Assessing the role of ageing feminizing & better-educated workforces on TFP growth

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Main objective= assess impact of:

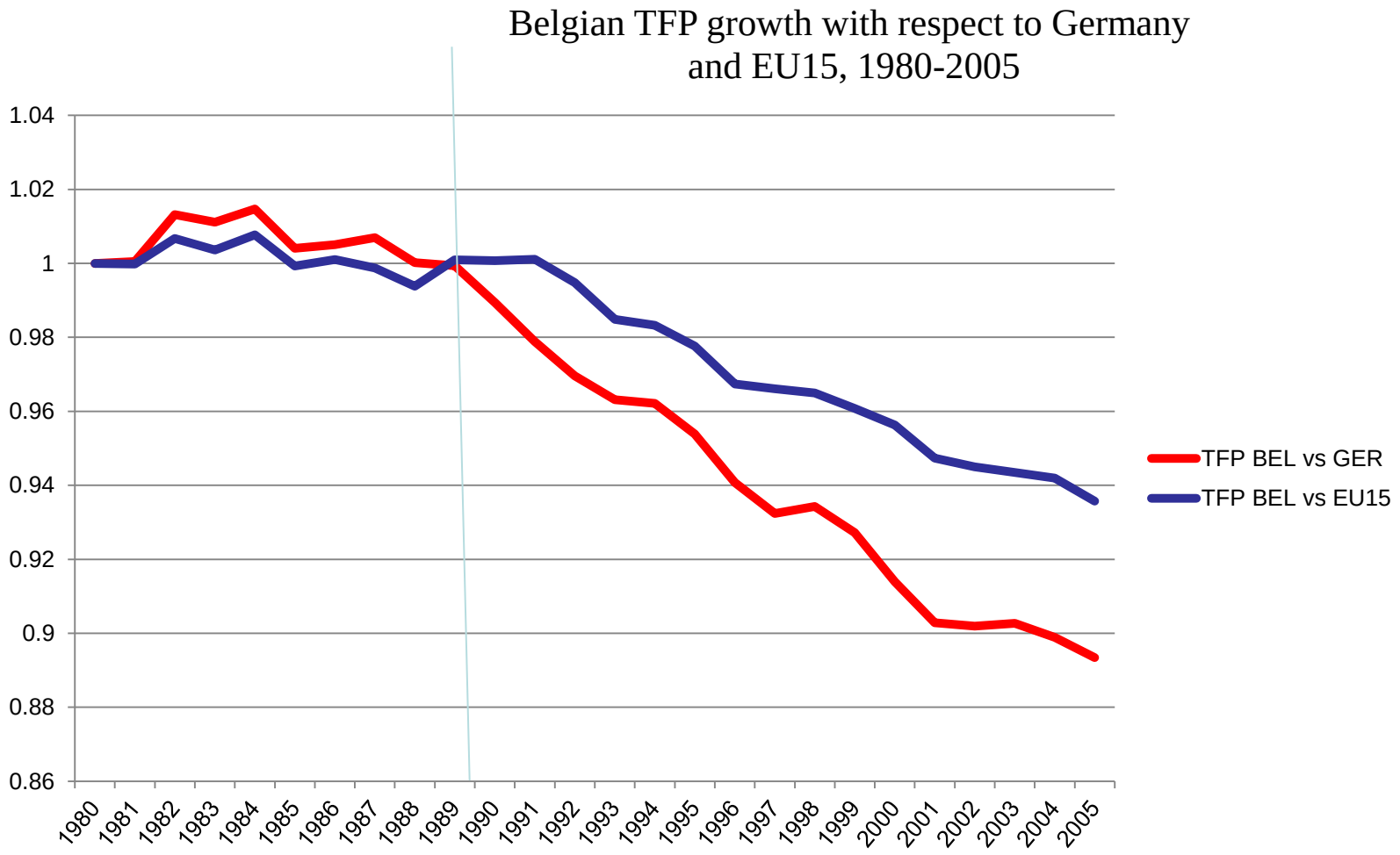
- Ageing
- Feminisation
- Rising educational attainment

on TFP growth rate at the level of the firm

Secondary objective quantify/simulate the likely impact of socio-demographic changes on Belgium's overall TPF growth, retrospectively (1990-today) and prospetively (today-2040) using demographic & employment data/projections

Motivation

Belgium has experienced a decrease in TFP growth (Biatour et al., 2011)



Age

- the share of workers aged 50 and more increased from 18% in 1980 to 21% in 2005
- the share of workers with less than 35 years decreased from more than 30% in 1980 to about 20% in 2005 (Statbel)

Gender

- The share of older women almost doubled passing from more than 3% in 1980 to 6% in 2005 (EU-KLEMS)

Education

- the share of 2-year-college-educated workers has increased from 17.9% to 19.2% (2002-2011)
- university-educated employees from 7.4% to 8% (Vandenberghe & Lebedinski, 2013)

