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Giuseppe Ferrero, Marco Gross, Stefano Neri

On secular stagnation and low interest rates: demography matters

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Abstract

Nominal and real interest rates in advanced economies have been decreasing since the mid-1980s and reached historical low levels in the aftermath of the global financial crisis. Understanding why interest rates have fallen is essential for both monetary policy and financial stability. This paper focuses on one of the factors that have been put forward in the literature within the secular stagnation view: adverse demographic developments. The main conclusion that we draw from our empirical, panel equation system-based assessment is that these developments have exerted downward pressures on real short- and long-term interest rates in the euro area over the past decade. Moreover, building on the European Commission projections for dependency ratios until 2025, we illustrate that the foreseen structural change in terms of age structure of the population may dampen economic growth and continue exerting downward pressure on real interest rates also in the future.

Keywords: Secular stagnation; demographic developments; real interest rates; monetary policy.

JEL classification: C32; E52; J11.

Non-technical summary

Nominal and real interest rates have been decreasing since the mid-1980s and have reached historical low levels in the aftermath of the global financial crisis. Understanding why interest rates have fallen is essential for both the conduct of monetary policy and the assessment of the risks to financial stability. The ability of central banks to preserve price stability and keep output at its potential in the future will be conditioned by the level of the natural or equilibrium interest rate.

Against this backdrop, we focus in this paper on one specific factor that has been put forward within the debate on the secular stagnation as a source of the declining trend of interest rates: adverse demographic developments. The demographic structure in many European countries has developed adversely according to various indicators already over the past one to two decades, and the adverse trends are expected to turn even more adversely over the coming decade.

The empirical model that we develop for the euro area countries (a dynamic panel model) reveals an economically important role for demographic structure to shape the outcome of macroeconomic aggregate dynamics. We conduct a backward-looking counterfactual scenario analysis by assuming that dependency ratios (the ratio of old and young to the working age population) behave more favorably than they did over the 10-year period from 2006-15. In addition, we present a forward-looking counterfactual assessment, assuming that the dependency ratios move in line with the quite adverse projections by the European Commission (EC), along with more favorable alternative assumptions over the 2016-25 period. In both cases, the counterfactual projections suggest an economically and statistically relevant role for demography. Interest rates would have been higher and economic activity growth measures stronger under the assumed more favorable historical demographic assumptions. Concerning the forward-looking assessment, interest rates would remain at relatively low levels under the assumption that demography develops as projected by the EC, and would rise visibly only under the assumed more favorable forward paths for dependency ratios.

The findings concerning the role of demographics imply a clear role for structural, fiscal policy measures that encourage later retirement and promote innovation and investment in R&D. Such policies would be necessary in order to limit the negative impact of ageing on long-term growth prospects. They may, however, take an extended period of time to exert their impact as time lags for policies to affect demographic structures are naturally relatively long, spanning up to several decades.

1 Introduction

> Demographic shifts, in particular the increase in life expectancy, can go a long way in explaining the decline in real interest rate over the past couple of decades. This is quite likely to be the main explanation for the sharp increase in house prices over the past couple of decades. This trend endangers the possibility for monetary policy to achieve full employment [...]. (Axel Gottfries and Coen Teulings, VoxEU, 30 January 2015)

Nominal and real short- and long-term interest rates have been decreasing since the mid-1980s and reached historical low levels in the aftermath of the global financial crisis. Understanding why interest rates have fallen is essential for both monetary policy and financial stability. To the extent that nominal and real interest rates are low in normal times, monetary policy may be constrained by the presence of the effective lower bound (ELB) of policy rates, potentially limiting the ability of the central bank to preserve price stability in the aftermath of a recessionary shock (Kiley and Roberts (2017)). This is, indeed, one of the lessons of the last decade: the probability of hitting the ELB of policy rates is higher than previously thought, as the real rate required for equating the supply and the demand for funds when output is at its potential, unemployment is at its natural level and inflation is on target, has declined (Holston et al. (2017), Cúrdia et al. (2015) and Christensen and Rudebusch (2017)). Low nominal and real interest rates may also pose risks to financial stability, reducing financial institutions' profitability and resilience, raising the likelihood of bubbles and potentially leading to excessive risk-taking by investors.

Two explanations for the persistent decline of interest rates have been put forward in the literature: one relying on financial-cyclical factors, the other one on changes in the structure and the functioning of the economy (Ferrero and Neri (2017)). According to Borio (2012) and Lo and Rogoff (2015) during the "Great Moderation", financial deregulation, excessively expansionary monetary policies and overly optimistic expectations about future returns have favored an excessive increase in the supply of funds, a compression of risk premia and a reduction of interest rates; the sharp correction in the financial cycle occurred with the outbreak of the financial crisis, followed by a persistent contraction in aggregate demand and an increase in the demand for safe assets, have led to a further reduction in interest rates. Looking forward, interest rates will remain low for an extensive period of time; however, as the deleveraging process ends and expansionary monetary policies are phased out, interest rates will increase from their current low levels.

Summers (2014), Eggertsson and Mehrotra (2014) and Gordon (2016) examine the role of structural economic changes that have led to a persistent imbalance between demand for investment and supply of savings, and to the consequent reduction in equilibrium real interest rates. A number of demand and supply factors, all characterized by a high degree of persistence, have been considered in the literature: adverse demographic developments, a falling (relative) price of investment goods, lower pace of technological innovation, rise in savings rates and scarcity of safe assets, increasing wealth and income inequality. According to this view, the global financial crisis added further downward pressure on real interest rates. Looking forward, structural factors would continue to keep real interest rates low for a long time, even after the effects of the crises fade away. While technological progress is very difficult to predict, demographic developments are very persistent and more predictable.

The high persistence of demographic factors makes them particularly relevant from a monetary policy and financial stability perspective, to the extent that they affect medium-term trends in nominal and real interest rates. However, only few papers have empirically assessed the role of demographic factors on real interest rates. Aksoy et al. (2016) examine the effects of changes in the demographic structure on macroeconomic trends using a panel VAR for the OECD economies; Favero and Galasso (2016), using a panel regression, conclude that demographic trends in Europe do not support empirically the secular stagnation hypothesis; Carvalho et al. (2016) and Gagnon et al. (2016) develop and calibrate a life-cycle model to assess the impact of demographic changes on the short-term real interest rate in developed economies.

The objective of this paper is to provide new evidence related to the impact of demographics on real interest rates and other macroeconomic variables in the euro area, adopting both a backward- and forward-looking perspective. The empirical analysis is based on a dynamic panel vector autoregressive model, the estimates of which suggest that an increase in dependency ratios, which results from the aging of the population, and a decrease in population growth have a clear potential to push nominal and real interest rates downward. The policy implication is that in advanced economies the ability of central banks to preserve price stability and keep output at its potential could be impaired to an extent by the decline in the natural rate of interest, over which slow-moving factors such as demographic ones may have a significant impact.

The paper is organized as follows. Section 2 discusses the long-term trends in nominal and real rates. Section 3 presents the explanations put forward in the literature. Section 4 presents the empirical model and the backward- and forward-looking counterfactual assessment. Section 5 concludes the paper, by highlighting the implications for monetary policy.

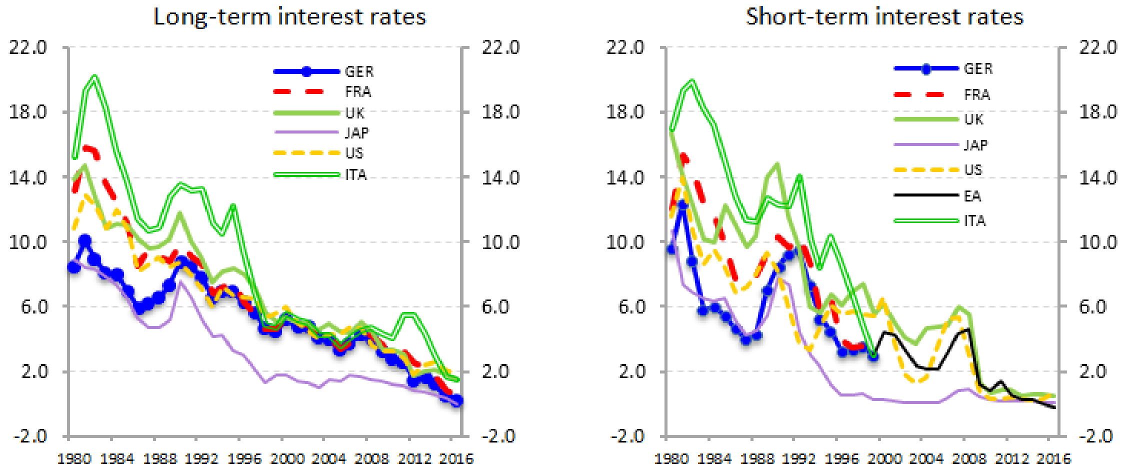
2 Stylized facts on nominal and real interest rates

The current macroeconomic environment is characterized by exceptionally low nominal rates in advanced economies. The decline of long- and short-term nominal interest rates started in the mid-1980s (Figure 1, panels a and b), as part of a global phenomenon and coincided with a decline of real interest rates, a strong and persistent reduction of inflation and a period of low macroeconomic volatility, the so-called "Great Moderation".

