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EURO AREA POLICIES

SELECTED ISSUES

July 2017

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EURO AREA POLICIES

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July 6, 2017

Approved By
The European Department

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CONTENTS

REAL INCOME CONVERGENCE IN THE EURO AREA[1]

After the European Union was established, the founding members of the euro experienced steady income convergence. However, this convergence process has stalled since the introduction of the euro, except for new euro area members which reduced their income gaps vis-à-vis the founding members until their adoption of the common currency. Convergence of income levels is not a prerequisite for a functioning monetary union, but has been considered an important objective of the European economic integration process. Lagging productivity growth in countries with lower initial GDP per capita is found to be the main explanation for the lack of convergence, suggesting that structural reforms can help to restart the convergence process.

A. Convergence: A Long-Standing Objective of European Economic Integration

1. Convergence of real income levels is not a prerequisite for a functioning monetary union *per se*, but it is a long-standing objective of European economic integration. Dating back to the Treaty of Rome (1957), real convergence – a gradual and sustained decline in per capita income gaps across euro area countries – has been a major goal of the economic integration process. The Delors Report (European Council, 1989), which together with the 1970 Werner Report sets out the conceptual framework underpinning Economic and Monetary Union (EMU), lists the convergence of living standards as an EMU policy objective, in addition to price stability, balanced growth, high employment and external equilibrium. The Maastricht Treaty, which lays the foundation for EMU, restates this objective, citing its member states' resolve to achieve the convergence of their economies in its preamble, while Article 2 defines the promotion of "a high degree of convergence of economic performance" as a task of the Union.

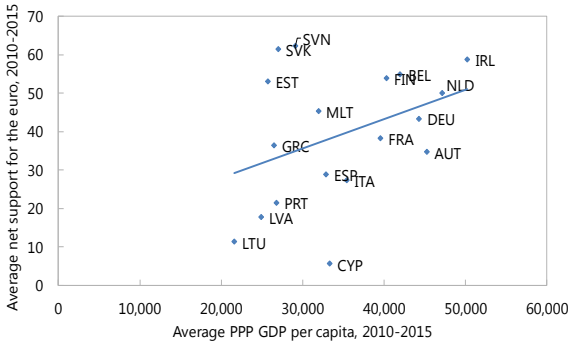
2. EMU was expected to foster income convergence through greater trade and capital flows and by creating incentives for reforms at the national level. At the outset of EMU, policymakers assumed that, by eliminating exchange-rate risk and allowing the free movement of goods, services, capital and labor, improved cross-border resource allocation would boost economic growth and help income levels to converge between countries (Aglietta and Brand, 2013). Moreover, the Delors Report predicted that, without recourse to devaluation, the discipline imposed by monetary union would increase incentives for reforms to boost productivity growth. Economic theory supported this thinking. In neoclassical growth theory, the removal of exchange-rate risk and other barriers encourages capital flows to "catching-up" economies with lower capital-output ratios and higher marginal products of capital, thereby boosting investment and economic growth (Blanchard and Giavazzi, 2002; Praet, 2014; Tressel et al., 2014). Likewise, labor could flow from lower-wage countries to higher-wage ones, producing convergence in the marginal product of labor.

[1] Prepared by Hanni Schoelermann, based on forthcoming IMF working paper by Franks et al., "Economic Convergence in the Euro Area: Coming Together or Drifting Apart?"

3. The founders of EMU recognized, however, that there were forces which could potentially produce divergence. Economic activity could concentrate in more prosperous areas with an agglomeration of human capital and physical infrastructure—a centripetal force also put forward by academic research (De la Dehasa and Krugman, 1992; European Council, 1989). The Delors Report identifies such regional and structural disparities as "grave economic and political risks," and advocates the "spread of welfare gains throughout the Community" by means of investment programs in areas such as infrastructure, communications, transport and education, to facilitate the equalization of production conditions. EU structural funds were considered an important – though potentially insufficient – instrument in this regard (Emerson et al., 1992; European Council, 1989).

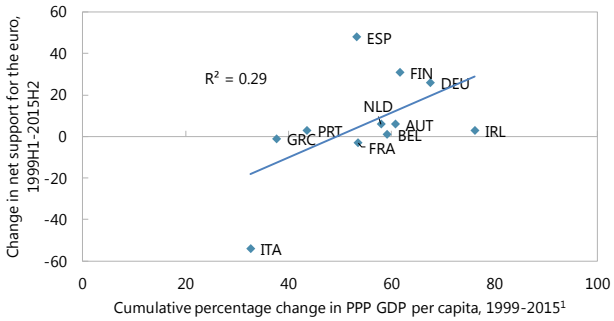
4. The diverging experiences of euro area countries after the crisis have renewed the focus on convergence. The euro area is emerging from a deep crisis that has challenged the ability of its macroeconomic policy framework to deliver stability and prosperity. While countries such as Germany are now well above their pre-crisis GDP levels, for other countries such as Italy, GDP is only expected to return to its pre-crisis level in the mid-2020s. Although support for the euro area remains high, it is highest in countries with high income levels (text chart). Moreover, countries that have experienced high growth since euro introduction are more likely to have seen an increase in support for the euro (text chart). Convergence may indeed be important for the cohesion of the monetary union, as it helps to ensure that the gains from economic integration are shared.

Support for the Euro and Income Level



Sources: Eurobarometer, WEO, and IMF staff calculations.

Support for the Euro and Convergence



1/ Using 2014 GDP data for Ireland to avoid bias from recent data revisions.
Sources: Eurobarometer, WEO, and IMF staff calculations.

B. Real Income Convergence in the Euro Area

5. Convergence analysis considers whether countries with lower per capita income have caught up with richer ones, and whether income dispersion has been reduced. As summarized in Sala-i-Martin (1996), the literature on real convergence distinguishes between β- and σ-convergence. β-convergence occurs when countries with lower GDP per capita grow faster than those with higher GDP per capita, also referred to as catching-up. σ-convergence is observed when the dispersion of countries' levels of real GDP per capita declines over time, meaning their income levels become more similar. The two kinds of convergence are related: faster growth of countries with lower GDP per capita (β-convergence) is necessary for the dispersion of income levels to

narrow (σ-convergence), but not sufficient. Both concepts are therefore considered when gauging the quality of convergence in the euro area.

6. This paper looks at the convergence performance of euro area countries before and after euro introduction. The analysis compares per capita incomes across countries, both for the initial group of twelve countries that adopted the euro before 2002 (the so-called EA-12) as well as the current group of 19 euro area members (EA-19). Luxembourg is excluded from the analysis because its high GDP, small population and large influx of cross-border workers make it an outlier in GDP per capita terms. Per capita GDP at purchasing power parity (PPP) is used to control for cross-country differences in price levels.[2] The results confirm those of several recent studies (auf dem Brinke et al. 2015; Barkbu et al., 2016; ECB, 2015, Kaitila, 2014).

7. There was steady income convergence across euro area countries in the decades leading up to the Maastricht Treaty.[3] Simple cross-country regressions of average annual per capita GDP growth on the log of per capita GDP show that EA-12 countries with initially lower GDP per capita tended to grow faster than their counterparts with higher initial income levels over the period from 1960 to 1992, implying that there was strong β-convergence (Table 1).[4] The dispersion of GDP per capita across countries (as measured by the coefficient of variation) also fell, confirming that higher growth in countries with initially lower incomes produced σ-convergence (text charts).[5]

8. However, contrary to expectations, income convergence among EA-12 countries slowed after Maastricht and subsequently came to a halt.[6] While 23 years is a short time span for convergence analysis, regressions point to a lack of β-convergence of GDP per capita from 1993 to 2015 (Table 1). The time-series plots of cross-country income dispersion (σ-convergence) show slow convergence in the 1990s, a lack of convergence in the first decade of the euro, and divergence since the crisis, reversing the initial narrowing in income dispersion. This recent divergence is found to be statistically significant at the 5 percent level.[7]

[2] For assessing β-convergence, there is a trade-off between using real GDP data, which is comparable over time, and PPP GDP data, which is comparable across countries. The subsequent analysis uses the latter, to allow the comparison of living standards across countries, but includes robustness checks with real GDP data.

[3] This finding is consistent with other research. See Kaitila (2014), auf dem Brinke et al. (2015), ECB (2015), and Barkbu et al. (2016).

[4] As the regressions are run for a very small sample of 9 countries due to data availability and the omission of outlier Luxembourg, the precise results should be taken as indicative.

[5] The coefficient of variation (i.e. the standard deviation divided by the mean) is typically used in convergence analysis because it relates the standard deviation to the size of the underlying variable across the sample. This allows for meaningful comparisons over time in instances where the underlying variable, such as GDP, displays a clear trend and the standard deviation expressed in absolute units would overstate (understate) dispersion given a rise (fall) in the magnitude of the variable.

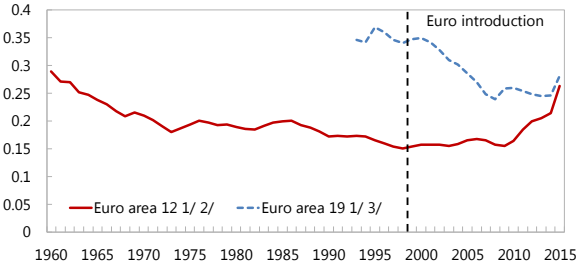
[6] This is consistent with auf dem Brinke et al. (2015), ECB (2015) and Barkbu et al (2016), who find that the dispersion of per capita income levels among the initial euro area countries increased in the period from 1999 to 2014.

[7] Bootstrapping is used to estimate a 95-percent confidence interval around a median coefficient of variation.

Table 1. β-Convergence Among Euro Area Countries[1]		
EA-12 (excl. Luxembourg)[2]	β	R^2
1960–2015[3]	1.93***	0.77
1960–1992[3]	3.86***	0.91
1990–1998	7.83	0.23
1999–2015	-6.28	0.24
1993–2007	8.04	0.25
1993–2015	5.64	0.10
EA-19 (excl. Luxembourg)[2]	β	R^2
1990–1998[4]	9.40**	0.38
1999–2015	8.08***	0.66
1993–2015[5]	6.59***	0.64
memo: EU-28 (excl. Luxembourg)[2]	β	R^2
1993–2015[6]	5.25***	0.63

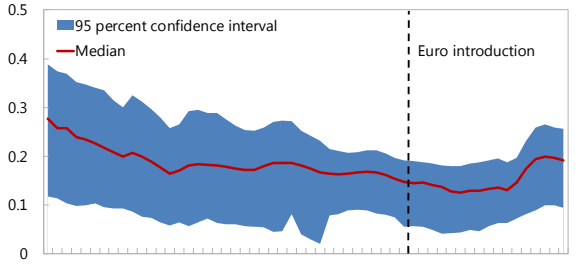
Note: *** significant at 1 percent level; ** significant at 5 percent level; * significant at 10 percent level.
1/ Linear cross-country regressions of average annual PPP GDP per capita growth (γ) between time t+1 through T on the logarithm of PPP GDP per capita (y) at time t. Positive values indicate convergence: $\gamma_{i,t+1,t+T} = \alpha - \beta \log(y_{i,t}) + \varepsilon_{i,t}$. Regressions were also run for average annual real GDP per capita growth, with essentially unchanged results (i.e. very similar coefficient sizes and degrees of statistical significance).
2/ Luxembourg excluded because it is an outlier with high PPP GDP per capita and a large number of cross-border workers.
3/ No data available for Ireland and the Netherlands.
4/ No data available for Estonia, Latvia, Lithuania, Slovak Republic and Slovenia.
5/ No data available for Lithuania.
6/ No data available for Czech Republic and Lithuania.

σ-Convergence Across EA Countries, 1960-2015
Coefficient of variation, PPP GDP per capita



Sources: WEO database and IMF staff calculations.
1/ Excludes Luxembourg.
2/ Includes Ireland from 1970 and the Netherlands from 1980 onwards.
3/ Includes Lithuania from 1995 onwards.