Contribution

- **Firm-level perspective on TFP growth**

- **Negative effect of age (**BELGIUM/ Lallemand & Rycx, 2009; Cataldi, A., S. Kampelmann & F. Rycx, 2011; Vandenberghe, 2013 ; Vandenberghe, Rigo & Waltenberg, 2012, Vandenberghe, 2011a,b; FRANCE/ Crépon, Deniau & Pérez-Duarte, 2002; USA/ Hellerstein & Neumark, 2007)

- **Gender and Education dimensions of ageing**

- **Focus on TFP rather than on labour productivity or wages**

Analytical framework

Consider a labour-augmented Cobb-Douglas technology

$$Y_{it}=A_{it}\,K_{it}^{\alpha}\,(QL_{it})^{\beta} \qquad [1]$$

with Q_{it} a labour-quality index à la Hellerstein – Neumark (HN), specified as a CES

$$QL_{it}=[\mu_1\,(L_{it}^{1})^{\rho}+\ldots.+\mu_n\,(L_{it}^{n})^{\rho}\,]^{1/\rho} \qquad [2]$$

- L_{itj} , $j=1\ldots n$ labour types (e.g age, gender, blue-vs white collar categories)
- μ_j reflects the (relative) marginal productivity of type j labour
- ρ the CES substitutability parameter
- $A_{it}=A_{i0}\,e^{\tau.t+\omega_{it}}$; with A_{i0} the starting value of firm i's TFP, $e^{\tau.t+\omega_{it}}$ capturing its dynamic
  - τ is the common annual rate of growth;
  - ω_{it} the firm-specifc term, with $\omega_{it}=\Theta_i+\delta_{it}$ containing a fixed effect

Growth specification (T= # year lags)

$$\overbrace{ln\,(Yit/\,Yit_{-T})}^{Output\ growth} = \overbrace{\alpha ln(Kit/Kit_{-T}) + \beta ln(Lit/Lit_{-T})}^{Growth\ in\ use\ of\ inputs} + \overbrace{\tau\,T + \beta/\rho ln(\Omega_{it}/\Omega_{it-T})}^{TFP\ growth} + \omega_{it} - \omega_{it-T} \qquad [3]$$

with

$\Omega_{it} \equiv S_{it}^{r} + \lambda_{1r}[S_{it}^{1}]^{\rho} + \ldots + \lambda_{nr}[S_{it}^{n}]^{\rho}$

$S_{it}^{j} \equiv L_{it}^{j}/L_{it}$ the employment shares $j=1....n$

$\lambda_{jr} \equiv \mu_j/\mu_r$; $j=1....n, j\neq r$; r= ref. cat.

and rel. (marginal) labour productivities (dropping t)

$$\partial Y/\partial L^{j}/\partial Y/\partial L^{r} = \mu_j/\mu_r\,(L^{j}/L^{r})^{\rho-1} = \lambda_{jr}\,(S^{j}/S^{r})^{\rho-1}$$

Data and descriptive statistics

Source 1: Bel-first ($Y_{it,}$ K_{it}…)

- Panel of about 9,000 firms (>20 workers) located in Belgium, from all sectors of the for-profit economy (except agri & mining), from 1998 to 2006
- Info on sector, location, size, capital (K_{it}), labour & value added (Y_{it}), edu. attainment, ownership nationality, multinational status

Source 2: Carrefour database (i.e. social security registers) (S_{it}^{j})

- Individual-level information on age, gender, blue-/white collar status of <u>all</u> workers from Bel-first sample.

- Aggregation of Carrefour data at firm level + merge with Bel-first
- Resulting firm-level panel contains labour shares S_{it}^{j} *;j* ≡*Age X Gender X Blue/White collar* status

NB about educational attainment

- Educational attainment (primary, secondary, tertiary degree) only available at firm-level in Bel-first; while age, gender & blue/while-collar status exists at individual level in Carrefour

- We proxy education using the white/blue collar status and interact it with the two other dimensions

- But we provide evidence that this approximation is reasonable

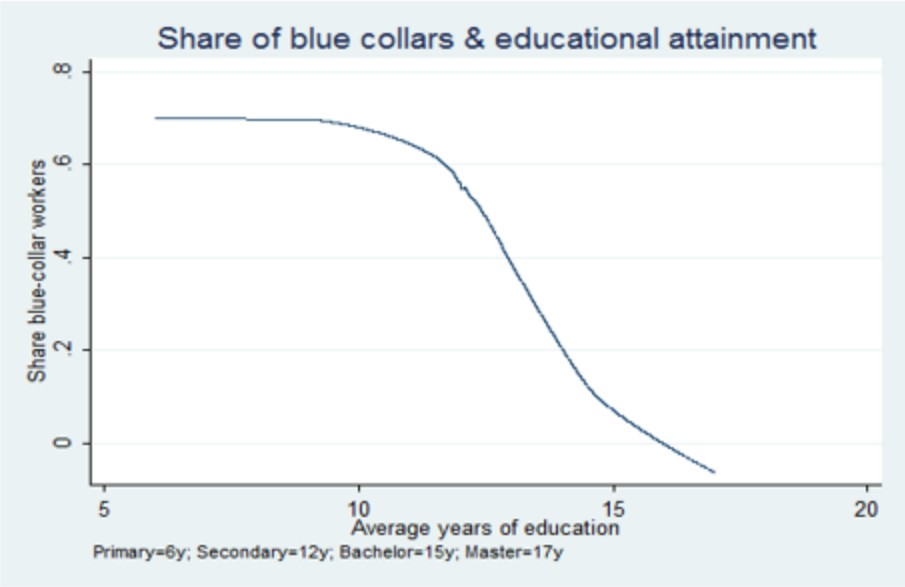
Table 4: Ageing-Feminisation and rising educational attainment