The decline accelerated with the outbreak of the global financial crisis. Since late 2008-early 2009, the slack in the economy and protracted low inflation rates contributed to further reducing nominal interest rates, as monetary policies turned very accommodative (Figure 2, left), also by means of unconventional measures. In some countries a strong compression of risk premia and flight to quality phenomena pushed nominal interest rates into negative territory even at long maturities (Figure 2, right).

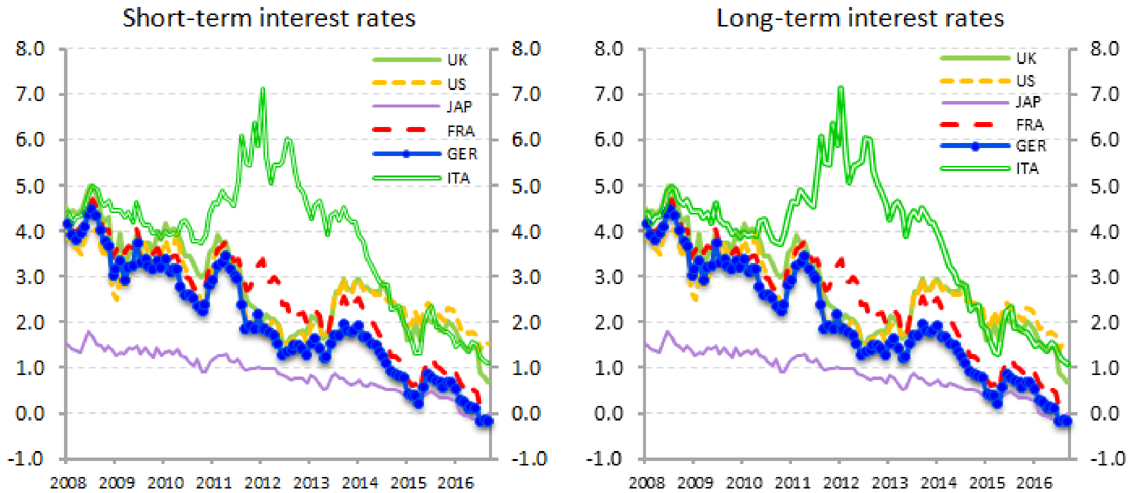
Since mid-2013, long-term interest rates in the euro area have declined at a faster pace than in the

Figure 1: Nominal interest rates in advanced economies: 1980-2016



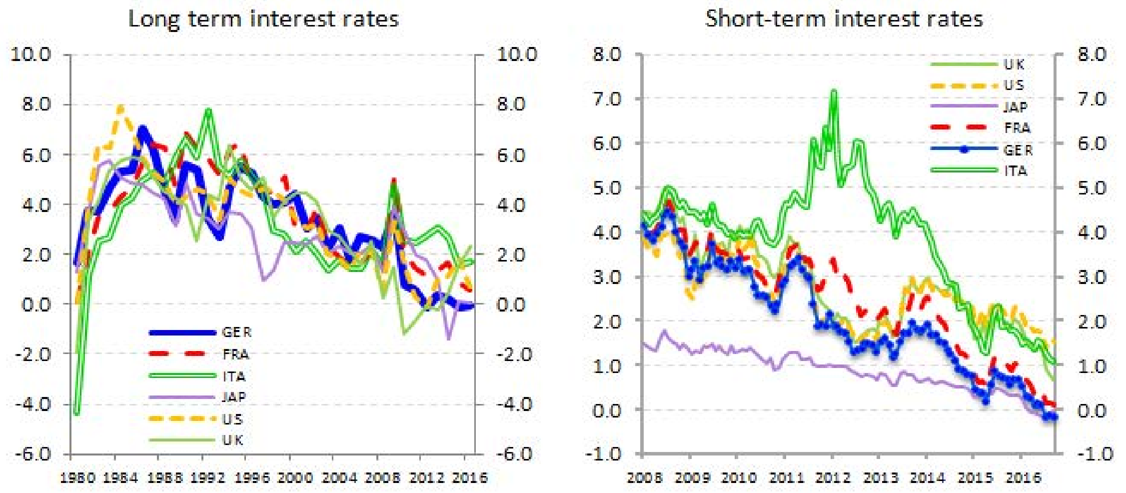
Source: European Commission, AMECO Database.

Figure 2: Nominal interest rates in advanced economies: 2008-2016



Source: Datastream.

Figure 3: Real interest rates in main advanced economies



Source: European Commission, AMECO Database.

U.S. due to the consequences of the sovereign debt crisis and the new measures adopted by the European Central Bank (ECB) to preserve the proper functioning of the monetary transmission mechanism and to provide further monetary accommodation when the policy rates reached the effective lower bound. The decline in short- and long-term interest rates brought about a decline in the financing costs of banks, non-financial corporations, households and governments, which reached historical minima (European System Risk Board (2016).

Real interest rates have been decreasing since the second half of the 1980s (Figure 3). This trend, too, has accelerated with the outbreak of the global financial crisis, and in the euro area after the sovereign debt crisis.

According to some recent analyses (Cúrdia et al. (2015) and Holston et al. (2017)), a similar trend has characterized the evolution of the natural interest rate, which is defined as the real short-term interest rate that keeps output at its potential, unemployment at its natural rate and inflation at the central bank's target. Holston et al. (2017) show that the natural rate of interest decreased in recent years in the main advanced countries, from around 3% in the 1980s to close to zero in the U.S. and to negative values in the euro area. Cúrdia et al. (2015) and Gerali and Neri (2017), using dynamic stochastic general equilibrium models, have shown that the natural rate in the U.S. between 2008 and 2016 has remained well below zero; in the euro area, the natural rate has become negative in the aftermath of the sovereign debt crisis. Being an unobservable variable, however, there is no consensus neither on how to estimate nor on the specific estimates of the natural rate, in particular for the period after the global financial crisis.

The debate about the drivers of the dynamics of real interest rates over the past decades is open and lively especially at the policy-making level.[1] Two views have been put forward in the literature:

[1] See, among others, International Monetary Fund (2014), Bean et al. (2015), Council of Economic Advisers (2015),

the "real/structural" and the "cyclical/financial" views. Among the "real/structural" explanations, the "secular stagnation" is probably the most famous (Summers (2014)). As for the "financial/cyclical" explanation, Borio (2012) and Lo and Rogoff (2015) are two key references.

The two views share some common elements (Borio (2017)). First, they take a long-term perspective. Second, they question the presumption that the economy is always self-equilibrating. Third, they encourage academics and policy-makers to question the prevailing macroeconomic framework and to invest in developing models in which real and financial factors influence each other.

3 Low interest rates: the structural and cyclical views

According to the structural view, advanced economies suffer from a persistent imbalance resulting from an increasing propensity to save and a decreasing propensity to invest; in this context, excessive savings act as a drag on growth and inflation, exerting a downward pressure on real interest rates. This explanation implies that the natural interest rate has structurally declined in the last decades; this would explain why during the Great Moderation period, inflation remained on target even if nominal interest rates were low in historical perspective. The structural view also highlights that after the outbreak of the global financial crisis, the effective lower bound to policy rates has prevented central banks from providing the necessary accommodation through conventional (i.e. interest rate) policies, prompting the adoption of non-standard measures. Looking forward, the structural factors may continue to keep real interest rates low even after the effects of the global financial crisis have completely faded away.

According to the financial cycle view, low real interest rates are consistent both with periods of credit expansion and credit contraction. Periods characterized by deregulation in the financial sector, excessively expansionary monetary policies and overly optimistic expectations of future returns contribute to a large and persistent increase in the supply of funds that allow economies to accumulate excessive (often housing) debt at low interest rates and grow at a sustained pace. As credit increases, asset prices are pushed up, raising their value as collateral, relaxing borrowing constraints and inducing a further increase in credit and asset prices. According to Lo and Rogoff (2015), Borio (2015), Borio (2017), these developments have characterized the main advanced economies between mid-90s and mid-2000s. During periods of growing indebtedness, resources may be allocated towards low productivity growth sectors, notably construction (Borio et al. (2015)), which do not contribute to increasing potential output growth.

When financial shocks hit the economy, both the supply and demand of funds decrease. To counteract the effects on inflation and economic activity, the central bank significantly eases monetary conditions. When expansionary monetary policies begin exerting a positive effect on the supply of funds, however, an extensive need for deleveraging and a high degree of uncertainty about future income dampen investment and consumption, further reducing real interest rates.

The bust in the financial cycle can cause a long-lasting damage to the economy (Reinhart and Reinhart (2010), Jorda et al. (2013) and Mian et al. (2017)). This sharp correction is seen to cause a

Rachel and Smith (2015), Praet (2017) and Williams (2016).

permanent loss in output and a slow and protracted recovery. To some extent, this persistent effect may arise from the fact that in an over-indebted economy, financial institutions may not be in the position to reallocate resources away from the sectors that have been hit by the bust in the financial cycle and the consequent recession.

3.1 Demographic factors and interest rates

Demographic trends affect both the demand and the supply side of the economy. Lower fertility and longer longevity, which lead to a higher old-age dependency ratio, require more savings for old age, unless these are offset by an increase in the retirement age, and may cause a decline in aggregate consumption as a share of income. Population trends also affect investment demand, as lower population growth implies that lower investment is required to maintain a given capital-to-labor ratio, reducing real interest rates. An increasing proportion of elderly people leads to a shrinking working-age population; given the capital stock, this lowers the real rate due to the higher capital intensity. As time goes by, however, the elderly consume their own wealth and reduce their savings, potentially exerting upward pressure on real interest rates.