Statistical Significance of σ-Convergence Among EA-12[1]
Two-sided 95 percent confidence interval around median coefficient of variation



Sources: WEO, and IMF staff calculations.
1/ PPP GDP per capita data. Excludes Luxembourg. Includes Ireland from 1970 and the Netherlands from 1980 onwards.

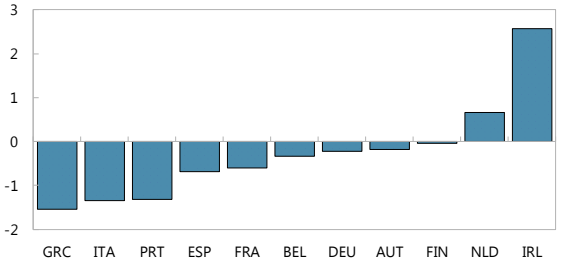
9. Weak growth in southern euro area countries has held back convergence. Comparing countries' actual with their expected average annual growth for the period 1993 to 2015,[8] it emerges that in three of the four EA-12 countries with the lowest GDP per capita in 1993 – namely Greece, Portugal and Spain – growth fell significantly short of what would have been implied by their

[8] A country's expected growth is calculated by multiplying the log of 1993 PPP GDP per capita with the β-coefficient of the EA-12 convergence regression for the period 1960-1992, and deducting the product from the regression constant. This yields the fitted growth rate consistent with the country's 1993 GDP level under the assumption of steady convergence going forward.

income levels and their previous convergence performance. Growth in Ireland, on the other hand, exceeded expectations by far, driving what little convergence there has been among EA-12 countries since the Maastricht Treaty (text chart). Among the countries with higher initial income levels, Italy stands out with a very weak growth performance compared to what is predicted, despite the already modest growth implied by its high initial GDP. While part of the disappointing growth performance is cyclical in nature, it is worth pointing out that even excluding the recent crisis and looking at the period from 1993 to 2007, there is a lack of β-convergence among the EA-12 (Table 1).[9]

Growth Performance v. Convergence Expectations, 1993-2015[1]

Actual minus adjusted average annual growth in PPP GDP per capita, in percentage points

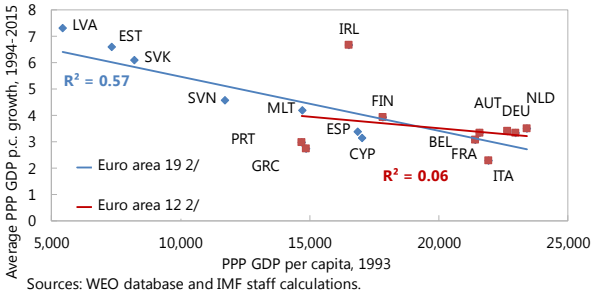


1/ Convergence expectations are defined as a country's hypothetical average annual PPP GDP per capita growth implied by its 1993 GDP level and its previous degree of convergence between 1960 and 1992.
Source: WEO, and IMF staff calculations.

10. At the same time, countries that joined the euro area in 2007 or later experienced continued convergence in the run-up to their accession.[10] Income differences between 'old' and 'new' euro area members were large in the 1990s, but narrowed substantially prior to EU and euro area accession of the latter group (text charts). However, convergence for these countries has also slowed since the global financial crisis. Despite this weaker convergence performance in recent years, over the entire period 1993-2015 convergence among countries now in the euro area has been stronger than among EU countries as a whole (Table 1).[11]

β-Convergence Across EA Countries, 1993-2015[1]

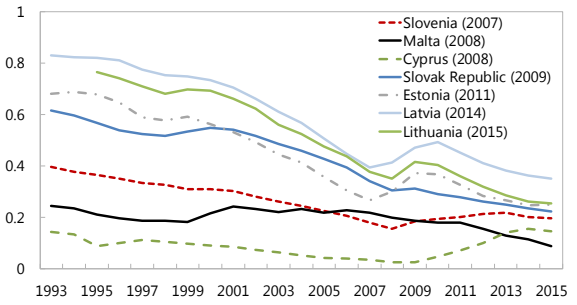
PPP GDP per capita



Sources: WEO database and IMF staff calculations.
1/ As GDP not logged, R^2 values shown differ from results in Table 6.
2/ Excludes Luxembourg, and in the case of euro area 19 Lithuania due to missing data.

Convergence of New EA Member States, 1993-2015

Coefficient of variation with EA-12 average[1], PPP GDP per capita. (Year of euro adoption).



Sources: WEO database and IMF staff calculations.
1/ Excluding Luxembourg.

11. Income disparities persist also at the regional level within euro area countries. Box 1 compares the very different track records on regional convergence within Italy and Germany over

[9] Replicating the expected growth analysis for the period 1993–2007 reveals a mixed picture: all countries apart from Portugal and Italy exceeded growth expectations up to 2007, with Ireland, Finland, Greece and Spain outperforming growth expectations by most.

[10] See also Benczes and Szent-Ivanyi (2015), ECB (2015), and Forgo and Jevčák (2015).

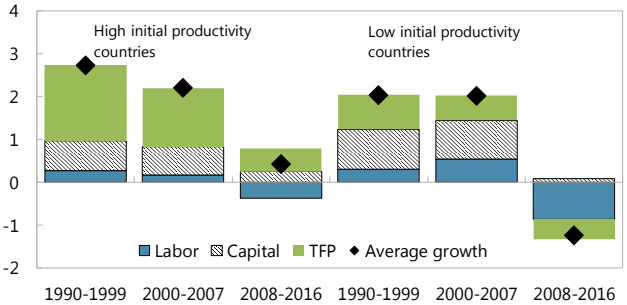
[11] Of course, this stronger convergence may reflect the convergence demands of the accession process before joining rather than convergence under the monetary union. It may also be the result of selection bias—countries already more predisposed to convergence were the ones who chose to join the euro.

the past decade and a half. The two countries feature considerable income variation across regions, but while German regions have converged since 2000, Italian regions have not. Both are countries with extensive fiscal transfers and labor mobility between regions, suggesting that the difference in convergence outcomes cannot be explained by these factors alone. Rather, how fiscal transfers are used as well as differences in policies and underlying economic structures appear to play a decisive role: whereas East German *Länder* have undergone large-scale infrastructure improvements and structural change spurred by reunification, progress in these areas has been slow in the south of Italy, in part hampered by pervasive corruption (Burda, 2009; Felice, 2013; Iuzzolino et al., 2011). It is interesting to note in this respect that for U.S. states, where data span almost a century, convergence has been strong (Box 2). The convergence has likely been helped by fiscal stabilization transfers and a high degree of labor mobility, though tight economic integration and few obstacles to cross-border activities may also have contributed.

12. Limited productivity catch-up holds the main explanation behind the lack of income convergence between euro area countries. A decomposition of annual GDP per capita growth across euro area countries with high and low labor productivity levels (defined according to real GDP per hour worked in 1999) shows that both groups of countries have experienced a slowdown in total factor productivity (TFP) growth over recent decades. However, the countries with low initial productivity experienced consistently lower TFP growth throughout the sample periods and a more pronounced slowdown. The sharper fall in investment and employment in countries with low initial productivity is also important in explaining the post-crisis divergence in growth trends.

Growth Decomposition

Average annual per capita growth rates in percent, unweighted



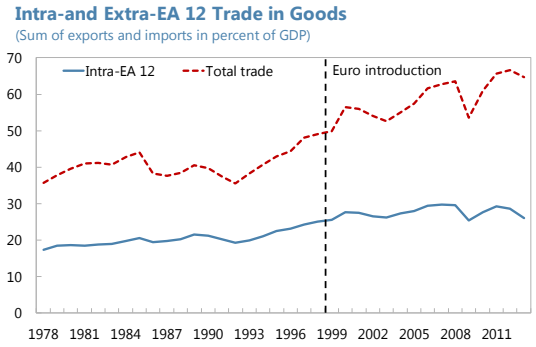
Note: Productivity groups defined on the basis of labor productivity. Countries with high initial productivity include Austria, Belgium, Finland, France, Germany, Ireland, and the Netherlands. Countries with low initial productivity include Greece, Italy, Portugal and Spain. No 1990s data available for Austria.

Sources: AMECO, Haver Analytics, and IMF staff calculations.

13. The main adjustment channels – trade, labor and capital flows – did not produce the expected convergence dynamics. Intra-euro area trade is substantial, but has not increased significantly under EMU. Labor mobility continues to be low, with only around two percent of the EU-15 working age population living in another EU-15 country, partly due to language barriers and limited portability of social security claims (Arpaia et al., 2014). Finally, capital flows rose considerably, yet fueled unsustainable credit booms in recipient countries, while foreign direct investment flowed disproportionately to central European, rather than other euro area, countries. The limited catch-up in productivity growth is an underlying factor explaining these developments (Figure 1).

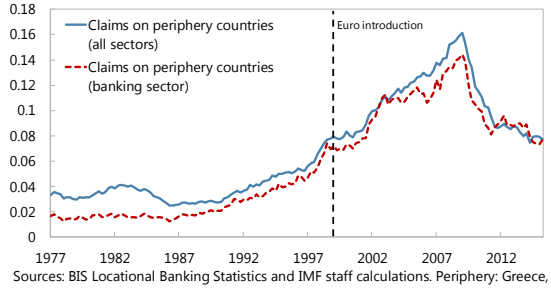
Figure 1. Adjustment Channels in the Euro Area

Intra-euro area trade has only increased moderately.



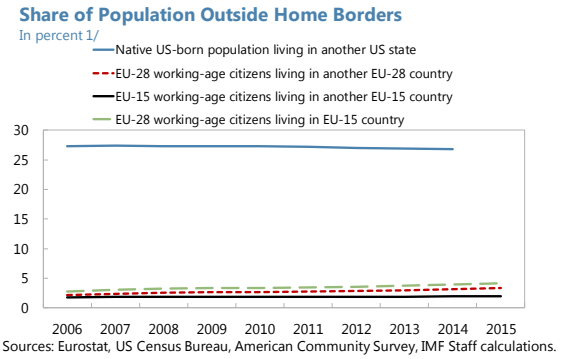
Sources: OECD Monthly Statistics on International Trade, AMECO.

Cross-border capital flows rose sharply under EMU…



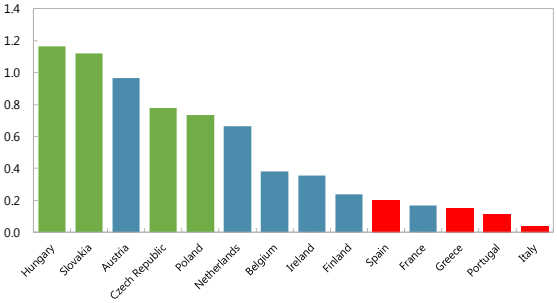
Sources: BIS Locational Banking Statistics and IMF staff calculations. Periphery: Greece, Ireland, Portugal, Spain. Core: Austria, Belgium, Finland, France, Germany, and Netherlands (ex. Germany claims on banking sector due to data limitations).

Labor mobility remains very low, especially compared to the United States.



Sources: Eurostat, US Census Bureau, American Community Survey, IMF Staff calculations.
1/ In percent of population (US data) and working-age population (EU data).

…but FDI flows mostly went to central Europe rather than EA-12 economies expected to catch up.



Sources: OECD, Eurostat, and IMF staff calculations.