	Age-mean	Share female	Share blue collars	Aver. years education*
1998	36.567	0.249	0.563	11.490
1999	36.609	0.256	0.551	11.562
2000	36.695	0.262	0.541	11.631
2001	36.764	0.271	0.529	11.709
2002	37.336	0.280	0.488	11.769
2003	37.873	0.281	0.482	11.818
2004	38.109	0.284	0.481	11.766
2005	38.363	0.289	0.475	11.816
2006	38.689	0.294	0.465	11.803
N	75,437			

Source: Bel-first; Carrefour. Weight: number of fte (full-time equivalent) workers in the firm.

*Primary degree=6; Secondary degree=12, Bachelor=15 and Master=17 years

Figure 3- Share of blue-collar workers & average educational attainment. Year 2006.



Source: Bel-first; Carrefour. Weight: number of fte workers in the firm. Based on lowess estimation i.e. locally weighted regression of *y* on *x*.

Econometric results

AGE

Table 5 - Econometric analysis of the role of age(ing) on & TPF level and growth- 7 age groups:<30,30-35,35-40[ref],40-45,45-50,50-55,55-65

	[1] Level	[2] Growth(FE)	[3] Growth(FE)+ controls	[4] Growth(FE)+ controls incl. cohorts	[5] Growth(FE)+ controls incl. cohorts/2steps LP
Cst	4.110***	0.0377***	0.0280***	0.0488**	0.0684***
	(0.0266)	(0.00115)	(0.00400)	(0.0180)	(0.0199)
α	0.112***	0.0317***	0.0423***	0.0423**	
	(0.00119)	(0.00271)	(0.00313)	(0.0148)	
β	0.908***	0.638***	0.574***	0.571***	0.273***
	(0.00250)	(0.00487)	(0.00583)	(0.0244)	(0.0677)
ρ	1.054***	0.792***	0.794***	0.790***	0.540***
	(0.0163)	(0.0128)	(0.0169)	(0.0383)	(0.0710)
$\eta_{<30}$ (a)	-0.599***	0.079**	0.217***	0.187**	0.263*
η_{30-34}	0.209***	-0.026	0.010	-0.013	-0.087
η_{40-44}	-0.212***	-0.144***	-0.066	-0.039	-0.140
η_{45-49}	-0.537***	-0.237***	-0.116**	-0.057	-0.210*
η_{50-54}	-0.566***	-0.360***	-0.318***	-0.236***	-0.436***
η_{54-64}	-0.143***	-0.376**	-0.396***	-0.277**	-0.580***
Controls	Year*Sector	Firm fixed effects	Firm fixed effects+ Share of women, blue-collar wks	Firm fixed effects+ Share of women, blue-collar wks + cohort	Firm fixed effects+ Share of women, blue-collar wks + cohort
Nobs	75,437	65,750	48,777	48,777	48,076
$\sigma \equiv 1/(1-\rho)$	-18.643	4.810	4.865	4.751	2.172
Implied relative marginal productivities (1=35-39 ref)					
$RMP_{<30}$	0.403	1.014	1.151	1.121	1.156
RMP_{30-34}	1.192	0.982	1.025	1.002	0.965
RMP_{35-39}	1(ref)	1(ref)	1(ref)	1(ref)	1(ref)
RMP_{40-44}	0.771	0.880	0.954	0.983	0.923
RMP_{45-50}	0.449	0.812	0.935	0.999	0.920
RMP_{50-55}	0.417	0.701	0.744	0.835	0.704
RMP_{55-65}	0.814	0.699	0.674	0.809	0.554

Standard errors in parentheses All models are estimated using non linear least squares, with standard errors robust to firm-level clustering. Source: Bel-first; Carrefour * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

(a): $\eta \equiv \lambda - 1$

AGE
X
GENDER

Table 6 - Age-gender & TFP growth- 7 age groups:<30,30-34,35-39,40-44,45-49,50-54,55-64