Several contributions on the role of demographic factors have recently appeared in the literature, conveying different conclusions as to their impact on interest rates. Aksoy et al. (2016) investigate the impact of changes in the demographic structure and show that ageing leads to subdued output growth, higher savings and lower interest rates. Favero et al. (2016) show that the common persistent component of the term structure of interest rates is related to the ratio of middle-aged to young population. Projections based on the estimated model show that real interest rates would remain negative only for the next few years, and then would recover rather than continuing their secular decline. Favero and Galasso (2016) show that interest rates are depressed by increased savings by the middle-aged population, due to longer life expectancy. However, this effect is compensated by longevity, as the longer-living generations of retirees raise aggregate consumption and interest rates. All in all, a change in the age composition of the population measured by the replacement of population between 40 and 59 with the population aged 60 and over, has a negative impact on output and a positive effect on real interest rates.

Carvalho et al. (2016) develop and calibrate a life-cycle model to capture the salient demographic features in developed economies. Demographic trends between 1990 and 2014 reduced, ceteris paribus, the equilibrium interest rate by 1.5 percentage points. Gagnon et al. (2016) develop an overlapping-generation model with a rich demographic structure to assess the impact of the demographic changes occurred in the U.S. since the early 80s on real interest rates and real GDP growth. The model accounts for around one percentage point of the decline in both real GDP growth and the equilibrium real rate and suggests that they may remain low in a "new normal" economy. Ikeda and Saito (2014) develop a model for the Japanese economy and show that an exogenous decline in the ratio of workers to total population causes a reduction in the real interest rate. Backus et al. (2014) assess the persistence of international capital flows (i.e. "global imbalances"), showing that demographic factors could be a factor that is driving these developments. The authors show that among demographic factors, changes in life expectancy can explain much of the pattern of capital flows across countries. These changes are consistent, ceteris paribus, with the pattern of declining interest rates over the past decades.

The relationship between demographic trends and inflation has also been examined in the literature. Juselius and Takats (2015) find evidence of a stable and significant correlation between demography and low-frequency developments in inflation over the period 1955-2010. A larger share of dependents (i.e. young and old) is associated with higher inflation, while a larger share of working age cohorts is associated with lower inflation. Bobeica et al. (2017) have developed a co-integrated VAR to estimate the long-run relationship between inflation and the growth of the working-age population (as a share of total population) in the euro area as a whole, in the U.S. and Germany. The analysis highlights the existence of a positive long-run relationship. This result has important implications for central banks since demographic trends can shape the economic environment in which monetary policy operates. Yoon et al. (2014) analyze the relationship between population dynamics and various macroeconomic variables, including inflation. As for the latter, the empirical analysis suggests that the ongoing demographic changes could have a significant deflationary impact in the years ahead, in particular in those economies which are experiencing a rapid declining and a significant aging of the population.

3.2 Stylized facts on demographic trends

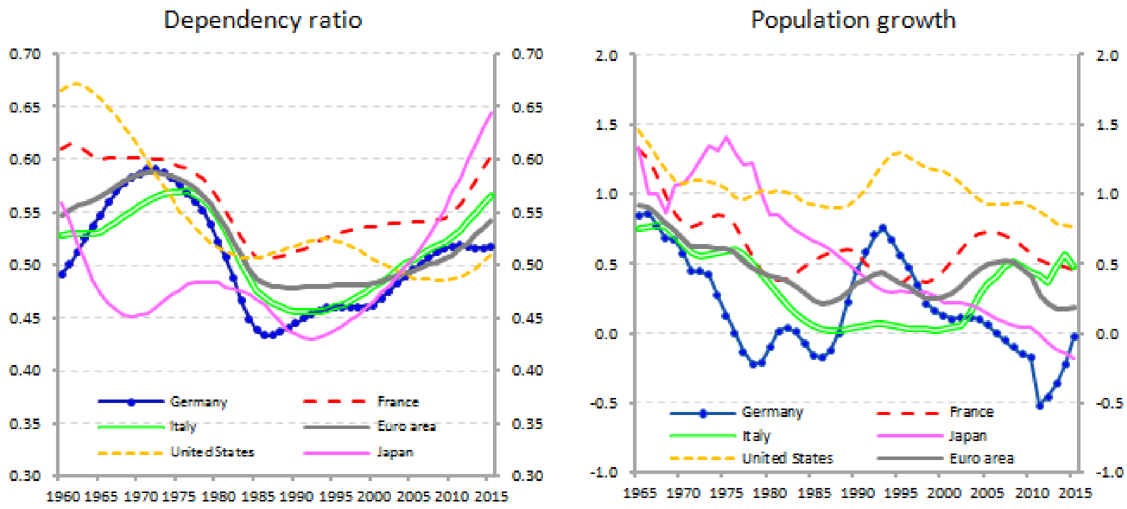
Over the last 45 years there has been considerable increase in dependency ratios – the amount of people at non-working age (0 to 14 and above 65) compared to the number of those at working age (15 to 64) – a key statistic for measuring the degree of aging of a society (Figure 4, left). Population growth has also declined in most economies, although with varying patterns (Figure 4, right). Lower population growth implies that the elderly cohorts increase in size relative to the younger ones. Declining fertility rates, which have fallen sharply after the introduction of the contraceptive pill in developed countries in the early sixties (Figure 5, left), and increased life expectancy have contributed to the aging of the population. Within this generalized trend, Japan is an extreme case: population growth has been slowing down since the mid-1970s and the dependency ratio has reached new historical maxima.

The discovery of the contraceptive pill has led to a strong demographic imbalance in some countries. While in the U.S. the size of cohorts has remained stable over time, the effects of the introduction of the pill on the population pyramid has been strong in countries such as Germany, where total fertility fell from 2.5 in 1967 to 1.4 in 1970 (Gottfries and Teulings (2015) and Lu and Teulings (2016)).

The sharp and persistent decline in fertility rates can be seen as the end point of a global demographic transition that started with the decline in child mortality which led to exceptionally large young age cohorts and an unprecedented growth in population. The decline in fertility, in addition to reflecting the introduction of the pill, could constitute a delayed response to the survival of many children, reinforced by rising income, increased education of women and higher labor force participation by women (Bussolo et al. (2015)).

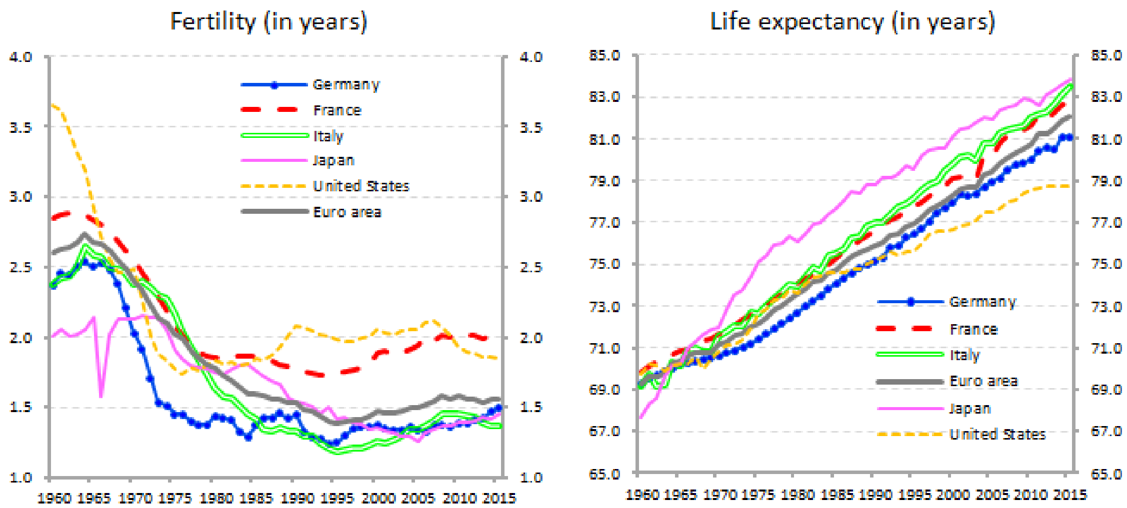
Other factors equal, these demographic trends have led to an increased supply of savings, as workers have to save more to finance their consumption during the retirement period (Lu and Teulings (2016)). For a given demand for investment, this excess saving may have contributed to driving interest rates

Figure 4: Dependency ratios and population growth



Source: European Commission and World Bank Open Data.

Figure 5: Fertility and life expectancy



Source: World Bank Open Data.

down.

In several countries, the population size is expected to decline in the course of the coming four decades (United Nations (2015)). Fertility in all European countries is now below the level required for full replacement of the population in the long run (around 2.1 children per woman, on average); in the majority of the countries, fertility has been below the replacement level for several decades. Fertility in Europe as a whole is projected to increase from 1.6 children per women in 2010-2015 to 1.8 in 2045-2050, but such an increase may not be sufficient to prevent a contraction of the population. Migration could possibly offset these worrying trends to some extent.

As the figures above show, future age composition and growth of the population depend on fertility and longevity. As fertility declines and life expectancy rises, the proportion of the elderly people increases. This population ageing is occurring throughout the world; at the global level, the population aged 60 or over is the most rapidly growing. Europe has the largest percentage of its population at ages 60 or older (24%). In the short- to medium-term, the projected increase of the older population is very likely or even inevitable. These unprecedented developments in demographic trends raise the issue of assessing their impact on growth and real interest rates. Section 4 will shed additional light on this.