C. Conclusion and Policy Recommendations

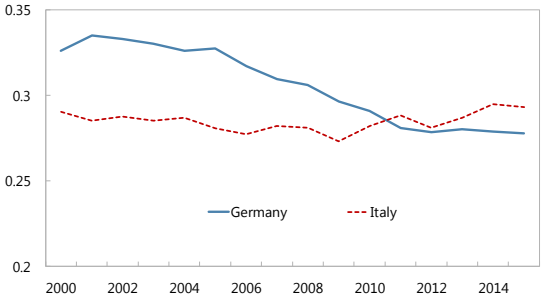
14. Euro area economies' convergence performance has fallen short of expectations. Following a catching-up process in the decades before the euro, the convergence of EA-12 countries' per capita incomes has stalled under EMU. New euro members continued to converge up to their accession, though this process slowed during the financial crisis. Convergence among euro area countries is nevertheless stronger than among EU-countries, supporting our conclusion that the euro is not the reason for the slowdown in convergence. Rather, disappointing productivity growth in countries with lower per capita incomes appears to be the key factor holding back convergence.

15. Policy efforts to foster convergence should focus on raising productivity growth. Structural reforms would help improve productivity growth in lagging countries. While the central level can help push productivity-enhancing reforms by deepening the single market and the effective use of EU instruments, the main responsibility for reviving productivity growth rests at the national level. Empirical research has shown that structural reforms play an essential role in boosting productivity growth (Adler et al., 2017). Furthermore, Banerji et al. (2017) shows that labor and product market reforms have a larger impact on productivity growth in countries with low initial productivity levels, thereby providing an important tool to restart convergence.

Box 1. Regional Convergence in Italy and Germany

Significant differences in per capita income levels exist within Italy and Germany. Looking at Eurostat regional data, per capita GDP in purchasing power standards (PPS) varies greatly across German and Italian regions. In both cases, the per capita income level in the richest region is approximately twice that in the poorest. Overall, there is a similar level of regional dispersion, with the coefficient of variation of PPS GDP per capita for Germany's sixteen *Länder* just below 0.28 in 2015 and a little above 0.29 for Italy's five regions (chart).

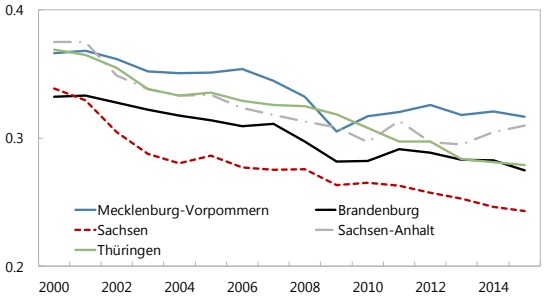
σ-Convergence within Germany and Italy
Coefficient of variation, PPS GDP per capita.



Sources: Eurostat, and IMF staff calculations.

There has been some convergence across German regions, supported by a rise in per capita incomes in the East German *Länder*. While data is only available from 2000 and provides an incomplete picture, the regional dispersion of per capita incomes in Germany declined noticeably between 2000 and 2015, indicating σ-convergence. Looking at the coefficient of variation of the East German *Länder* vis-à-vis the West German average, convergence appears to be driven by the catch-up of the former with their West German peers (chart).

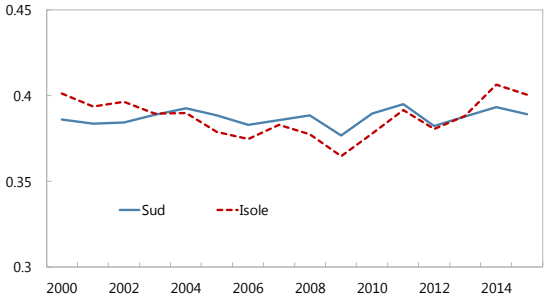
σ-Convergence of East German Länder
Coefficient of variation vis-a-vis West German average, PPS GDP per capita



Sources: Eurostat, and IMF staff calculations.

Italian regions have not converged in recent years. Unlike in Germany, the overall regional dispersion of per capita income in Italy has remained roughly unchanged over the past 16 years. The economically weaker regions in the south have failed to convergence toward the rest of the country, with the result that their coefficients of variation vis-à-vis the central and north Italian regional average are now significantly higher than those between the East and West German *Länder* (charts).

σ-Convergence of Southern Italian Regions
Coefficient of variation vis-a-vis North and Central Italian average, PPS GDP per capita.



Sources: Eurostat, and IMF staff calculations.

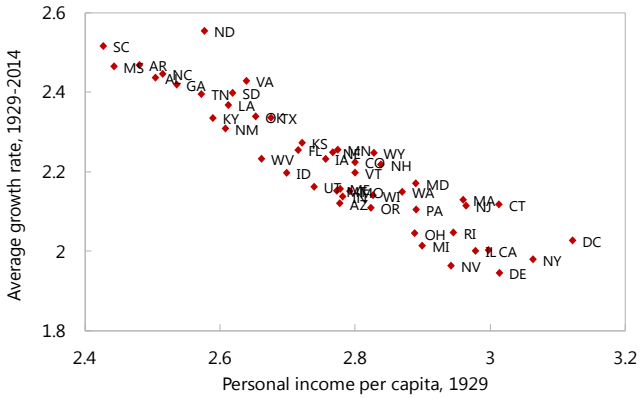
Box 2. Real Income Convergence Across U.S. States

Updating Barro and Sala-i-Martin (1992), U.S. states continue to show clear evidence of convergence. Using data for personal income per capita since 1929, a more adequate time horizon for convergence analysis, we find that poorer U.S. states grew faster than richer ones (β-convergence) and that income dispersion was reduced considerably until the 1970s, remaining flat thereafter (σ-convergence).

The U.S. and the euro area are not directly comparable, as the U.S. is a federation, and has greater labor mobility. The strong income convergence across U.S. states may also be supported by fiscal transfers.

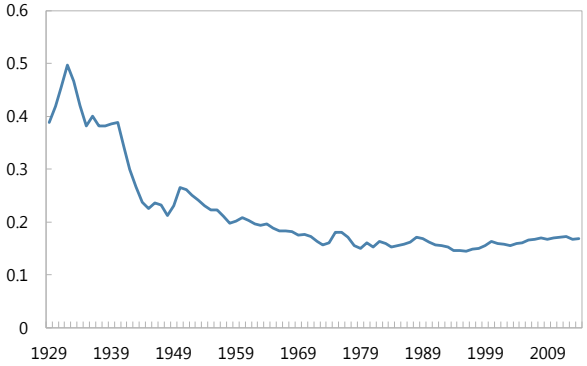
Interestingly, however, income dispersion across U.S. states is in the same ball park as dispersion across euro area countries. The coefficient of variation across U.S. states is currently 0.17, above the lowest level of EA-12 countries in 1998 (0.15), but below its current level (0.26). This suggests that income convergence may not be crucial for a well-functioning monetary union, in particular if fiscal transfers are allowed to smooth out the impact of asymmetric shocks.

β-Convergence Across U.S. States, 1929-2014
(Per capita personal income)



Sources: U.S. Bureau of Economic Analysis.

σ-Convergence Across U.S. States 1929-2014
(Per capita personal income)



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CAN STRUCTURAL REFORMS FOSTER REAL CONVERGENCE IN THE EURO AREA?[1]

A lack of productivity catch-up—lower productivity growth in countries with lower initial per capita income and productivity—explains much of the lack of income convergence within the euro area. This paper shows that countries with lower initial productivity levels can have larger productivity gains from labor and product market reforms than countries with higher initial productivity. This points to structural reforms as critical to reducing productivity gaps to foster real income convergence.

A. Context

1. There has been a secular decline in productivity across all advanced economies. This decline occurred even before the global financial crisis because of several factors. First, aggregate productivity declined due to the reallocation of resources toward sectors where productivity growth was slower, and declining productivity growth within sectors which accounted for the bulk of employment and economic activity (Dabla Norris and others, 2015). Second, structural headwinds—from an aging workforce, slower human capital accumulation and slowing trade integration—also contributed to the decline in productivity (Aiyar and others, 2016; IMF 2016a). Finally, in the aftermath of the global financial crisis, some euro area countries have displayed persistent productivity losses stemming from weak corporate and bank balance sheets; adverse feedback loop of weak aggregate demand, investment and capital-embodied technological change; and elevated economic and policy uncertainty (Adler and others, 2017).

2. In addition, there have been significant and persistent productivity differentials across countries in the euro area. These productivity differences pre-dated, but were aggravated by, the global financial crisis and took place against the background of the wider long-term slowdown of productivity in all advanced economies (as noted above).

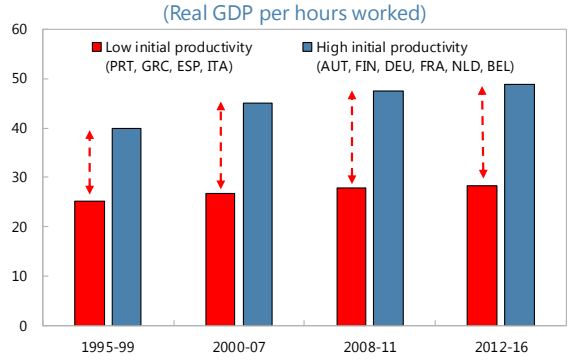
- *There has been little catch-up in labor productivity*. Productivity gaps between euro area countries have persisted over the years (Figure 1). Countries with higher levels of labor productivity in 1999 (i.e., before the euro was introduced) have continued to witness a rise in labor productivity since then, in sharp contrast with the stagnant labor productivity levels in countries which already had low productivity in 1999 (left panel, Figure 1). This led to a widening gap in labor productivity within the euro area over time. As a result, the dispersion of labor productivity levels between EA-12 countries has remained broadly unchanged over the past 20 years, displaying a lack of σ-convergence (right panel, Figure 1).[2]

[1] Prepared by Angana Banerji, Christian Ebeke, Hanni Schoelermann and Jesse Siminitz (all EUR) as well as Ksenia Koloskova (RES).

[2] See Schoelermann, H. (forthcoming) for a detailed analysis of real income convergence in the euro area.

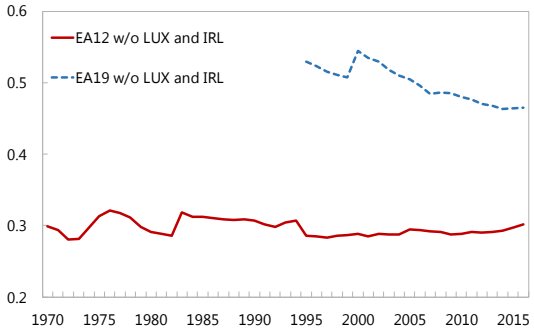
Figure 1. Cross-Country Labor Productivity Gaps in the Euro Area

Labor Productivity in Euro Area
(Real GDP per hours worked)



Sources: AMECO; and IMF staff calculations.
Note: Productivity groups defined on the basis of labor productivity in 1999. Low initial productivity is the average of countries below the median in 1999 and high initial productivity is average of countries above the median in 1999. The data is PPP adjusted.

σ-Convergence in Labor Productivity (excl. LUX and IRL)
Coefficient of variation of real GDP per hour worked

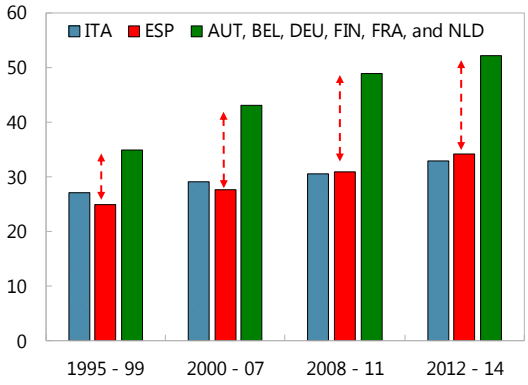


Sources: AMECO, Haver Analytics, and IMF staff calculations.
Note. σ-Convergence is defined as dispersion (standard deviation over the mean) of real per capita income levels across a group of economies over time. EA-12 and EA-19 excludes Luxembourg and Ireland as these countries are outliers given their high PPP-adjusted GDP per capita income levels.