	[3] Growth(FE) + controls		
Cst	0.0713***		
	(0.0177)		
α	0.0266***		
	(0.00517)		
β	0.515***		
	(0.0272)		
ρ	0.774***		
	(0.0335)		
	Women	Men	Prob η_j W=M
$\eta_{<30}$ (a)	-0.112	0.181**	0.001***
η_{30-34}	-0.170	-0.048	0.242
η_{35-39}	-0.240	0 (ref)	0.048**
η_{40-44}	-0.246**	-0.048	0.064*
η_{45-49}	-0.218*	-0.149*	0.591
η_{50-54}	-0.239**	-0.248***	0.950
η_{55-64}	-0.432***	-0.202*	0.290
Controls	Firm fixed effects+ Share of part-time workers, blue-collar wks		
Nobs	40,969		
$\sigma \equiv 1/(1-\rho)$	4.432		
	Implied relative marginal productivities (1=35-39 ref)		
$RMP_{<30}$	0.925	1.117	
RMP_{30-34}	0.905	0.975	
RMP_{35-39}	0.835	1 (ref)	
RMP_{40-44}	0.833	0.970	
RMP_{45-49}	0.875	0.896	
RMP_{50-54}	0.868	0.814	
RMP_{55-64}	0.654	0.883	

Standard errors in parentheses. All models are estimated using non-linear least squares, with standard errors robust to firm-level clustering. Source: Bel-first 1998-2006; Carrefour. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

(a): $\eta \equiv \lambda - 1$

AGE x Blue vs white collars

Table 10 – Age, blue/white collar status & TPF growth- 7 age groups:<30,30-35,35-40,40-45,45-50,50-55,55-65

	Growth(FE) + cohorts		
Cst	0.0826***		
	(0.0189)		
α	0.0250***		
	(0.00590)		
β	0.560***		
	(0.0248)		
ρ	0.856***		
	(0.0319)		
	Blue collars	White collars	Prob η_j blue=white
$\eta_{<30}$ (a)	0.019	-0.101	0.238
η_{30-34}	-0.119	-0.110	0.928
η_{35-40}	-0.081	0 (ref)	0.395
η_{45-49}	-0.213**	-0.236**	0.814
η_{50-54}	-0.331***	-0.282***	0.681
η_{54-64}	-0.391***	-0.479***	0.524
η_{54-64}	-0.275*	-0.604**	0.065*
Controls	Firm fixed effects+ Share of part-time workers, blue-collar wks		
Nobs	47830		
$\sigma \equiv 1/(1-\rho)$	6.947		
Implied relative marginal productivities (1=35-39 ref)			
$RMP_{<30}$	0.903	0.873	
RMP_{30-34}	0.824	0.888	
RMP_{40-44}	0.850	1 (ref)	
RMP_{45-50}	0.732	0.781	
RMP_{50-55}	0.633	0.752	
RMP_{55-65}	0.591	0.551	
$RMP_{<30}$	0.729	0.418	

Standard errors in parentheses. All models are estimated using non-linear least squares, with standard errors robust to firm-level clustering. Source: Bel-first 1998-2006; Carrefour. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

(a): $\eta \equiv \lambda - 1$

AGE x GENDER X Blue/White collars

Table 8 - Age (<30,30-49,50-64), gender, blue/white collar status & TFP growth

	[3] Growth(FE) + controls
Cst	0.0814***
	(0.0168)
α	0.0255***
	(0.00575)
β	0.564***
	(0.0240)
ρ	0.861***
	(0.0317)

	Blue collars			White collars			Prob η_j Blue=White	
	Women	Men	Prob η_j W=M	Women	Men	Prob η_j W=M	M	W
$\eta_{<30}$ (a)	-0.076	0.045	0.241	-0.201	-0.019	0.110	0.502	0.349
η_{30-49}	-0.276*	0.009	0.067*	-0.187	0 (ref)	0.184	0.927	0.610
η_{50-64}	-0.354**	-0.207*	0.455	-0.489***	-0.335**	0.458	0.431	0.553
Controls	Firm fixed effects+ Share of part-time workers							
Nobs	50,398							
$\sigma \equiv 1/(1-\rho)$	7.180							

Implied relative marginal productivities (1=30-49 white collar man ref)

	Blue collars		White collars	
	Women	Men	Women	Men
$RMP_{<30}$	0.904	0.933	0.814	1.003
RMP_{30-49}	0.718	0.891	0.847	1 (ref)
RMP_{50-64}	0.681	0.775	0.559	0.715

Standard errors in parentheses

All models are estimated using non-linear least squares, with standard errors robust to firm-level clustering.