4 Empirical analysis

4.1 Model specification

The empirical analysis is based on a dynamic panel vector autoregressive model with 11 endogenous and 2 exogenous variables, containing a sample of 19 euro-area countries and spanning the period from 1990 to 2015. The model has the following form:

$$Y_{it} = \alpha_i + A(L)Y_{i,t-1} + \gamma(L)D_t + \epsilon_{it} \tag{1}$$

where i and t denote, respectively, the country and time dimensions, α_i is a vector of country fixed effects, $A(L)$ are the coefficients of an autoregressive polynomial, D_t denotes the vector of exogenous variables and ϵ_t^i the error term.

The endogenous model variables are potential output growth, real GDP growth, total factor productivity (TFP) growth, investment growth, private consumption growth, GDP deflator inflation, investment deflator inflation, private consumption deflator inflation, changes in unemployment rates and real short-term and long-term interest rates. The two exogenous variables are population growth and the (change in the) total dependency ratio, defined as the share of the population under 15 and over 64 relative to the population aged 15-64. All the data, whose frequency is annual, are taken from the AMECO database of the European Commission. The model equations have up to one lag in terms of autoregressive terms of the left hand-side variables as well as the right hand-side variables. The model has been constrained to some extent, by excluding statistically insignificant relationships resulting after a first, unconstrained estimation of the model. Moreover, there are some time-contemporaneous relationships included, for example with respect to the unemployment rate changes in the TFP equation, the real long- and short-term interest rates in the TFP and unemployment rate equation, and also with respect to the population growth and dependency ratio variable in (almost) all equations. We have tested for the role and significance of the reverse relationships for all but the demographics-related variables, i.e. for instance for whether a contemporaneous relationship from TFP back to unemployment was present and could not find evidence for that; and neither for all other contemporaneous relationships that we allowed except for the demographics variables which we treat as strictly exogenous by assumption. The latter assumption is an important one, which our counterfactual assessment hinges upon.

The choice of focusing on the dependency ratio is motivated by the fact that, under certain conditions, the change in the ratio is a summary statistic for the evolution of the composition of the population (Carvalho et al. (2016)). Consider, for simplicity, workers (w) and retirees (r). Let ω_t be the probability of remaining in the labor force between time $t-1$ and t, and let γ_t be the probability of surviving in the same period if retired. The aggregate labor force (equivalent to total population under our assumptions) evolves according to:

$$N_t^w = (1 - \omega_t + n_t)N_{t-1}^w + \omega_t N_{t-1}^w = (1 + n_t)N_{t-1}^w \tag{2}$$

where n_t is the growth of the labor force. The number of retirees evolves according to:

$$N_t^r = (1 - \omega_t)N_{t-1}^w + \gamma_t N_{t-1}^r \tag{3}$$

Re-arranging the two equations yields the evolution of the dependency ratio $\Psi_t = N_t^r / N_T^w$:

$$\Psi_t = \frac{1 - \omega_t}{1 + n_t} + \frac{\gamma_t}{1 + n_t}\Psi_{t-1} \tag{4}$$

which describes the evolution of the age composition of the population. An increase in life expectancy (higher γ_t), a decrease in fertility rates (lower n_t) raise the dependency ratio or a decrease in the probability of remaining in the labor force.[2] In this sense, the simulations in which we condition on the evolution of the dependency ratio can be rationalized in terms of past developments in life expectancy and fertility rates.

We have employed an LSDVC estimator (Kiviet (1995) and Bruno (2005)) to estimate the model, to thereby account for the presence of the autoregressive lags in the equations which would—if not reflected in the estimation method—have the potential to bias the estimates.[3] All model variables were normalized by their historical standard deviations prior to the estimation. The rationale for using

[2] An increase in the retirement age that would offset the increase in life expectancy or the decrease in the fertility rate can be simulated by increasing the probability of remaining in the labour force.

[3] Standard errors (p-values, respectively) were obtained by means of a bootstrap procedure.

Table 1: Panel system estimates (selected equations)

	Potential output growth	TFP growth	Real GDP growth	GDP deflator Inflation	Real long-term interest rate	Real short-term interest rate	Unemploy-ment 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 unemploym. 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	*0.94*	*0.40*	*0.40*	*0.81*	*0.63*	*0.69*	*0.49*	*0.29*	*0.46*	*0.63*
Adj. R^2	*0.93*	*0.35*	*0.36*	*0.79*	*0.61*	*0.67*	*0.45*	*0.24*	*0.42*	*0.60*
SE of regression	*0.35*	*0.74*	*0.80*	*0.33*	*2.45*	*2.30*	*0.89*	*0.87*	*0.69*	*0.44*
Durbin Watson	*1.53*	*1.84*	*1.91*	*2.09*	*1.93*	*2.02*	*1.89*	*1.83*	*1.96*	*2.15*
N. observations	*396*	*395*	*396*	*396*	*395*	*396*	*395*	*396*	*396*	*396*

Note: The model is estimated allowing for cross-section (country) fixed effects based on annual data spanning the 1990-2015 period. ** and * denote significance at least at the 5% and 10% levels, respectively.

the normalization is to better account for cross-country differences in sensitivities in a model in which sensitivities are assumed to be homogeneous across countries.[4]

4.2 Estimation results

Table 1 shows the estimates of the parameters for selected equations. Table A1 in the Annex shows the complete set of estimates. Potential output growth depends positively on TFP growth and negative on the change in the dependency ratio. These results confirm that the aging of the population affects the economy long-run potential output growth: a smaller share of the younger cohorts may imply lower innovation and investment in R&D, which would reduce potential growth in the long-run. This result is consistent with the empirical evidence and the theoretical model in Aksoy et al. (2016).

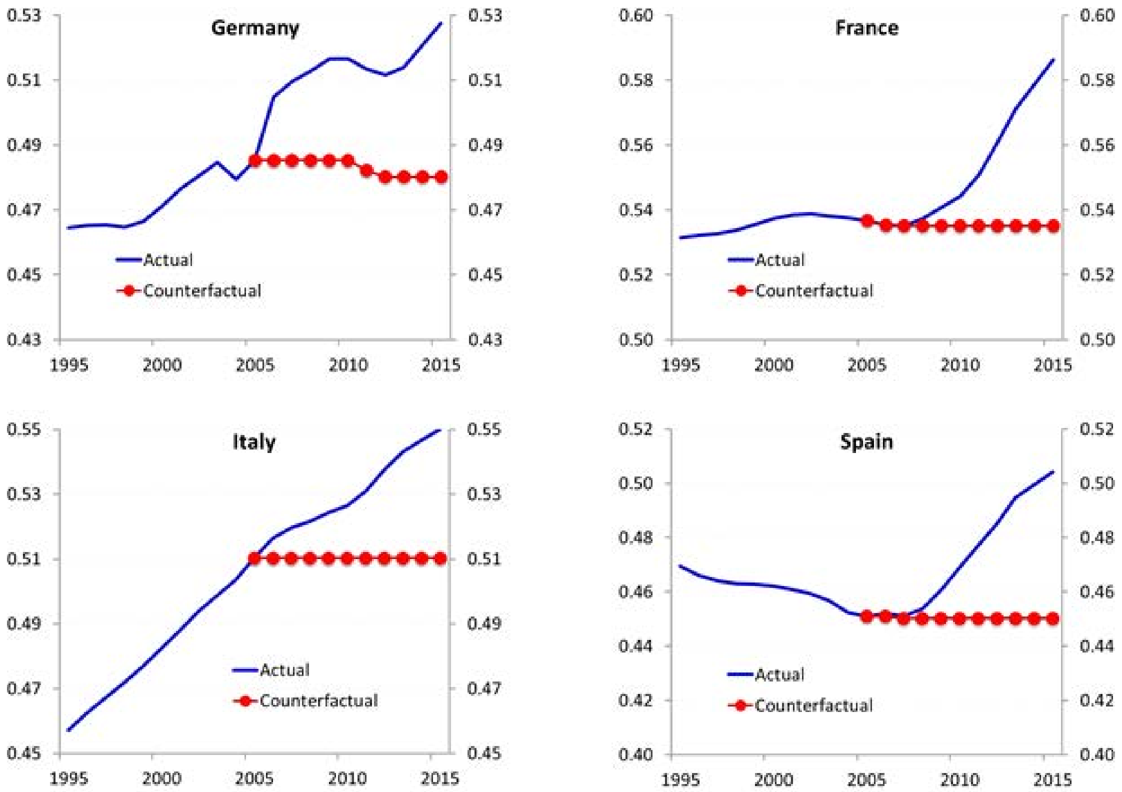
Real GDP, potential output, investment and consumption growth depend negatively on the change in the dependency ratio. Real investment and consumption growth also depend positively on TFP growth, consistently with standard growth models. Inflation, as measured by the change in the private consumption and in the GDP deflators, is negatively affected by the change in the dependency ratio. This finding is consistent with the evidence in Bobeica et al. (2017) who document a positive relationship between inflation and the growth rate of the working-age population in the euro area.

The real short-term interest rate depends negatively on population growth and the change in the dependency ratio, whereas the real long-term rate depends negatively only on population growth. These results are in line with those by Aksoy et al. (2016), Carvalho et al. (2016) and Gagnon et al. (2016).[5]

[4]The model in which the variables were not normalized prior to estimation turned out to result systematically inferior in-sample predictive performance measures.