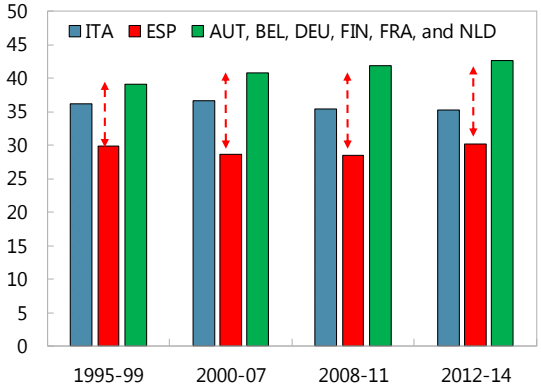
- *Productivity gaps exist even at the sectoral level* (Figure 2). The median labor productivity level in the manufacturing sector in Spain and Italy remains well below that of other euro area countries even though it is on a rising trend. The gaps are narrower in the service sector. But it is noteworthy that, even here, the productivity levels have stagnated over the last two decades in Italy and Spain, whereas productivity levels in other euro area countries are on a rising trend.

Figure 2. Cross-Country Sectoral Labor Productivity Gaps in the Euro Area

Hourly Labor Productivity Level in Manufacturing
(Real Value Added Per Hour Worked)



Hourly Labor Productivity Level in Services
(Real Value Added Per Hour Worked)

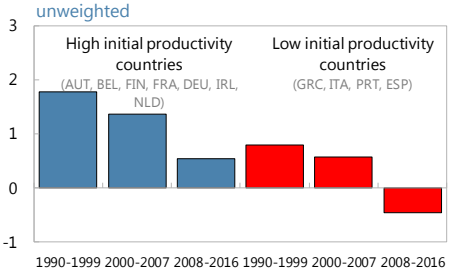


Source: EU KLEMS (2016) and IMF staff calculations.
Note: The green bar is the median productivity level in manufacturing and services sector for the listed countries. The data are not PPP adjusted.

- *Moreover, while TFP growth has slowed across the board it has declined faster for countries with lower initial productivity levels* (text figure). TFP growth—derived from decomposing income per capita growth into capital, labor and TFP contributions—has been particularly weak in the four countries that had the lowest labor productivity in 1999 (Greece, Italy, Portugal and Spain).

Compared to their EA-12 peers, TFP growth in these countries accounts for a smaller share of total output growth, both before and after 1999, pointing to structural features as part of the underlying explanation. In the aftermath of the crisis, TFP even shrunk due to the failure to resolve crisis legacies (Adler and others, 2017).

TFP Dynamics
Average annual per capita growth rates in percent, unweighted



Note: Productivity groups defined on the basis of labor productivity in 1999. The cutoff for the low and high initial productive countries is based on the median of the observed productivity value in 1999. Low initial productivity is the average of countries below the median in 1999 and high initial productivity is average of countries above the median in 1999. No 1990s data available for Austria.
Sources: AMECO, Haver Analytics, and IMF staff calculations.

3. The persistent differences in productivity led to the lack of real income convergence within the euro area (based on Schoelermann (forthcoming), ECB 2015, ECB (forthcoming), Franks and others, (forthcoming)).[3] Before the global financial crisis, there was steady income convergence in the period leading up to the introduction of the euro. After the euro was introduced, convergence stalled, followed by divergence starting with the global financial crisis. At the same time, countries that joined the euro area from 2007 onwards experienced continued convergence in the run-up to their accession.

4. This paper examines the role of structural reforms in reducing the divergence of productivity within the euro area. There is an extensive literature which shows that labor and product market reforms can improve resource allocation and enhance productivity gains. To the extent productivity gains are higher for countries with low initial levels of productivity than they are for countries with high initial levels of productivity, they can also narrow productivity differentials over time, thereby facilitating real income convergence.

B. Methodological Framework

5. The analysis focuses on three model specifications to assess how productivity at the country and sector level responds to country- and sector-specific reforms.

Model specification

6. Model 1: Country-level reform, country-specific productivity effects. Following IMF (2016b), and Adler and others (2017), the analysis uses a dynamic approach to identify the effect of labor and product market reforms on real productivity over time, using a sample of 20 European countries over the period 1980 to 2014.[4] The main innovation in this paper is that it models the effect of reforms in a non-linear way by conditioning the effect of reforms on countries' initial

[3] Real convergence is defined in these papers as the process whereby the real per capita GDP levels of lower-income economies catches up with those of higher-income economies on a durable basis.

[4] The sample is restricted to European countries and includes Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Slovak Republic, Spain, Sweden, Switzerland, and the United Kingdom observed over the period 1970 to 2013.

productivity levels. Hence, the model allows us to examine whether the effect of structural reforms is stronger in countries with initially larger productivity gaps.[5] Since reforms have lagged effects on productivity, the non-linear impact of reforms on productivity growth is estimated at different time horizons using the local projections method (Jordà, 2005). Specifically, the model takes the following form:

$$(p_{i,t+h} - p_{i,t-1}) = (\theta_{1,h} + \theta_{2,h} p_{i,t-1}) R_{i,t} + \Gamma_h X_{i,t} + u_i + \gamma_t + \epsilon_{i,t+h} \quad [1]$$

where $p_{i,t+h}$ is the natural logarithm of real hourly labor productivity (defined as real value added divided by total hours worked from the Penn World Tables dataset) in the country *i* in year *t*+*h*. The model 1 is estimated at each yearly horizon *h* = 0, 1, …, 5. The variable $R_{i,t}$ is a binary variable which captures the occurrence of a structural reform at time *t*. The reform can be a product market (PMR) or an employment protection legislation (EPL) reform. Control variables X include the lagged hourly productivity level (in natural logarithm), and contemporaneous and past crisis dummies (defined as annual growth below -3 percent). The crisis dummies help control for the cyclicality of productivity changes within countries as they recover from a crisis. These variables also help ensure that the estimated effect of reforms on productivity growth is not contaminated by the correlation between reforms and cyclical developments as illustrated in IMF 2016b. The model also controls for country and year fixed effects (u_i, γ_t) to account for country-specific unobservable factors and common shocks to all countries, respectively.

7. Model 2: Country-level reform, sector-specific productivity effects. The above analysis is replicated at the sector level to identify the effects of reforms at the country level on productivity growth at the country-specific sectoral level. The identification strategy relies on the assumption that productivity growth at the sectoral level will not directly affect reform adoption and implementation in the country as a whole. To estimate the effect of labor and product market reforms on sectoral productivity growth, an amended version of equation [1] above is estimated at different time horizons using the local projection method:

$$(p_{sc,t+h} - p_{sc,t-1}) = (\theta_{3,h} + \theta_{4,h} p_{sc,t-1}) R_{c,t} + \Gamma_h X_{sc,t} + u_{s,c} + \gamma_t + \epsilon_{sc,t+h} \quad [2]$$

where the subscript *s* denotes the sector, *c* the country, and *t* the year.[6] $p_{sc,t+h}$ is the natural logarithm of real hourly labor productivity in constant euros observed in sector *s* (defined as real euro value added divided by the total number of hours worked by employees engaged in sector *s* in country *c* in year *t*+*h*). The model controls for a rich set of sector-cum-country fixed effects to account for time-invariant factors that are specific to sectors belonging to different countries such as the size of sectoral employment, sector*country and year fixed effects.

8. Model 3: Sector-specific reform, sector-specific productivity effects. The availability of disaggregated sectoral data makes it possible to identify the impact of sector-specific reforms on

[5] In the absence of data on TFP levels, the following analysis focuses on labor productivity developments.

[6] In this study, sectors are based on the highest level of aggregation provided in NACE Rev. 2 classification and do not include the financial sector (identified by the letter K).

sector-specific productivity growth. For example, given the availability of the sectoral EUKLEMS data, it is possible to assess the extent to which a reform shock at the sectoral level (such as, the reduction in the number of licenses needed to engage in retail trade, or the reduction in the regulations pertaining to the professional service sector) influences the productivity growth of the retail trade and professional services sectors. The main caveat surrounding this analysis would be the high risk of endogeneity associated with the sector-specific reform as this reform is more likely to be triggered by expected productivity gains in the sector. The model takes the following form where the unit of observation becomes the country and the reform impact is estimated for a given sector. The model controls for the log of employment in the specific sector and country and year fixed effects.

$$\left(p_{c,t+h} - p_{c,t-1}\right) = \left(\theta_{5,h} + \theta_{6,h} p_{c,t-1}\right) R_{c,t} + \Gamma_h X_{c,t} + u_c + \gamma_t + \epsilon_{c,t+h} \quad [3]$$

Data

9. Reform measures. Equations [1] and [2] are estimated using a new narrative-based dataset of major labor and product market reforms that was used in IMF 2016b and Adler and others (2017), and will be published in Duval and others (forthcoming). An important advantage of this database is that it identifies the precise *nature* and timing of *major* legislative and regulatory actions taken by advanced economies since the early 1970s in key labor and product market policy areas.[7, 8] Equation [3] is estimated using sector-specific reforms drawn from the OECD database. Sector-specific reform measures are only available for product market reforms and not labor market reforms.

10. Labor productivity. Equation [1] is estimated using country-level data on labor productivity drawn from Penn World Tables. This data is in international PPP terms, therefore allowing cross-country comparisons in the levels of productivity. Equations [2] and [3] are estimated using the 2016 release of EUKLEMS sectoral data by the European Commission which provides a rich source of information on labor productivity but also employment and other macro variables that are critical to assessing sectoral performance. The sectoral-level data are available for a set of 11 countries (Austria, Belgium, Finland, France, Germany, Italy, Spain, Sweden and the United Kingdom) for 1995–2014. Unlike the country-level productivity data from the Penn World Tables, the EUKLEMS data is

[7] The database identifies all legislative and regulatory actions related to product market regulation and employment protection legislation mentioned in *OECD Economic Surveys*. For any of these actions to qualify as a major reform or "counter-reform"—namely a major policy change in the opposite direction—one of the following criteria has to be met: (1) the *OECD Economic Survey* uses strong normative language to define the action (e.g., "major reform"); (2) the policy action is mentioned repeatedly across different editions of the *OECD Economic Survey*; or (3) the OECD indicator of the regulatory stance displays a very large change (in the 5th percentile of the distribution of the change in the indicator). Consequently, the EPL reform dummy takes values {1; 0; -1}, denoting a deregulating reform, absence of a reform, or a reversal of a reform. For PMR, the analysis focuses on major deregulation in seven network industries and the PMR reform dummy takes value of 1 if there were at least two reforms over three years in one or more of the seven network industries (airlines, gas, electricity, postal services, rail, road transportation, and telecom) and 0 otherwise.

[8] The reform dummy captures only reforms that are sufficiently large. As a robustness check, a forthcoming working paper on this topic will assess the impact of the actual size of reforms. Ebeke (2017) shows that countries with high initial levels of employment protection—and thereby low initial levels of productivity—tend to have a higher probability of big labor market reforms.

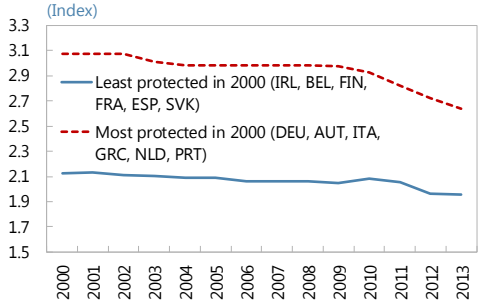
not PPP adjusted. While this may bias the results somewhat, the bias is limited by controlling for sector-country fixed effects. This is because the gap between PPP and non-PPP adjusted labor productivity at the country level is relatively constant over time for a specific country, suggesting that the gaps between PPP and non-PPP adjusted sectoral labor productivity might also be constant over time for a given country, and thereby absorbed by the fixed effects.