Source: Bel-first; Carrefour 1998-2006

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

(a): $\eta \equiv \lambda - 1$

To sum up

- Strong (negative) effect of age on TFP growth
- No statistically significant additional impact of:
  - gender
  - blue-collar status → education does not counterbalance the negative effect of ageing

Additional results:

- Industry (service VS manufacturing) : age-related decline of productivity is slightly more pronounced in manufacturing
- Region (VL, W, Bxl) : no differential effect
- Foreign Ownership : no differential effect
- Multinational Status: no differential effect

Estimating the overall impact of ageing on TFP growth …

1990-2040

i) Strategy & data

The key idea is to use

- estimated $\hat{\lambda}$'s, $\hat{\beta}$ and $\hat{\rho}$ (stemming from the estimation of model [3] using 1998-2006 firm-level data)
- alongside observed + projected values of the labour shares by age S_t^j,

to compute

$$\textit{Annual TFP growth loss} = \hat{\beta}/\hat{\rho}\ ln\ (\Omega_t\ /\Omega_{t-1}) \qquad [4]$$

$$\text{with } \Omega_t \equiv [S_t^r]^{\hat{\rho}} + \hat{\lambda}_{1r}\,[S_t^1]^{\hat{\rho}} \ldots + \hat{\lambda}_{nr}\,[S_t^n]^{\hat{\rho}}$$

NB : we drop firm index *i* as we no longer work with firm-level Bel-first data

Table 5 - Econometric analysis of the role of age(ing) on & TPF leve

34,35-39[ref],40-44,45-49,50-54,5

	[1] Level	[2] Growth(FE)	[3] Growth(FE)+ controls
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α	0.112***	0.0317***	0.0423***
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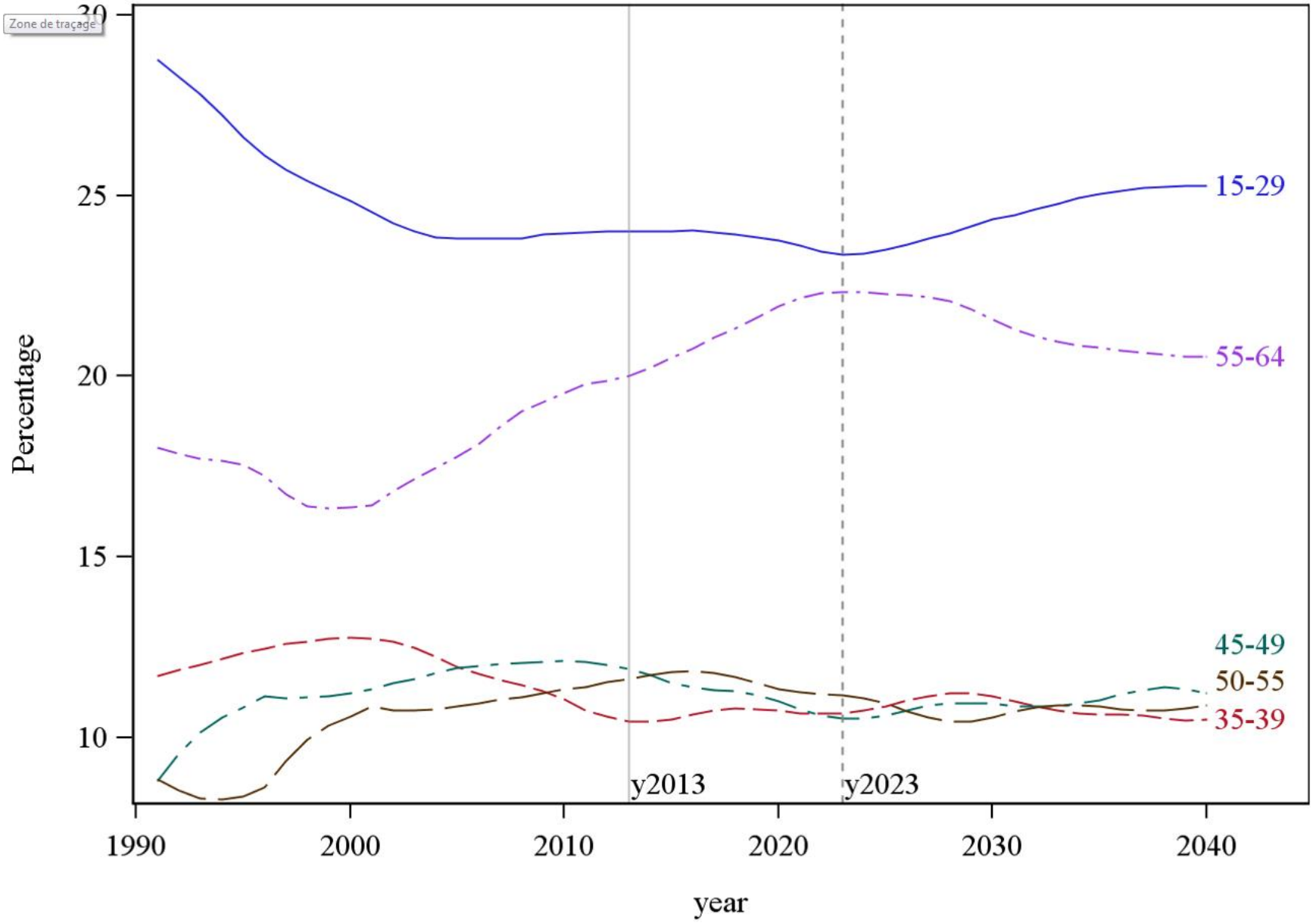
η_{55-64}	-0.143***	-0.376**	-0.396***