[5]Our results are also conform with the predictions by the overlapping generations model developed by Eggertsson and Mehrotra (2014) who illustrate, based on the assumptions they built into their model, that a slowdown in demand for

Figure 6: Historical counterfactual assumptions for dependency ratios (selected countries, in %)



Note: The chart shows the historical evolution of the dependency ratio over the 1995-2015 period along with the assumed more favorable evolution over the period 2006-2015.

Finally, an increase of the dependency ratio indirectly reduces also TFP growth and long-term real interest rates through the effect that the demographic variable exerts on potential output and short-term real interest rates, respectively.

4.3 Historical counterfactual analysis: 2006-15

The historical counterfactual assessment is conducted by assuming that the dependency ratios did not increase between 2006 and 2015: in constructing the counterfactual evolution of the ratios, we set to zero the annual changes in the years in which they are positive and leave unchanged the observed negative changes. Figure 6 shows the resulting counterfactual paths for the dependency ratios, along with the observed ones for the largest euro-area countries. For almost all countries, dependency ratios started trending upward around 2005.

Table 2 shows the counterfactual and the observed average growth rates and interest rate levels

loans of the young (middle-aged) population would let real interest rates drop as a result. Similar in spirit and therefore also compatible with our findings is the model presented in Krugman (1998).

Table 2: Historical counterfactual under more favorable dependency ratios, 2006-15, euro area

		Population growth	Dependency ratio	Real long-term interest rates	Real short-term interest rates	Nominal long-term interest rates	Nominal 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%	3.3%	1.6%	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%	3.8%	2.5%	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	0.5	0.9	0.2	0.3	0.5	1.0	0.6	0.4	0.4	-0.7

Note: Euro area aggregates based on data and estimates of the 19 euro-area countries. Averages over the period 2006-15. The nominal interest rate counterfactual paths are proxied by the sum of the real rates and the GDP deflator inflation averages per annum.

for the period 2006-15. The table reports nominal GDP-weighted aggregates for the euro area. The conditional forecasts are dynamic, meaning that the lags in the model are the previous period conditional forecasts and not the observed realizations. Figure 7 shows the observed evolution along with the counterfactual projections for the euro area aggregate.

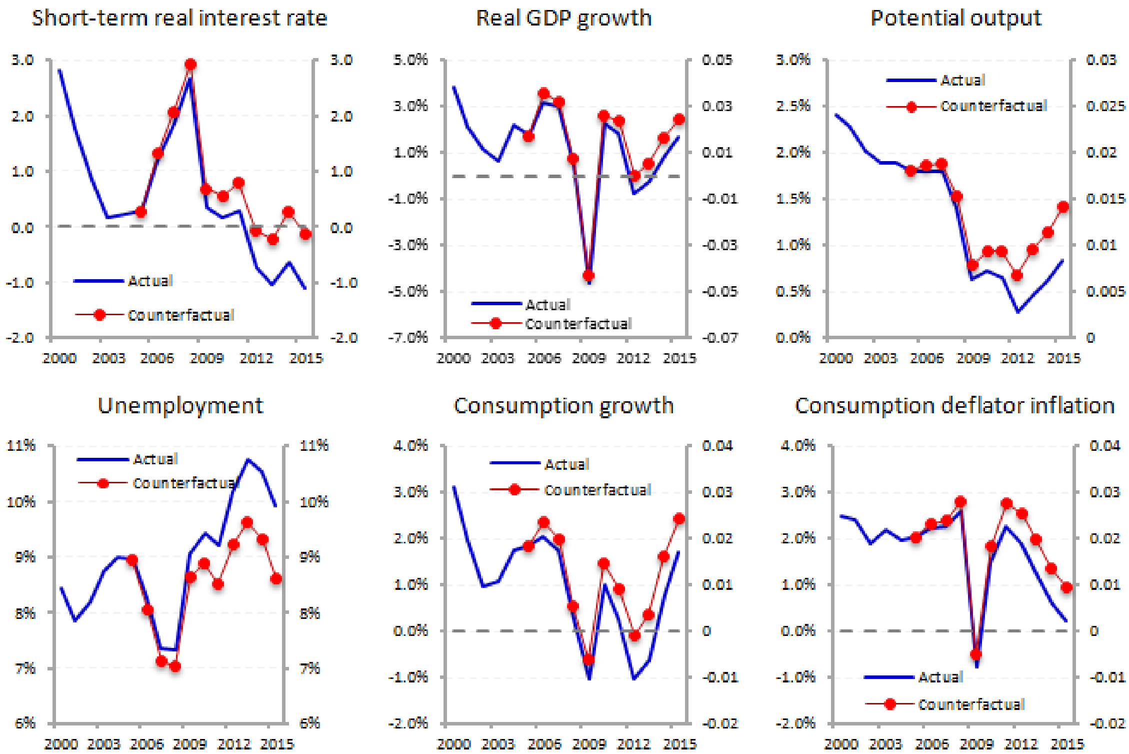
In the counterfactual scenario, the real short-term interest rate in the euro area would have been 0.5pp higher on average than the actual value. Macroeconomic variables would have evolved more favorably, with real GDP growth averaging 1.3%, 0.5pp above the realized value. Real investment growth would have been 1pp above the actual per annum growth (-0.2%) and real consumption growth by 0.6pp (1.1%, compared with 0.5%). The average unemployment rate would have equaled 8.5%, against the actual 9.2%. The differences in the paths of the real long-term rates are small. The estimates in Table 2 and Figure 8 confirm the non-negligible impact of the assumed more favorable demographic evolution between 2006 and 2015.

The significance estimates related to the differences between the observed and the counterfactual paths are presented in Table A2. The p-values were computed by positioning the observed variable paths in the counterfactual-conditional density forecasts, to measure the significance of the deviation between the observed and the counterfactual conditional mean on average along the projection horizon. The way the counterfactual-conditional density forecasts were generated reflects both the residuals and coefficient uncertainty.[6] For the euro area, the nominal GDP-weighted aggregates of the variable paths were first generated for all bootstrap replicates, to then compute the p-values. The estimates suggest that for numerous variables the counterfactual paths is statistically different from the observed trajectories at least at the 10% level. Against this threshold, the only exceptions are TFP growth and real long-term rates, which at 13% and 15% respectively may still be deemed as border-line significant, however. The relatively low p-values for the euro area are driven to a large extent by the low levels (and high GDP weight) for France, Spain, and the Netherlands.

In addition to the historical counterfactual analysis based on the 2006-15 period, we have conducted the same exercise for the preceding 10 year window, spanning the 1996-2005 period. During this period,

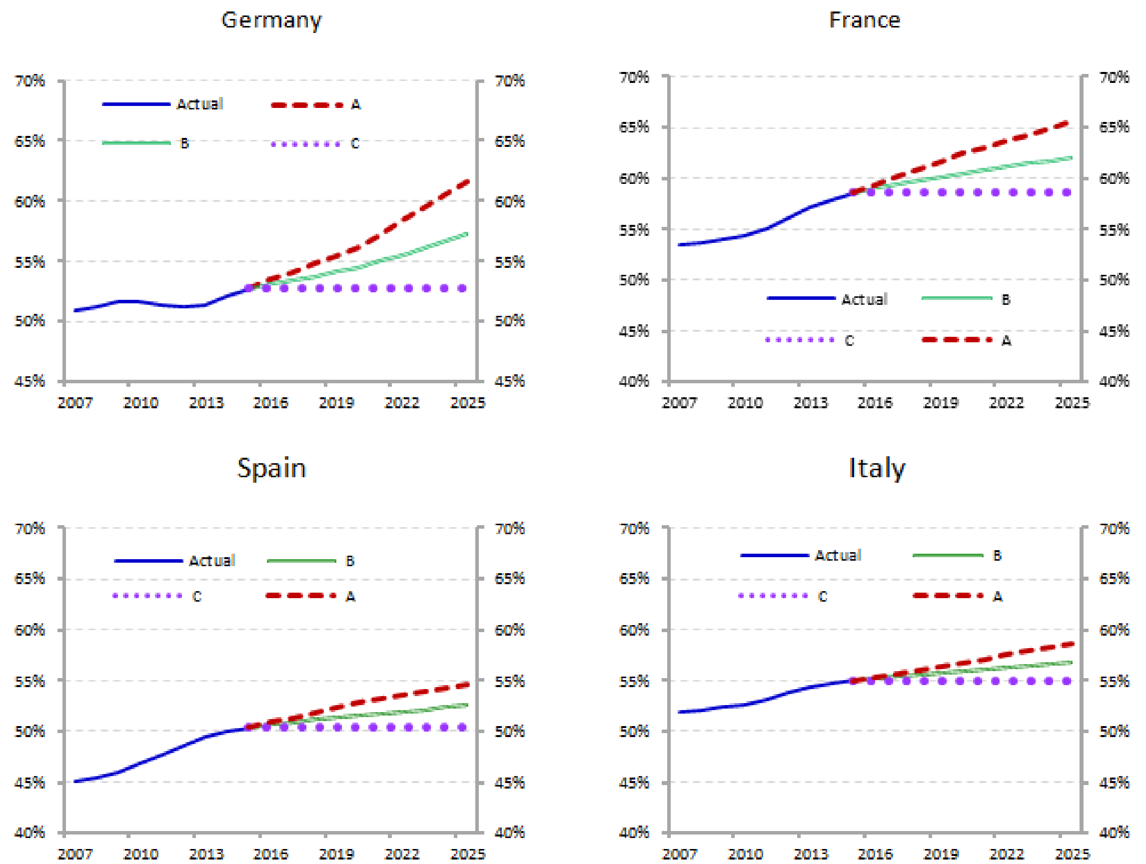
[6] A nonparametric bootstrap on the residuals was combined with a parametric bootstrap from the estimated means and the covariance matrix of the model coefficients to generate 5,000 forward paths for all model variables conditional on the counterfactual assumptions for the demographic factors.