Choice of Reforms

11. While the structural reform priorities in euro area countries are wide ranging, the analysis below focuses on employment protection reform and product market reforms. These reforms boost flexibility in the labor market and facilitate the efficiency and the entry exit of firms respectively. The role of product and labor market deregulation in fostering output and productivity growth is well documented (e.g., Adler and others, 2017; Bouis, Duval and Eugster, 2016; Nicoletti and Scarpetta, 2005). The productivity boost arises because such reforms can facilitate the diffusion of technology and innovation across companies, increase the incentives to innovate, and improve resource allocation by weeding out less productive firms and workers (OECD, 2015). The analysis can, in principle, be expanded to include additional reforms.

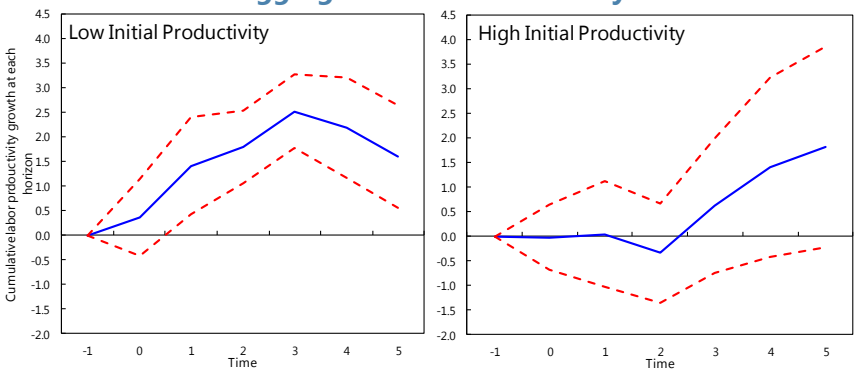
C. Results of Empirical Analysis

12. There have been persistent differences in the degree of labor market flexibility amongst euro area countries. Countries with the most protected labor markets in 2000 continue to remain more protected than the most flexible euro area labor markets despite some progress since the global financial crisis (text figure). Empirical analysis suggests that, should countries with low initial productivity levels further reduce excessively high levels of employment protection on regular work contracts, this could be associated with a significant boost in labor productivity (Figure 3, left panel). The impact of further reforms on countries with high initial productivity levels is likely to be more muted (Figure 3, right panel). The differential productivity implications suggest that reforms could eventually foster real convergence. Similarly, at the sectoral level, the gains in labor productivity tend to be larger for those sectors which had low levels of productivity to begin with compared to the high initial productivity sectors (Figure 4, right panel versus left panel, respectively).



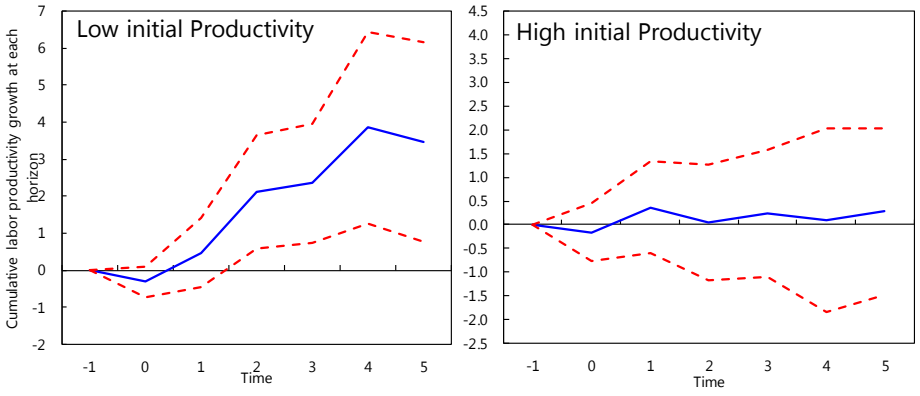
Source: OECD/IDB Employment Protection Database.
Note: The indicator measures the strictness of regulation of individual dismissal of employees on regular/indefinite contracts. Calculated across 21 aspects of employment protection regulation and then converted into a score of measured on a 0-6 scale, with higher values representing stricter regulation. The cutoff for the most and least regulated countries is based on the median of the observed EPL value in 2000. Least protected index is the average of countries below the median in 2000 (i.e. least regulated) and most protected is average of countries above the median in 2000 (i.e. most regulated).

Figure 3. Estimated Impact of Employment Protection Reform on Aggregate Labor Productivity



Source: IMF staff estimates.
Note: See footnote 7 of the paper for the definition of the reforms. The shock occurs at t = 0. The x-axis measures years after the reform effects.The dependent variable is cumulative labor productivity growth at each horizon. The estimation method is the local projection method (Jorda 2005) –equation [1]– and the reform dummy enters additively, and in interaction with lagged log level of productivity. The models control for lagged log of productivity level, past crisis dummies, country and year fixed effects. The dashed lines denote 90 percent confidence bands.

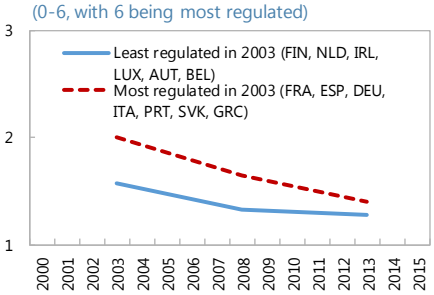
Figure 4. Estimated Impact of Employment Protection Reform on Sectoral Labor Productivity



Source: IMF staff estimates.
Note: See footnote 7 of the paper for the definition of the reforms. The shock occurs at t = 0. The x-axis measures years after the reform effects.The dependent variable is cumulative labor productivity growth at each horizon. The estimation method is the local projection method (Jorda 2005) –equation [1]– and the reform dummy enters additively, and in interaction with lagged log level of productivity. The models control for the log of sectoral employment, sector*country and year fixed effects. The dashed lines denote 90 percent confidence bands.

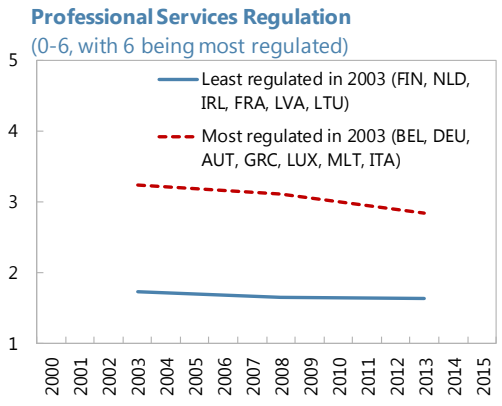
13. Differences in product market efficiency and flexibility have persisted across euro area countries. The gaps in the overall OECD index of product market flexibility (PMR) have closed significantly over time (text figure), and especially after the crisis, in part due to the important role of EU-legislated reforms in network industries. However, at a more granular level, the gaps in the professional services sector regulations and business climate have marginally narrowed but not closed (Figure 5, right panel), whereas the gaps in the retail trade sector have widened as reforms appear to have occurred in the better performing countries (Figure 5, left panel).

Product Market Reform
(0-6, with 6 being most regulated)

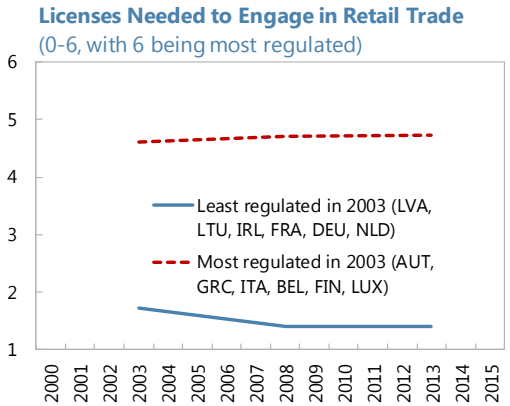


Source: OECD, Product Market Regulation Database.
Note: Product market reform indicators are normalized on a 0-6 scale, where lower values reflect a more competition-friendly regulatory stance. The cutoff for the most and least regulated countries is based on the median of the observed product market reform value in 2003. Least protected index is the average of countries below the median in 2003 (i.e. least regulated) and most protected is average of countries above the median in 2003 (i.e. most regulated).

Figure 5. Evolution of Sector-Specific Measures of Product Market Flexibility



Source: OECD, Product Market Regulation Database.
Note: Professional services regulation indicators are normalized on a 0-6 scale, where lower values reflect a more competition-friendly regulatory stance. The cutoff for the most and least regulated countries is based on the median of the observed professional services regulation value in 2000. Least protected index is the average of countries below the median in 2000 (i.e. least regulated) and most protected is average of countries above the median in 2000 (i.e. most regulated).



Source: OECD, Product Market Regulation Database.
Note: Retail trade regulation indicators are normalized on a 0-6 scale, where lower values reflect a more competition-friendly regulatory stance. The cutoff for the most and least regulated countries is based on the median of the observed licenses needed regulation value in 2000. Least protected index is the average of countries below the median in 2000 (i.e. least regulated) and most protected is average of countries above the median in 2000 (i.e. most regulated).

14. Product market reforms can bridge productivity gaps. Were countries with low initial levels of aggregate labor productivity to implement product market reforms, they would receive a more significant boost to productivity than those with high levels of initial productivity (Figure 6, top panel). These results also hold at the sectoral level across countries as well as at the sector specific level. Thus, the cumulative impact of product market reforms on sectoral productivity is larger over time for sectors with low productivity levels versus high productivity sectors (Figure 6, middle panel). Likewise, at the sector-specific level, reforms that lower entry barriers, for example, in the professional services sector, have a greater impact on productivity in countries where the initial productivity in this sector was low (Figure 6, last panel).

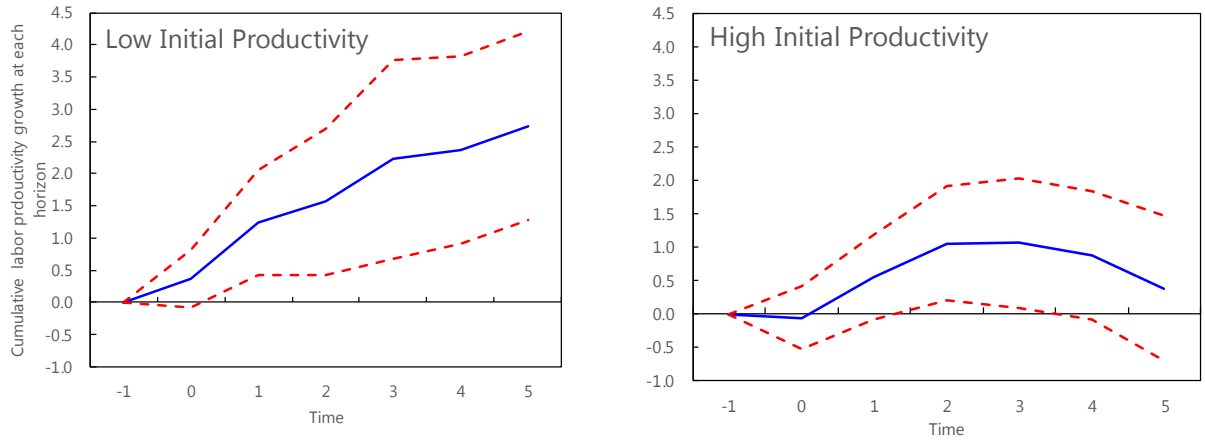
D. Conclusions

15. The marginal return from reforms is higher for countries or sectors that are further away from the productivity frontier. The intuition for these results is as follows. Since low productivity countries tend to also be those that exhibit significant resource misallocation, there is greater scope for reforms to move factors of production toward the most productive sectors. Moreover, reforms which facilitate the entry of productive workers and firms and the exit of less productive workers and firms may be disproportionally beneficial in low-productivity countries. This is because such reforms would allow the most productive firms to attract the most productive workers, while providing incentives for boosting innovation—including through greater investment in technology and human capital—in the face of stronger competition. Finally, empirical evidence suggests that countries with large labor market rigidities (and therefore low productivity) tend to have a higher probability and intensity of labor market reform when compared to countries with low labor market rigidities (Ebeke, 2017). All these factors may help explain why reforms are likely to be stronger in countries in need of a bigger supply-side boost.