(a): $\eta \equiv \lambda - 1$

ii) Evolution population shares by age



Source: INS 2014, population perspectives 2013-2060

iii) From population shares to employment shares

This said, demographics (P_t^j) is only one part of the full story. What matters are employment shares (S_t^j), driven by (relative) employment rates (ER_t^j)

$$S_t^j = (ER_t^j / ER_t) P_t^j \qquad [5]$$

- For the period 1991-2013, employment shares are known
- Beyond 2013, assumptions about employment rates ER_t^j are needed

S 1= we freeze employment rates (ER_t^j) to their 2013 levels

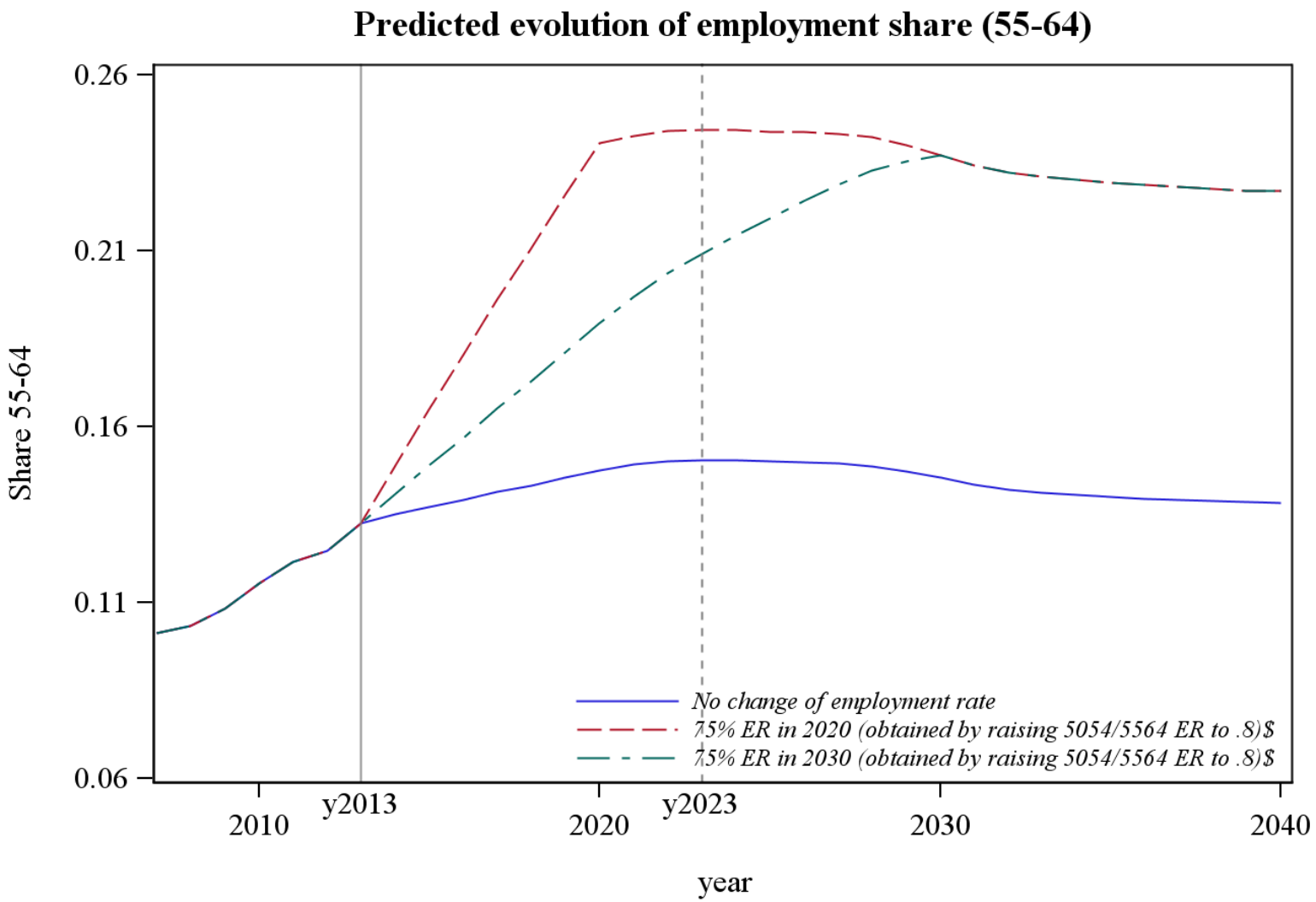
S 2= EU target of a 75% overall employment rate, in 2020

S 3= EU target of a 75% ----------in 2030

Table 12: Hypothesis about evolution of employment rates by age (2014-2040)