Figure 7: Historical counterfactual projections for euro area aggregates, 2006-15



Note: The charts depict the historical evolution of the variables over the 2005-2015 period along with the counterfactual projections conditional on a more favorable evolution of demographic factors over the 2006-15 period.

Figure 8: Forward-looking counterfactual projections for euro area aggregates, 2016-25



Note: For Scenario A, the assumptions from the 2015 EC Ageing Report were adopted (red dashed line). In Scenario B (green dashed line) the dependency ratios move half way in between the EC projections and a flat path. Under Scenario C (purple dotted line), the ratios are assumed to remain flat at their 2015 levels.

approximately half of the countries in the sample experienced an upward trend of their dependency ratios, while for the other half the ratios were trending downward. We do not report the results of this additional exercise; the counterfactual-observed gaps equaled about one third of the size of the gaps based on the 2006-15 period, on average across countries. The reason why in this case the gaps are visibly smaller is that dependency ratios did not trend upward that significantly yet during this period. All in all, while dependency ratios started trending upward in a subset of countries already in the second half of the 1990s, these trends intensified only afterwards, implying a more sizable drag on macroeconomic developments in the last part of the sample.

4.4 Forward-looking counterfactual analysis: 2016-25

Three scenarios are considered for the evolution of the dependency ratios for the forward-looking counterfactual assessment that we present now. Figure 8 shows the assumptions again for the subset of the largest four euro area countries.

Table 3: Counterfactual scenario-conditional forecasts, euro area, 2016-25

Scenario		Population growth	Dependency ratio (2025)	Real long-term interest rate (2025)	Real short-term interest rate (2025)	Nominal long-term interest rate (2025)	Nominal short-term interest rate (2025)	TFP	Potential output	Real GDP	GDP deflator	Real investment	Real private consumption	Private consumption deflator	Unem. rate (2025)
2000-06		0.46%	49.5%	2.3%	1.1%	4.4%	3.2%	0.6%	2.0%	2.1%	2.0%	2.3%	1.8%	2.2%	8.5%
2007-15		0.34%	52.0%	2.0%	0.2%	3.3%	1.5%	0.0%	0.8%	0.5%	1.3%	-0.8%	0.3%	1.3%	9.3%
2015		0.43%	54.1%	0.1%	-1.1%	1.2%	0.0%	0.8%	0.8%	1.6%	1.3%	2.8%	1.7%	0.2%	10.0%
2016-25	A	0.13%	60.7%	1.9%	0.1%	2.8%	1.0%	0.1%	0.6%	0.6%	1.0%	0.7%	1.0%	1.1%	9.9%
	B	0.13%	57.4%	2.1%	0.7%	3.3%	1.9%	0.3%	0.8%	0.9%	1.2%	1.3%	1.4%	1.4%	9.0%
	C	0.13%	54.1%	2.4%	1.3%	3.9%	2.8%	0.4%	1.0%	1.3%	1.4%	1.9%	1.8%	1.7%	8.3%

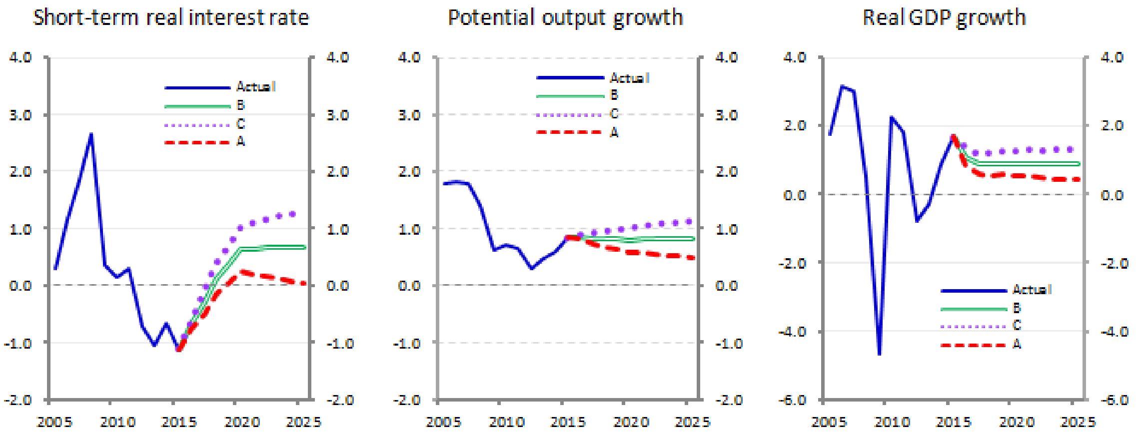
Note: All estimates refer to euro area (nominal GDP-weighted) aggregates. Under Scenario A, the dependency ratio is assumed in line with the European Commission Ageing Report; under Scenario B, it is assumed to evolve halfway between the EC projections and constant levels at 2015 values; in Scenario C, the dependency ratio is constant at 2015 levels. The real interest rates were included in the model and projected conditional on the scenarios as such. The figures for the nominal interest rate counterfactual are proxied by the sum of the real rates and the GDP deflator inflation averages per annum.

Under Scenario A, which can be referred to as a "baseline" simulation, the ratios are aligned for all the countries with the projections by the European Commission's 2015 Ageing Report (European Commission (2015)). The aging implied in this scenario is the result of slowing dynamics of fertility, rising life expectancy and specific assumptions in terms of migration. The proportion of young people (aged 0-14) is projected to remain relatively constant over the next decades in the euro area (around 15%), while those aged 15-64 are expected to constitute a substantially smaller share, declining from 66% to 57%. Those aged 65 and older are expected to constitute a much larger share (29% of the population, from 19%). Under Scenario B, the dependency ratios are assumed to move half way in between the EC projections and a flat path with respect to 2015, thereby implying, to some extent, more favorable demographic developments, given that the EC paths imply a relatively steep upward trend compared to historical trends for numerous countries. Scenario C entails the assumption that dependency ratios remain flat at their 2015 values and therefore can be interpreted as an optimistic upside scenario (in economic terms) when judged against the projections of the EC.

The ratios are expected to trend up in the four largest economies: in Germany, the ratio would increase by 9pp between 2016 and 2025, one of the most sizable increases among the euro area countries, after Lithuania, Malta and Slovenia. Ireland, Italy and Spain would experience the lowest increase (4pp).

Table 3 presents the counterfactual model estimates for the main euro area variables for the 2016-2025 period. The estimates confirm the important role that the dependency ratio plays in shaping macroeconomic outcomes. In Scenario A, average TFP, real GDP, real investment and consumption growth would be lower than in Scenarios B and C; TFP would be almost flat, growing by just 0.1% on average and real GDP growth by 0.6%. Compared with the more benign Scenario C, TFP and real GDP growth would be lower by, respectively, 0.3pp and 0.7pp. The increase in the dependency ratio would have a sizable impact on real investment, which would grow on average by 0.7% per annum in Scenario A, compared with 1.9% in the more favorable scenario. The projections of real variables in Scenario B would be in between those implied by Scenarios A and C.

Figure 9: Counterfactual scenario-conditional forecasts: euro area



Note: The charts show the actual data and the conditional projections in the three scenarios.