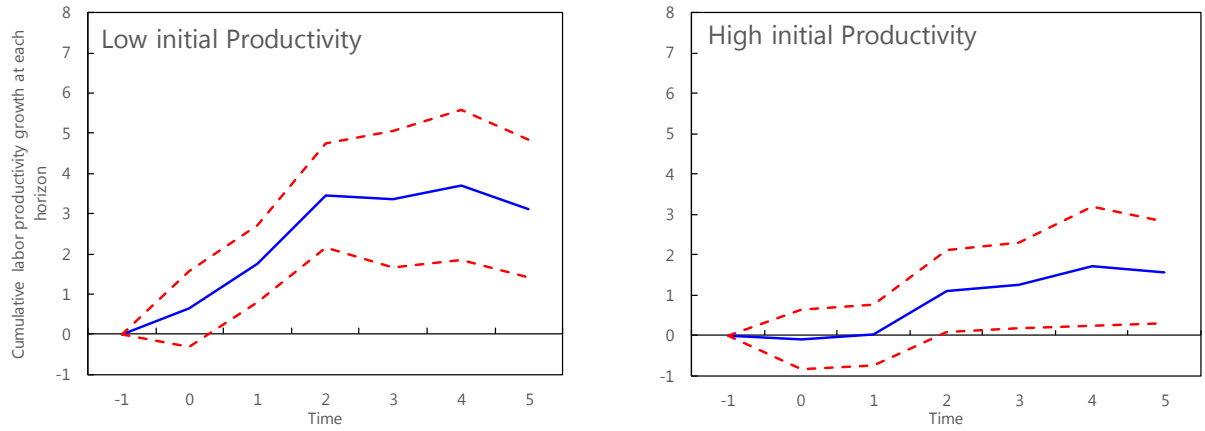
Figure 6. Effect of Product Market Reforms on Labor Productivity in Europe

(Percent)

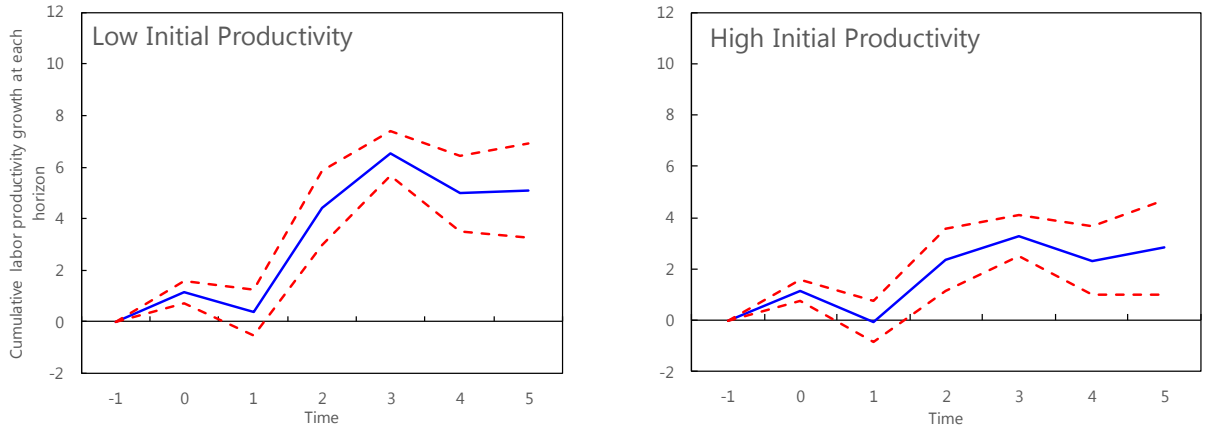
Estimated effect of lower product market regulations on aggregate labor productivity



Estimated effect of lower product market regulations on sectoral labor productivity



Estimated effect of Lower regulatory barriers in professional services on labor productivity in the professional services sector



Source: IMF staff estimates.

Note. See footnote 7 of the paper for the definition of reforms. The shock occurs at t = 0. The x-axis measures years after the reform effects. The dependent variable is cumulative labor productivity growth at each horizon. The estimation method is the local projection method (Jorda 2005) and the reform dummy enters additively, and in interaction with lagged log level of productivity. The models control for lagged log of productivity level, past crisis dummies, country and year fixed effects. The dashed lines denote 90 percent confidence bands.

16. Policy implications. Labor and product market reforms need to be implemented in all euro area countries to reverse the long-term secular decline in productivity and facilitate adjustment to challenges from technological innovation. These reforms are especially important in countries with low initial productivity levels such as Greece, Italy, Portugal and Spain because the productivity effects of reform are likely to be greater in these countries, allowing them to catch up with the higher productivity euro area countries. By helping to narrow productivity differences, reforms will help reduce productivity and competitiveness gaps, reduce current account imbalances and foster real convergence. Reforms should also be accompanied by measures to improve labor force participation and address the crisis legacies of weak balance sheets and economic and policy uncertainty (Adler and others, 2017).

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EXTERNAL ADJUSTMENT IN EUROPE: COMPETITIVENESS, THE REAL EXCHANGE RATE, AND THE TRADE BALANCE[1]

Large and persistent competitiveness gaps within the euro area (EA), as captured by labor cost and productivity differentials, are often cited as contributing to the large external imbalances of some EA countries. Using a newly constructed dataset, we unpack developments in the real effective exchange rate (REER) on a unit labor cost (ULC) basis, which incorporates wages and labor productivity. We examine the contributions of the nominal effective exchange rate (NEER), own ULCs, trading partner ULCs (within and outside the EA), and underlying ULC components. There were large differences in own ULC inflation across EA countries prior to the crisis, exacerbating cost gaps. Despite some marked adjustments post crisis, gaps remain. Since the euro adoption, changes in trading partners outside the EA—but not within—have dominated trading partner ULC changes. We find evidence that countries' ULC-based REER appreciations are correlated with lower trade balances, with the relationship stronger for EA countries. Unpacking the REER, different components exhibit different associations with the trade balance. Going forward, further declines in own ULC could enhance competitiveness, supporting external adjustment, but this should occur mainly through rises in total factor productivity (TFP), also boosting income.

A. Introduction

1. Competitiveness gaps between EA countries are often cited as obstacles to their external adjustment (ECB, 2012; Chen, Milesi-Ferretti, and Tressel, 2013). Several EA countries have recently had, or continue to have, large and persistent current account balances, whether deficits (such as Spain in the 2000s) or surpluses (such as Germany in the later 2000s up to today), leading to rising vulnerabilities to either sudden stops or adverse external wealth shocks. In parallel, differences in ULCs between EA countries grew post-euro adoption, with persistent deficit countries often seeing large rises while costs in persistent surplus countries tended to be relatively stable. This experience and the literature suggest that changes in competitiveness can play a role in facilitating external adjustment, helping to shrink or even reverse large and persistent current accounts and thereby reduce external vulnerabilities (IMF, 2015).

2. In this paper, we examine how competitiveness, measured by the relative ULC and its components, has evolved in the EA and how it is associated with the trade balance. To do so, we first construct the ULC-based REER bottom-up, allowing us to decompose each country's REER

[1] John Bluedorn and Huidan Lin (EUR). Xiaobo Shao provided outstanding research assistance. We would like to thank staff from the European Commission for their helpful comments and feedback.

and its changes into its bilateral elements (that is, *vis-à-vis* trading partners or trading partner groups). We are also able to further decompose the REER by component—the NEER, wages (either in common USD or in local currency units, LCUs, if unadjusted by nominal exchange rates and defined as compensation per unit of employment), and labor productivity (defined as real output per unit of employment).[2] We then estimate the association of these REER developments (including by component) with the trade balance, which typically accounts for the bulk of the variability in the current account. In some robustness checks, we consider how the estimated association with the relative ULC changes when other cost and non-cost competitiveness controls, such as energy costs (an additional production input) and the investment climate, are included. We emphasize that the results presented here do not attempt to control for potential endogeneity, nor address questions or causation. Instead, the focus is on the simple historical, statistical association between the REER, its underlying components, and the trade balance, for countries either inside or outside the EA.

3. Some of the divergences in ULCs between EA countries have narrowed since the crisis, but the adjustment has relied heavily on wage and job cuts in persistent deficit economies. Since euro adoption the relative ULCs of EA countries have mostly been driven by own ULC developments, but ULC changes among trading partners outside the EA have also contributed importantly. Throughout, we will use the terms "REER," "REER-ULC," and "relative ULC" interchangeably. Drivers of the relative ULC have differed markedly across countries. In Germany, the major contributor is lower relative wage growth in both pre- and post-crisis periods. Post-crisis adjustment in some net external debtors (Greece, Portugal, Spain, Italy, and France) benefited, to varying degrees, from lower relative wage growth. Some other countries (such as Portugal and Spain) benefited more from higher relative productivity post-crisis. Relative labor productivity improvements before 2013 mainly reflected falling employment rather than rising output. Over 2014–15, the pace of relative productivity improvement moderated, but with different drivers across countries—in Spain, both relative employment and output rose, while in Italy, output growth continued to be slower than trading partners and there was little rise in relative employment.

4. REER appreciations are associated with lower trade balances. The statistical relationship is stronger for EA countries than for other advanced economies. Unpacking ULCs into wages and labor productivity (real output and employment) reveals that wage moderation and productivity rises (whether due to lower employment or higher real output) are associated with a rise in the trade balance.

5. Going forward, further declines in own ULCs by net debtor countries could enhance competitiveness and facilitate external adjustment. Much of the earlier REER adjustment by net external debtors has been accomplished through wage moderation and job cuts. In countries where nominal wages remain high and labor markets rigid, further wage moderation could help improve

[2] Wages and labor productivity are defined on a per worker basis in the core analytic work. We also considered these variables defined on an hourly basis in a robustness check, finding that the results were generally similar to what is presented here.

competitiveness.[3] However, in general, a persistent boost in TFP growth would deliver more continuing competitiveness improvements and have the additional benefit of boosting income growth, making it a more socially desirable way to achieve adjustment over the medium-term. The onus would then lie on structural reforms and productivity-enhancing investments to raise countries' growth potential, which would help foster convergence as well as potentially contribute to reductions in external imbalances.

B. Data Construction and Stylized Facts

6. The REER/relative ULC is constructed from the bottom-up in order to decompose it into components on a bilateral basis. To maximize coverage and ensure cross-country comparability, we primarily draw upon the Penn World Table (version 9.0) from 1985–2014, splicing data forward where possible through 2015 using a variety of datasets, including the Conference Board's *Total Economy Database*, the IMF's *World Economic Outlook*, and the European Commission's (EC) AMECO database (further details are in Appendix I). The REER and NEER are defined as:

$$\ln REER_{i,t} = \ln e_{i,t} + \ln P_{i,t} - \sum_j w_j \left(\ln e_{j,t} + \ln P_{j,t}\right) \text{ [1]}$$

$$\ln NEER_{i,t} = \ln e_{i,t} - \sum_j w_j \ln e_{j,t} \text{ [2]}$$

where i indexes countries, t indexes years, j indexes trading partners, e is the exchange rate in USD per local currency unit (LCU), P is the relevant price measure (here ULC), * indicates the variable is the weighted average of trading partners, and w is the weight on a given trading partner, such that $\sum_j w_j = 1$ and $w_j \in [0,1] \forall j$. Weights are taken from the IMF's Statistics Department's Information Notice System (INS) database, calculated from bilateral trade flows and domestic sales for commodities, manufacturing goods, and services.[4] They capture how much a country competes with a given trading partner in particular markets, both at home and abroad. These log measures are additive in their weighted components, enabling us to construct various groupings of the trading partner factors by country (for example, EA and non-EA; EA net creditors, EA net debtors, and others). Recall that the ULC is defined to be the ratio of the nominal wage to real labor productivity. This implies that the log ULC may be further decomposed into the log nominal wage and log real labor productivity components, where the latter is the difference between log real output and log employment (see equation [3]). Thus, another expression for the REER/relative ULC is:

[3] Spilimbergo and others (2015) illustrate how wage moderation during a crisis can generate the additional benefit of a positive effect on output, helping to buffer the economy against adverse shocks.

