 65+}$
- benefit ratio* points to  $\frac{\text{average pension income}}{\frac{\text{GDP}}{\text{hours worked } 20-74}}$
- labour market effect* points to  $\frac{\text{population } 20-64}{\text{hours worked } 20-74}$

## ➤ Healthcare expenditures approach

*Health exp. = Share of Health exp. by age groups \* Wage growth \* Population by age groups*

# Historical decomposition



# Wage ratios by age, sex and education



Age group	16-24	25-34	35-44	45-54	55-64	65-74
<b>Female</b>						
<i>Low</i>	1.0	1.4	1.8	1.8	1.8	1.7
<i>Medium</i>	1.9	2.4	2.5	2.7	2.6	2.3
<i>High</i>	2.5	3.8	5.5	5.8	5.3	3.1
<b>Male</b>						
Female						
<i>Low</i>	1.4	2.1	2.1	2.4	2.1	2.0
<i>Medium</i>	2.1	3.1	3.8	3.5	2.9	2.3
<i>High</i>	2.6	5.8	9.2	8.1	6.1	6.7

Source: Own estimates based on EU-SILC micro data for 2018.