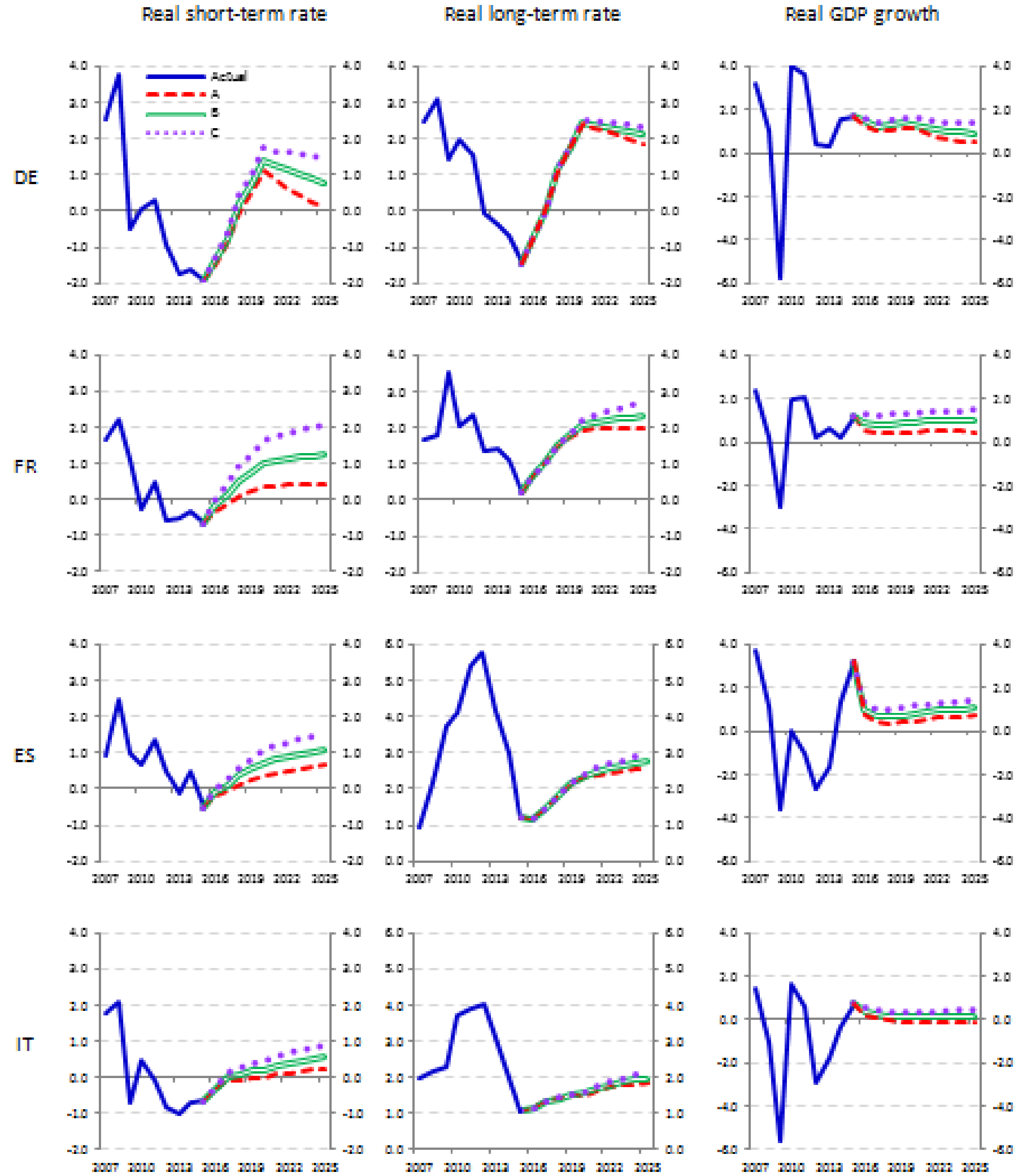
The conclusion we can draw from the forward-looking counterfactual assessment is that the evolution of the dependency ratios can be expected to play a key role in shaping macroeconomic developments in the future. In Scenario A the real short-term interest rate in the euro area would remain negative until 2019 and remain close to 0% over the 2020-25 period (Figure 9), not far from the average between 2007 and 2015. In the most favorable Scenario C, instead, the real short-term real rate would return to the levels observed in the 2000-2006 period (1.3% at the end of the horizon). Under Scenario A potential output and real GDP growth would decrease significantly along the simulation horizon, moving from 0.8 and 1.7% respectively in 2015, to 0.5% and 0.4% in 2025.

Figure 10 shows the conditional forecasts for short- and long-term real interest rates and real GDP growth of the four largest euro area countries. The projections confirm the important role played by the dependency ratios: to the extent that aging of the population continues, short and long-term real interest rates would remain below the pre-crisis levels.

Tables A3 and A4 in the annex present the p-values corresponding to the differences of Scenarios B and C, respectively, to Scenario A. Compared to the historical counterfactual significance estimates, the p-values comparing the forward-looking Scenario C with Scenario A are comparable in terms of their range with a view to the area aggregates, spanning from a sizable 2%-3% for potential output growth and unemployment rates, to the less significant 11%-14% for real long-term rates, real investment growth and TFP growth. The euro area aggregate p-values are driven quite a bit by the low p-values for France and the Netherlands again and in this case to a lesser extent by Spain (which was the case regarding the p-values related to the historical counterfactual projections).

We have carried out several robustness checks of the results presented in this Section. First, we have extended the sample back to 1980. The results that we presented both in terms of model estimates and historical and forward-looking counterfactuals change only marginally. Second, we have used nominal short- and long-term interest rates instead of the real counterparts and the results in terms of projections

Figure 10: Counterfactual scenario-conditional forecasts: Selected countries



Note: The charts show the realized (blue solid line) and projected short- and long-term real interest rates and real GDP growth in the three different scenarios (A: red dashed; B: green; C: violet dotted).

for the implied real and nominal rates remain very close to those presented in this Section. Third, we have excluded population growth from the model to judge whether there is a potential conflict with the dependency ratio. In this case, too, the projections were marginally affected. Fourth, in terms of the estimation method, we have considered conventional GGM estimators as developed by Arellano and Bond (1991) instead of the LSDVC estimator. Although the Arellano-Bond estimator is known for its sub-optimal small-sample properties, our estimates and the resulting counterfactual projections do not change much and all the conclusions hold up to the alternative estimation method.

5 Conclusions

Nominal and real interest rates have been decreasing since the mid-1980s and have reached historical low levels in the aftermath of the global financial crisis. Understanding why interest rates have fallen is essential for both the conduct of monetary policy and the assessment of the risks to financial stability. The ability of central banks to preserve price stability and keep output at its potential in the future will be conditioned by the level of the natural or equilibrium interest rate.

This paper has focused on one specific factor that has been put forward within the debate on the secular stagnation (Summers (2014)) as the source of the declining trend of interest rates: adverse demographic developments. The worrisome expected evolution of the demographic structure in Europe requires assessing the impact of demographic developments on real interest rates and potential output growth.

The empirical evidence presented in this paper suggests that over the next decade, adverse demographic developments in the euro area may continue exerting downward pressure on short- and long-term nominal and real interest rates, potentially limiting the ability of monetary policy to adjust its stance due to the presence of the lower bound to policy rates.

The pace at which real interest rates increase from current historically low levels may be influenced by structural, fiscal policies that encourage later retirement and promote innovation and investment in R&D. Such policies are also necessary in order to limit the negative impact of ageing on long-term growth prospects. Such policies may, however, take quite a long time to exert their impact as time lags for policies to affect demographic structures are naturally relatively long, spanning up to several decades.

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Table A1: Panel model estimates (1990-2015)

	Pot. output growth LN(PYER/PYER(-1))			TFP growth LN(TFP/TFP(-1))			Real GDP growth LN(YER/YER(-1))			GDP defl. infl. LN(YED/YED(-1))			Real l-term i-rate RLR			Real s-term i-rate RSR		
	coef	se	p	coef	se	p	coef	se	p	coef	se	p	coef	se	p	coef	se	p
Potential output growth (-1)	0.884	0.041	0.000	0.134	0.092	0.146	0.374	0.146	0.011	-0.026	0.025	0.292	0.392	0.172	0.023	0.228	0.188	0.225
TFP growth (-1)	0.103	0.033	0.002	-0.012	0.104	0.909	0.240	0.157	0.127	0.004	0.029	0.888	-0.081	0.244	0.741	-0.101	0.242	0.678
Real GDP growth (-1)							0.004	0.205	0.986	0.096	0.040	0.016	-0.272	0.277	0.328	0.182	0.305	0.551
GDP defl. infl. (-1)	-0.046	0.049	0.347				-0.200	0.145	0.168	0.612	0.041	0.000						
Investment growth (-1)																		
Investment defl. infl. (-1)																		
Private cons. growth (-1)																		
Private cons. deflator infl. (-1)																		
Change in unemploym. rate				-0.250	0.054	0.000												
Change in unemploym. rate (-1)																		
Real long-term i-rate				-0.088	0.033	0.007												
Real long-term i-rate (-1)	0.020	0.011	0.080	0.147	0.033	0.000	0.065	0.032	0.046	0.008	0.006	0.199	0.638	0.097	0.000	-0.028	0.072	0.697
Real short-term i-rate				0.056	0.034	0.099												
Real short-term i-rate (-1)	-0.015	0.011	0.188	-0.075	0.032	0.020	-0.073	0.033	0.026	0.005	0.006	0.386	0.113	0.090	0.210	0.741	0.081	0.000
Population growth	-0.001	0.018	0.933	-0.122	0.090	0.178	-0.010	0.061	0.865	0.047	0.016	0.003	-0.255	0.106	0.017	-0.255	0.112	0.023
Population growth (-1)				0.020	0.090	0.827												
Change in dependency ratio	-0.083	0.023	0.000	-0.017	0.069	0.801	-0.211	0.074	0.005	-0.037	0.017	0.028	0.001	0.129	0.995	-0.191	0.110	0.084
Change in dependency ratio (-1)				-0.072	0.071	0.309												
R2		0.94			0.40			0.40			0.81			0.63			0.69	
Adj. R2		0.93			0.35			0.36			0.79			0.61			0.67	
SE of regression		0.355			0.743			0.800			0.333			2.451			2.305	
DW		1.53			1.84			1.91			2.09			1.93			2.02	
Obs.		396			395			396			396			395			396	