[4] See Bayoumi, Lee, and Jayanthi (2005) for full details on the weights construction. In essence, the weights capture how much country i and country j tend to compete with each other in trade. The weight for country i of country j thus depends on the presence of country j in a typical global market for k (for example, commodities, manufacturing goods, and services) and the importance of this market k to country i.

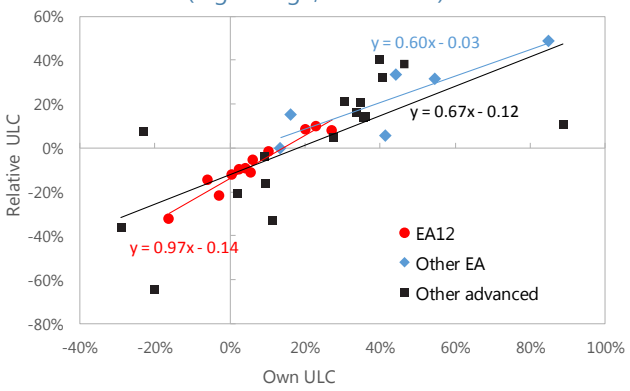
$$\Delta \ln REER_{i,t} = \{\Delta \ln e_{i,t} - \Delta \ln e^*_{i,t}\} + \{\Delta \ln c_{i,t} - \Delta \ln c^*_{i,t}\} - \{\Delta \ln Y_{i,t} - \Delta \ln Y^*_{i,t}\} + \{\Delta \ln L_{i,t} - \Delta \ln L^*_{i,t}\}, \quad [3]$$

where the terms are the approximate growth rates of the NEER, relative wage, relative output, and relative employment, respectively, and *c* denotes the wage, *Y* is real output, and *L* is labor employed. Since all elements are denominated in common units (2011 PPP-adjusted international dollars), the REER may be compared in levels across countries.[5]

7. Some EA countries saw large rises in their own ULCs from 1999 to 2008, but these have partly unwound post-crisis. After euro adoption in 1999, ULCs (in LCU) increased in most EA countries (except Germany and the Netherlands), with nominal wages outpacing real labor productivity (Figure 1). ULC rises tended to be larger in the net external debtor countries among the EA-12 (such as Greece, Ireland, Italy, Portugal, and Spain) and other EA countries who joined the monetary union later. This pattern partly reversed, led by various degrees of improvement in labor productivity, mostly during 2009–13. In Greece, Portugal, and Spain, the ULC reduction was driven largely by labor shedding, accompanied by wage declines in the case of Greece. Since 2014, Spain's ULC has been stable, with wage growth broadly in line with labor productivity (supported by job creation).[6] In all countries apart from Greece, wages rose during 2013–15, but at a much slower pace than in previous periods.

8. Overall REER changes in the EA since 1999 are largely explained by changes in own ULC. Interestingly, among the EA-12, a change in own ULC (in LCU) almost fully translates into a change in the relative ULC. The correlation is much weaker though for other EA countries and other advanced economies, suggesting that, for those economies, the increases (decreases) in ULC may be partly offset by currency depreciation (appreciation) and/or increases (decreases) in foreign ULC (text figure, right).

ULC-based REER and ULC in LCU
(log change, 1999-2015)

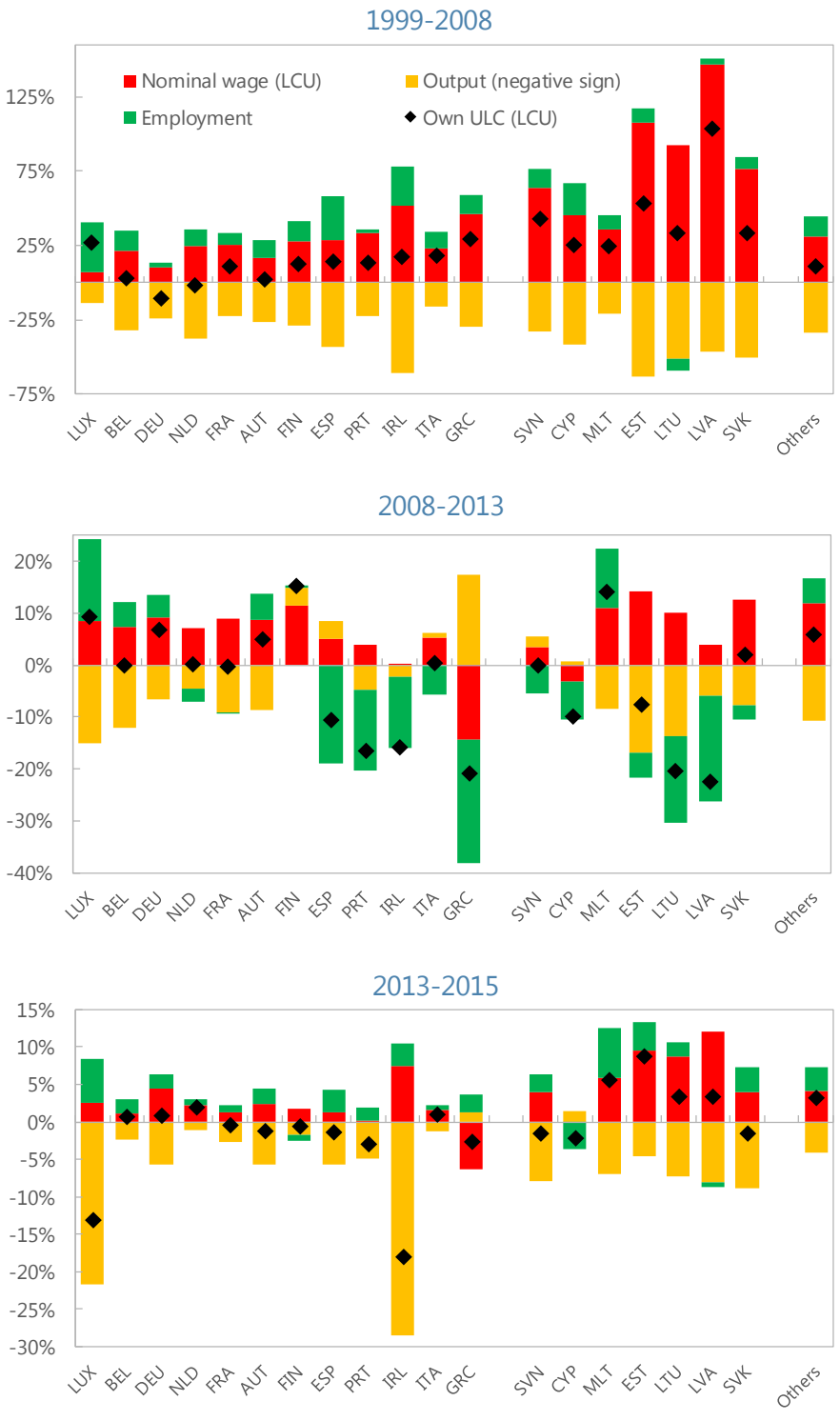


Sources: Penn World Table; Eurostat; INS; WEO; and IMF staff calculations.

[5] For the EA countries, the correlation between our ULC-based REER measure, constructed *vis-à-vis* all trading partners, and that from Eurostat relative to 28 trading partners is strong, with the average correlation coefficient of 0.7 across countries during 1999–2015.

[6] There is evidence that the 2012 labor market reforms implemented in Spain contributed to wage moderation and employment growth and made the labor market more resilient to shocks (IMF, 2015).

Figure 1. Decomposition of Own Unit Labor Cost
(log change)

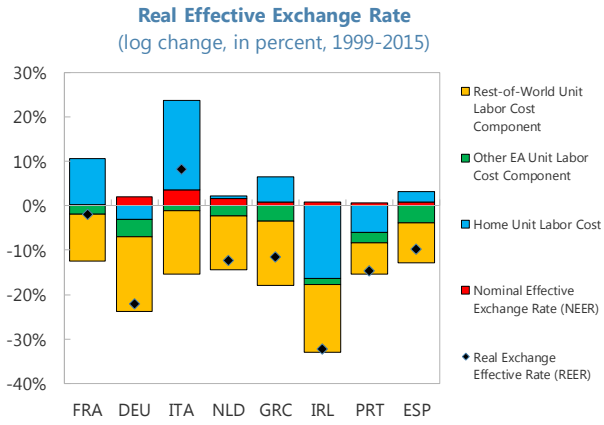


Sources: Penn World Table and IMF staff calculations.

Note: "Others" denotes average of 16 advanced economies outside the euro area. Countries are ordered by their 1999 ULC level.

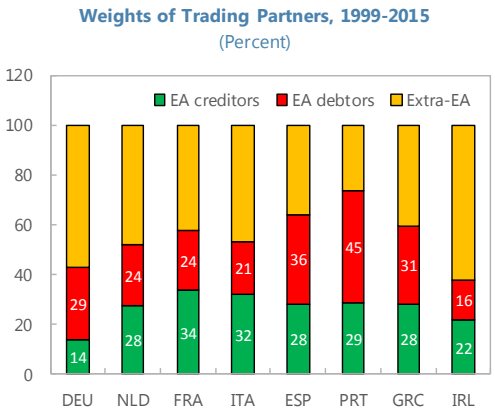
9. Decomposing the REER into relative wage, output, and employment components reveals significant cross-country variation in underlying drivers since 1999. In Germany, REER developments were heavily affected by relative wages both before and after crisis. In Italy, stagnant growth worsened relative output, driving REER appreciation prior to the crisis and partly offsetting post-crisis moderation in relative wages and employment. In Spain, the pre-crisis REER appreciation reflected growing relative wages and shrinking relative productivity but this pattern is now reversing. In Greece, the appreciation largely reflected increasing relative wages, but now the REER is falling from reductions in relative wages and employment (Figure 2).

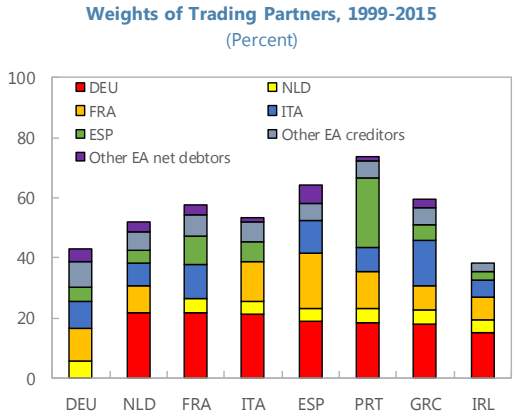
10. Other EA trading partner ULC changes account for little of the overall REER change at the EA country level since the euro adoption. Over this period, all major EA countries (except Italy) experienced a REER depreciation, with Germany and Ireland seeing the largest declines. Both own ULC and the ULC of trading partners outside the EA have tended to be the most important components of REER changes, despite the majority of EA country competition in trade typically occurring between EA countries (see below). This difference in adjustment *vis-à-vis* EA/non-EA trading partners is there even when the NEER is taken account of (text figure, right).



Sources: Penn World Table 9.0; AMECO; Total Economy Database; WEO; staff calculation.