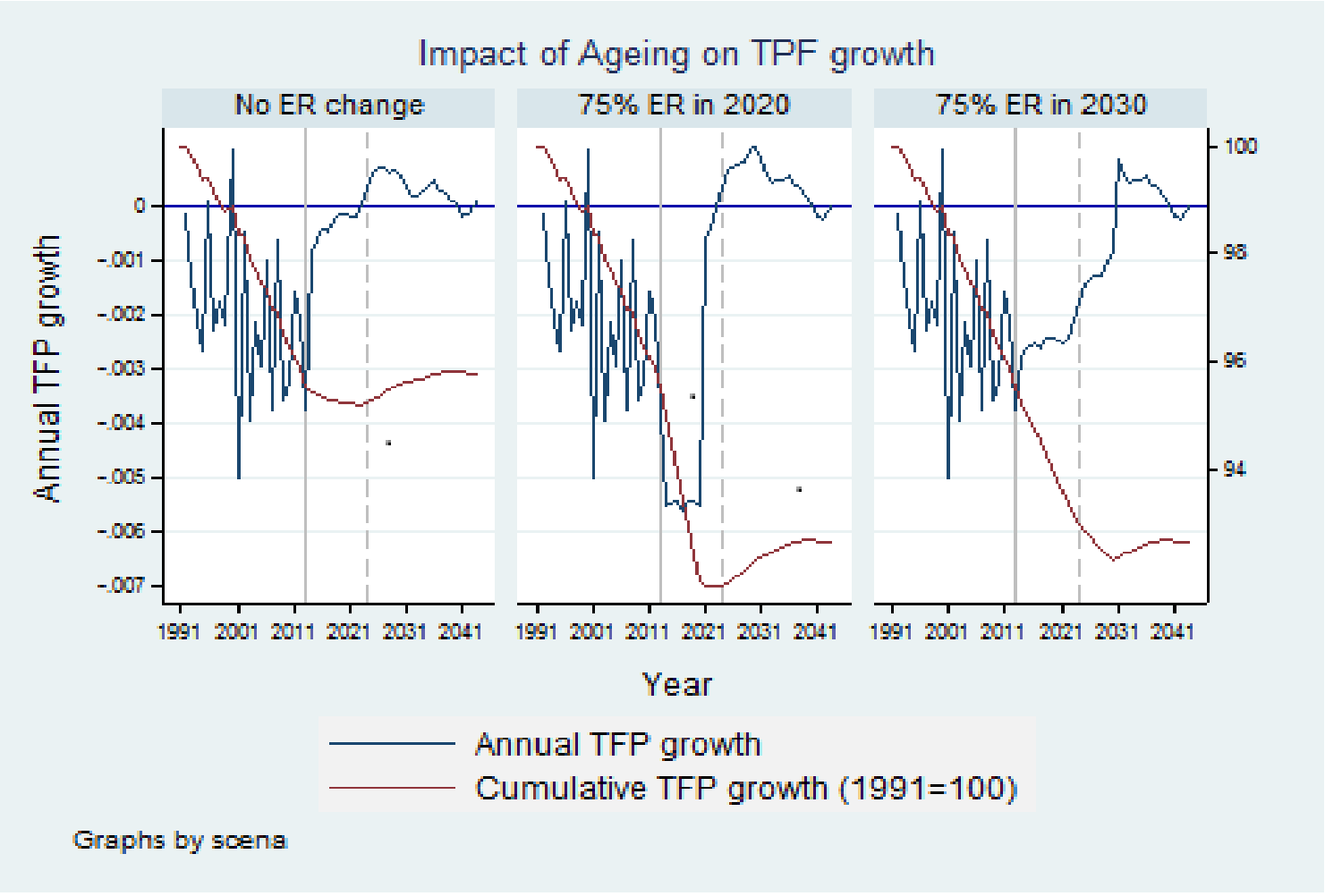
Scenario 1	<30	30-34	35-39	40-44	45-49	50-54	55-64
2013	.414	.803	.815	.817	.805	.751	.417
2020	.414	.803	.815	.817	.805	.751	.420
2030	.414	.803	.815	.817	.805	.751	.420
2040	.414	.803	.815	.817	.805	.751	.420
Scenario 2							
2013	.414	.803	.815	.817	.805	.751	.417
2020	.414	.850	.850	.850	.850	.800	.800
2030	.414	.850	.850	.850	.850	.800	.800
2040	.414	.850	.850	.850	.850	.800	.800
Scenario 3							
2013	.414	.803	.815	.817	.805	.751	.417
2020	.414	.822	.829	.831	.824	.771	.576
2030	.414	.850	.850	.850	.850	.800	.800
2040	.414	.850	.850	.850	.850	.800	.800