	D(unempl. rate) URX-URX(-1)			Inv. growth LN(ITR/ITR(-1))			Inv. defl. infl. LN(ITD/ITD(-1))			Priv. cons. growth LN(PCR/PCR(-1))			Priv. cons. Defl. infl. LN(PCD/PCD(-1))		
	coef	se	p	coef	se	p	coef	se	p	coef	se	p	coef	se	p
Potential output growth (-1)	0.184	0.098	0.060												
TFP growth (-1)				0.400	0.100	0.000	0.081	0.028	0.004	0.176	0.068	0.010	0.043	0.035	0.219
Real GDP growth (-1)	-0.391	0.120	0.001												
GDP defl. infl. (-1)															
Investment growth (-1)				0.097	0.090	0.284	0.023	0.026	0.381						
Investment defl. infl. (-1)				-0.143	0.117	0.222	0.491	0.055	0.000						
Private cons. growth (-1)										0.367	0.079	0.000	0.063	0.041	0.126
Private cons. deflator infl. (-1)										-0.391	0.109	0.000	0.483	0.081	0.000
Change in unemploym. rate															
Change in unemploym. rate (-1)	0.268	0.077	0.001												
Real long-term i-rate	0.219	0.042	0.000												
Real long-term i-rate (-1)	-0.212	0.043	0.000	0.042	0.034	0.219	0.006	0.008	0.503	0.007	0.026	0.793	0.009	0.012	0.447
Real short-term i-rate	-0.135	0.048	0.005												
Real short-term i-rate (-1)	0.173	0.046	0.000	-0.087	0.035	0.014	-0.009	0.010	0.369	-0.009	0.027	0.732	0.000	0.013	0.977
Population growth				-0.015	0.063	0.815	0.029	0.021	0.176	0.067	0.050	0.182	0.036	0.022	0.101
Population growth (-1)															
Change in dependency ratio	0.282	0.086	0.001	-0.223	0.091	0.015	-0.082	0.023	0.000	-0.268	0.064	0.000	-0.069	0.028	0.013
Change in dependency ratio (-1)	-0.192	0.088	0.029												
R2		0.49			0.29			0.57			0.46			0.63	
Adj. R2		0.45			0.24			0.54			0.42			0.60	
SE of regression		0.886			0.866			0.431			0.690			0.436	
DW		1.89			1.83			2.16			1.96			2.15	
Obs.		395			396			396			396			396	

Note: The model has been estimated with cross-section (country) fixed effects on annual data spanning the 1990-2015 period. An LSDV estimation method has been employed for estimation. The model has been constrained to some extent, by excluding insignificant relationships resulting after a first, unconstrained estimation of the model. Intercept/fixed effects estimates are not presented here. See text for details.

Table A2: Significance estimates (p-values): counterfactual versus actual, 2006-2015

	AT	BE	CY	DE	EE	ES	FI	FR	EL	IE	IT	LT	LU	LV	MT	NL	PT	SI	SK	EA
Potential output growth	16%	2%	14%	15%	3%	4%	3%	0%	6%	5%	7%	9%	23%	4%	4%	6%	7%	2%	10%	5%
TFP growth	20%	16%	17%	16%	12%	1%	12%	7%	11%	13%	15%	13%	22%	14%	13%	13%	4%	9%	15%	13%
Real long-term interest rates	24%	21%	25%	19%	20%	17%	20%	17%	22%	19%	19%	24%	25%	23%	14%	17%	20%	15%	23%	15%
Real short-term interest rates	19%	11%	10%	14%	9%	9%	9%	6%	12%	12%	14%	18%	23%	17%	3%	7%	11%	0%	17%	7%
Real GDP growth	17%	9%	12%	8%	5%	6%	5%	2%	6%	7%	11%	8%	22%	7%	6%	8%	1%	3%	10%	8%
GDP deflator inflation	19%	9%	19%	20%	14%	8%	2%	0%	14%	8%	12%	18%	23%	15%	15%	7%	8%	12%	18%	6%
Real investment growth	17%	11%	12%	8%	8%	10%	6%	6%	9%	9%	15%	9%	21%	10%	9%	9%	1%	5%	11%	10%
Investment deflator inflation	17%	7%	17%	18%	11%	6%	3%	1%	8%	9%	5%	14%	21%	13%	12%	4%	1%	9%	15%	5%
Real private consumption growth	12%	3%	8%	5%	3%	4%	2%	0%	5%	4%	8%	5%	20%	5%	4%	4%	0%	1%	6%	4%
Private consumption deflator inflation	17%	7%	17%	18%	11%	3%	1%	0%	11%	3%	9%	15%	21%	13%	12%	5%	3%	9%	15%	6%
Unemployment rate	26%	6%	12%	13%	1%	1%	0%	0%	2%	15%	9%	14%	41%	0%	0%	1%	4%	0%	7%	5%

Note: Lower levels imply larger significance in the difference between the observed and the counterfactual average values along the 2006-2015 simulation period. Green, orange and light grey colors are a visual support to seeing p-values less than 1%, between 1%-5%, and between 5%-10%.

Table A3: Significance estimates (p-values): counterfactual Scenario A versus Scenario B, 2016-2025

	AT	BE	CY	DE	EE	ES	FI	FR	EL	IE	IT	LT	LU	LV	MT	NL	PT	SI	SK	EA
Potential output growth	11%	5%	13%	14%	12%	16%	11%	2%	18%	18%	15%	3%	20%	10%	8%	10%	16%	7%	12%	10%
TFP growth	20%	20%	21%	20%	18%	14%	19%	17%	21%	22%	22%	14%	23%	19%	18%	19%	19%	16%	20%	19%
Real long-term interest rates	21%	19%	20%	20%	21%	22%	20%	18%	24%	23%	22%	21%	24%	23%	10%	19%	22%	13%	17%	17%
Real short-term interest rates	16%	14%	10%	12%	17%	19%	17%	14%	21%	21%	20%	14%	21%	20%	7%	11%	18%	4%	19%	12%
Real GDP growth	17%	15%	17%	17%	14%	19%	15%	12%	20%	19%	19%	7%	21%	14%	13%	14%	17%	11%	16%	16%
GDP deflator inflation	17%	15%	21%	21%	19%	20%	10%	7%	22%	20%	19%	23%	22%	20%	19%	12%	18%	18%	21%	12%
Real investment growth	18%	17%	18%	19%	15%	20%	16%	16%	21%	20%	22%	11%	22%	16%	15%	17%	19%	12%	17%	18%
Investment deflator inflation	16%	15%	20%	20%	18%	19%	11%	9%	21%	20%	17%	14%	20%	19%	18%	10%	14%	16%	19%	13%
Real private consumption growth	13%	11%	15%	16%	11%	17%	11%	9%	20%	18%	19%	6%	21%	13%	12%	12%	17%	8%	14%	14%
Private consumption deflator inflation	16%	14%	20%	20%	17%	17%	8%	8%	22%	17%	18%	13%	20%	19%	18%	11%	16%	16%	19%	14%
Unemployment rate	17%	11%	10%	12%	8%	22%	7%	7%	24%	26%	27%	0%	32%	4%	2%	4%	19%	1%	10%	13%

Note: Lower levels imply larger significance in the difference between the observed and the counterfactual average values. Green, orange and light grey colors are a visual support to seeing p-values less than 1%, between 1%-5%, and between 5%-10%.

Table A4: Significance estimates (p-values): counterfactual Scenario A versus Scenario C, 2016-2025

	AT	BE	CY	DE	EE	ES	FI	FR	EL	IE	IT	LT	LU	LV	MT	NL	PT	SI	SK	EA
Potential output growth	3%	0%	5%	6%	4%	9%	3%	0%	11%	13%	8%	0%	15%	2%	1%	2%	8%	1%	4%	3%
TFP growth	15%	15%	16%	16%	12%	6%	13%	10%	18%	18%	18%	6%	21%	14%	12%	13%	13%	9%	15%	14%
Real long-term interest rates	17%	14%	15%	16%	16%	18%	15%	12%	23%	21%	20%	17%	23%	21%	2%	13%	20%	5%	10%	11%
Real short-term interest rates	8%	6%	2%	4%	10%	13%	10%	6%	17%	18%	15%	6%	18%	15%	1%	3%	12%	0%	13%	5%
Real GDP growth	10%	7%	10%	10%	6%	13%	7%	4%	15%	14%	14%	1%	18%	6%	4%	6%	10%	3%	9%	9%
GDP deflator inflation	10%	7%	17%	17%	14%	14%	3%	1%	20%	15%	14%	20%	19%	15%	13%	4%	12%	11%	16%	6%
Real investment growth	12%	10%	12%	14%	7%	16%	8%	9%	17%	15%	19%	3%	20%	9%	8%	11%	14%	4%	10%	13%
Investment deflator inflation	9%	7%	16%	16%	11%	13%	3%	2%	17%	16%	10%	6%	16%	13%	12%	3%	6%	8%	14%	6%
Real private consumption growth	5%	3%	8%	9%	3%	11%	3%	1%	14%	12%	13%	0%	18%	5%	4%	4%	10%	1%	6%	7%
Private consumption deflator inflation	9%	7%	16%	15%	11%	10%	1%	1%	18%	10%	13%	5%	16%	13%	12%	3%	9%	8%	14%	7%
Unemployment rate	3%	1%	0%	2%	0%	6%	0%	0%	8%	10%	11%	0%	18%	0%	2%	0%	4%	0%	1%	2%

Note: Lower levels imply larger significance in the difference between the observed and the counterfactual average values. Green, orange and light grey colors are a visual support to seeing p-values less than 1%, between 1%-5%, and between 5%-10%.

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Giuseppe Ferrero
Banca d'Italia, Rome, Italy; email: giuseppe.ferrero@bancaditalia.it

Marco Gross
European Central Bank, Frankfurt am Main, Germany; email: marco.gross@ecb.europa.eu

Stefano Neri
Banca d'Italia, Rome, Italy; email: stefano.neri@bancaditalia.it

Postal address	60640 Frankfurt am Main, Germany
Telephone	+49 69 1344 0
Website	www.ecb.europa.eu

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