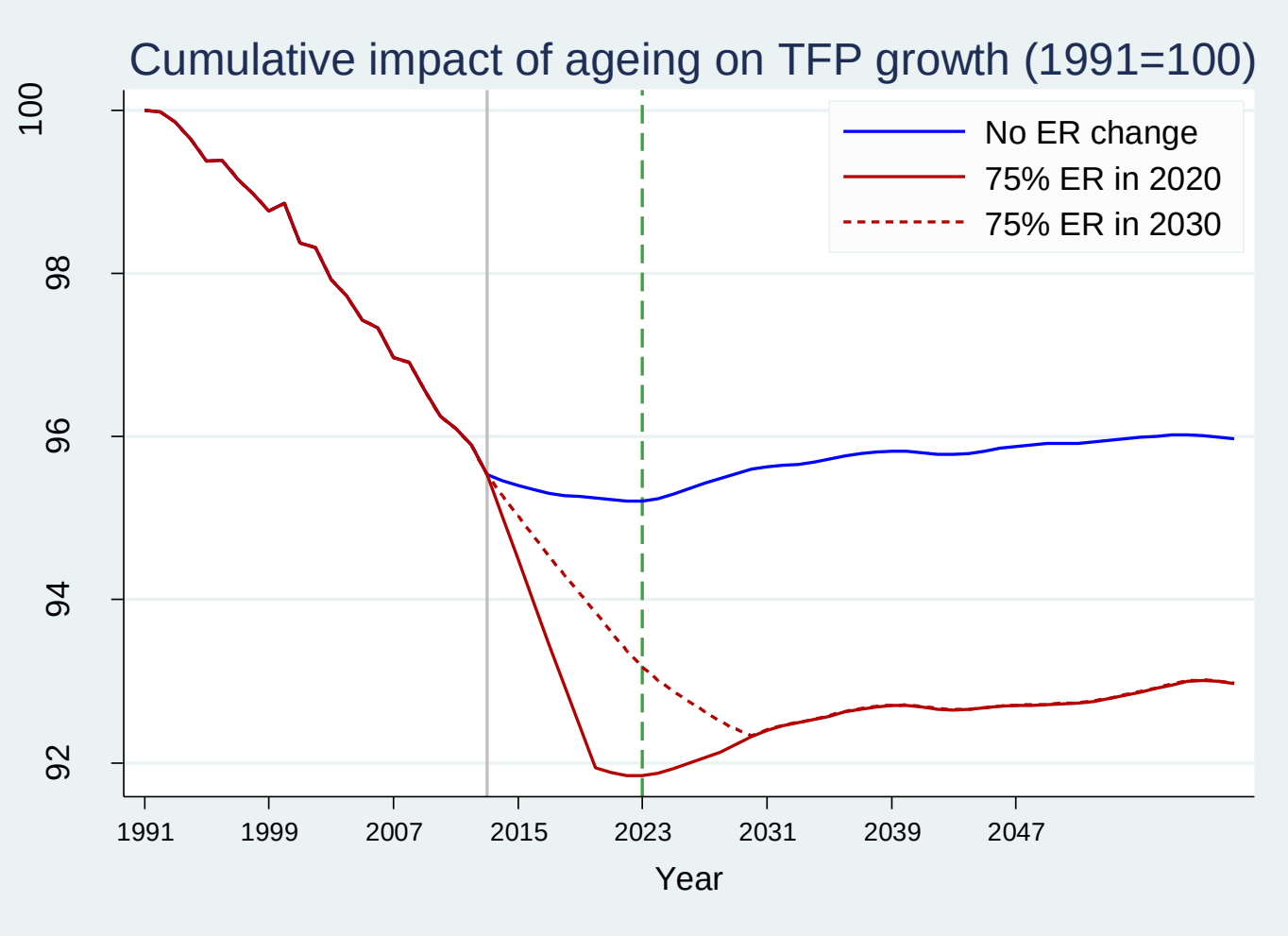
Source: OECD-LFS, our calculus



$:EU2020 target of 75% of the 20-64 year-olds to be employed
Source: INS 2014, Population Perspectives 2013-2060, OECD, Eurostat. Our calculs

Figure 7a,b – Impact of ageing on annual and cumulative TFP growth: 1991-2040, three scenari




Cumulative impact of ageing on TFP growth (1991=100)
100
98
96
94
92
No ER change
75% ER in 2020
75% ER in 2030
1991
1999
2007
2015
2023
2031
2039
2047
Year

Conclusions

This paper examines the role of socio-demographic changes in the composition of the workforce on TFP growth

- Ageing workforce
- Feminization of ageing
- Increased educational attainment of older workers.

Using data on Belgian firms (1998-2006), we find evidence that the TFP growth slowdown could have been driven by ageing

- But no gender bias
- And no sign that rising educational attainment could counterbalance ageing
- The impact of ageing uniform across industries, regions & degrees of international exposure

Combining firm-level results & country-level demographic/ employment data, we estimate that

- over the 1991-2013 period, ageing may have dented cumulative TPF growth by -4.5 percentage points.
- that loss could rise to -7 percentage points by 2030

The latter is not so much dictated by Belgium's demography (peak of ageing workforce = mid-2020s)…

Rather by the EU target of 75% overall employment rate. Reaching that target by 2020/2030 will require a sharp rise of the 55-64 employment rate

Thank you!

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