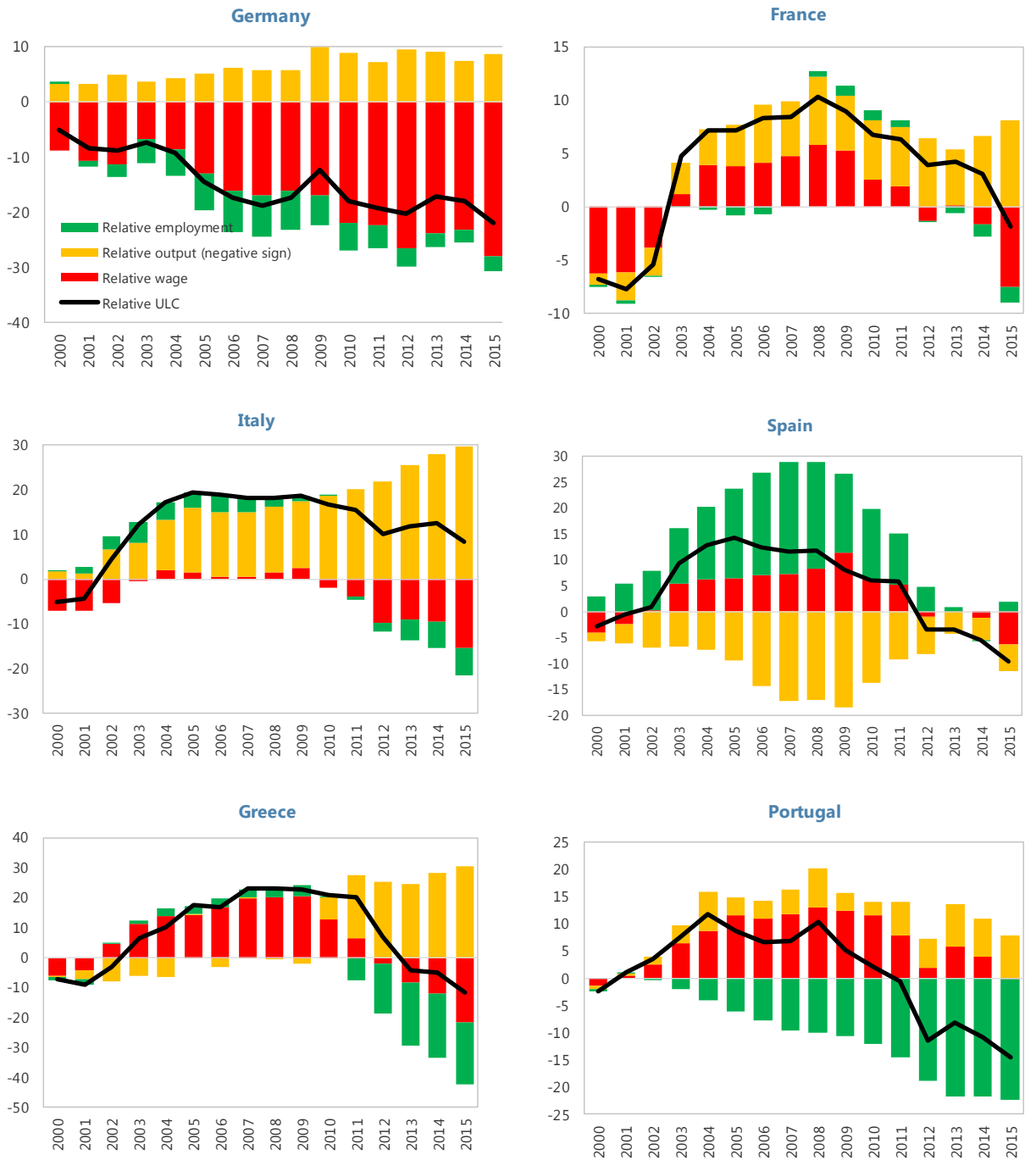
11. Delving into the bilateral aspects of the REER reveals that, apart from Germany and Ireland, the majority of EA countries' competition in trade is with other EA countries. Focusing on a subset of EA countries and using averages over 1999–2015, trade weights *vis-à-vis* other EA countries range from about 40 percent (Germany) to closer to 75 percent (Portugal; text figures, below). Importantly, any components of the REER *vis-à-vis* other EA countries do not benefit from a flexible, bilateral nominal exchange rate. In these cases, bilateral external competitiveness is solely a function of relative prices in local currency.





Sources: IMF Information Notice System (INS) and IMF staff calculations.

Figure 2. Decomposition of Relative Unit Labor Cost (REER)
(log level, 1999=0, in percent)



Sources: Penn World Table 9.0; AMECO; Total Economy Database; WEO; IMF staff calculation.

12. The scope for simultaneous external adjustment by EA countries may vary with their exposure to net external debtors versus creditors within the EA. Trade weights against other EA countries can be further broken down according to the net foreign asset position of trading partners

(text figure, above).[7] For Ireland, Italy, France, and the Netherlands, their intra-EA trade weights are mostly *vis-à-vis* EA net external creditors. By contrast, for Germany, Greece, Portugal, and Spain, it is mostly *vis-à-vis* EA net external debtors. This complicates the adjustment for Greece, Portugal, and Spain, since other net external debtors will also tend to need to depreciate their REER, dampening each other's relative price adjustment. Although Germany and the Netherlands are significant trading partners for EA net external debtors, they do not account for the majority of intra-EA trade competition for net external debtors. Hence, although greater inflation or rising ULCs in Germany and the Netherlands would contribute to REER depreciations among EA net external debtors, relative price adjustment *vis-à-vis* the rest of the EA (such as against other net external debtors) is also important.

C. Econometric Analysis and Findings

13. To gauge how the REER adjustment is related to trade adjustment, we estimate the statistical relationship between REER changes and the trade balance (relative to GDP). There is a large literature using various methods to attempt to get at the underlying causal relationship between the REER and the trade balance or the related current account. For example, using a panel VAR model, Diaz Sanchez and Varoudakis (2013) argue that domestic demand shocks have been the most important drivers of current accounts in Europe, although they also find that cost competitiveness has mattered. Relatedly, Wyplosz (2013) argues that competitiveness changes are endogenous to demand shocks, suggesting that competitiveness is a symptom rather than cause. By contrast, Zemanek, Belke, and Schnabl (2010) find that structural reforms can have a large impact on current accounts in Europe, suggesting that policy-driven productivity changes can improve competitiveness and reduce current account deficits. We do not attempt to disentangle these various channels nor argue for one identification scheme over another to determine causation. Instead, we focus on the simple statistical association between the REER, its components, and the trade balance, for countries either inside or outside the EA.

14. The estimation sample consists of 35 advanced economies over the period from 1985–2015 with data at an annual frequency.[8] The baseline linear regression model employed takes the form (equation [4]):

$$\Delta TB_{it} = \beta_{EA}(\Delta \log REER_{it}) \cdot EA_{it} + \beta_{Non-EA}(\Delta \log REER_{it}) \cdot (1 - EA_{it}) + \alpha_i + \alpha_t + \epsilon_{i,t} \quad [4]$$

where *TB* denotes the balance on goods and services (as a percent of GDP), *REER* denotes the real effective exchange rate on a ULC basis, *EA* is a dummy variable, taking the value of one if country *i*

[7] As of end-2015, based on the External Wealth of Nations II database (updated, 2017), the net external creditor countries in the EA are: Austria, Belgium, Germany, Luxembourg, Malta, and the Netherlands whose net international investment position was positive. The rest of the EA are classed as net external debtors.

[8] The definition of an advanced economy comes from the IMF's latest World Economic Outlook—see Appendix I for a full listing.

in year t is a EA country, and α are a set of country and time fixed effects, controlling for unobserved, time-invariant heterogeneity at the country level and common unobserved shocks, respectively.[9] ϵ is a mean-zero, but possibly heteroskedastic and auto- and cross-correlated error term.[10] In general, we expect the β coefficients to be negative, implying that an increase in REER (appreciation) is negatively associated with the trade balance. This relationship could differ between currency union members and those outside.

15. In further specifications, we consider decompositions of the REER terms, to estimate how the REER components are related to the trade balance. The breakdowns substitute in the definitions for REER and its components seen in equations [1], [2], and [3], allowing each separate term to have its own estimated coefficient. In addition to the components of the relative ULC/REER, we also attempt to see if the findings are robust to controlling for other cost competitiveness and non-cost competitiveness variables—in particular, we consider local electricity costs (a key input in many industries; from the International Energy Agency) and the investment climate (an amalgam of indices assessing contract enforcement, expropriation risk, ability to repatriate profits, and payments delays; from the PRS Group).

16. The results suggest that a rising relative ULC is associated with shrinking trade balances and that this correlation is stronger for EA countries (Table 1). In the simplest model specification, the estimates indicate that a one percent depreciation in a EA country's relative ULC is associated with a statistically significant 0.15 percentage points increase in trade balances. By contrast, for non-EA countries, the associated change is less than 0.1 percentage point. NEER depreciation and own ULC are also found to have statistically significant relationships to trade balance changes regardless of EA membership, although the magnitude is slightly larger for EA countries. Consistent with the perspective that it is relative price movements that drive international flows, an increase in foreign ULCs is associated with a rise in the trade balance, but the estimated coefficient is statistically insignificant.

17. Further decomposing the relative ULC suggests that own wage and employment changes are significantly associated with external adjustment. In general, NEER changes are a statistically significant negative correlate for trade balance changes regardless of additional covariates, most consistently for the EA countries. In other words, nominal exchange rate appreciations are associated with shrinking trade balances, in line with priors. Foreign variables tend to have the expected sign, but are typically not statistically significant—higher foreign wages and lower foreign productivity tend to lower the relative ULC, leading to a positive association with the

[9] Panel unit root tests and finding a lack of cointegration led to the decision to use differences. Moreover, tests for a distributed lag structure suggest that focus on the contemporaneous relationship is appropriate. We also considered models similar to Goldstein and Khan (1985), where log level exports and imports are considered separately and include external and domestic demand controls respectively. However, given the pervasive endogeneity issues, we decided to focus on the trade balance in a simple and transparent linear regression, emphasizing that the estimated coefficients should be interpreted solely as indicative of statistical associations rather than any causal effect. See Appendix II for further details on the specification choices.

[10] Standard errors are clustered along the country and time dimensions to account for possible heteroskedasticity, autocorrelation within country, and correlation across countries at the same point in time.

trade balance. Higher own wages (LCU) have a relatively robust negative relationship to the trade balance, with a one percent rise associated with about a 0.2 percentage point decline in the trade balance for EA countries. Own employment rises (which lower labor productivity holding real output constant) also have a relatively robust negative relationship, while own real output (raising productivity and controlling for employment, likely reflecting capital deepening and TFP effects) has a positive, but often statistically insignificant relationship with the trade balance. Overall, own labor productivity improvements appear to be associated with trade balance increases (particularly when controlling for energy costs and the investment climate).

D. Concluding Remarks

18. Since EA countries' competition in trade is largely with other EA countries, the nominal exchange rate may have a more limited role in external adjustment. However, NEER adjustment was still an important component of REER adjustment vis-à-vis non-EA trading partners in both the pre- and post-crisis periods, accounting for similar amounts of REER changes across EA countries. That said, monetary union members may have to rely more on relative price adjustment (whether via LCU inflation or ULC differentials) vis-à-vis all trading partners, both inside and outside the EA, in order to durably improve their competitiveness and adjust their current accounts.

19. Allowing for greater inflation and productivity growth differentials within the EA would help improve some countries' competitiveness, but is likely no panacea. The stylized facts suggest that, for the REER, relative price adjustment against non-EA trading partners is often nearly as important as that against EA trading partners. Above EA average inflation in Germany and other net external creditors would mechanically help the REER-ULC adjustment of EA net external debtors, by lowering their relative wage growth (assuming EA net creditors' price inflation would also be reflected in their wage inflation). However, it should also be accompanied by lower own-country ULC growth in EA net external debtors—wage moderation and higher productivity growth—relative to their trading partners, both inside and outside the EA.

20. Further improvements in own labor productivity by EA net external debtors could have the double impact of encouraging REER adjustment as well as boosting income growth. Although supply-side measures to lift productivity could have an ambiguous impact on the trade balance (and current account), by raising investment and import demand, the results here suggest that on balance, there has been a positive historical association between productivity and the trade balance for the EA countries. Net external debtors' REER adjustment post-crisis has largely occurred through wage moderation and job cuts. In countries where labor market rigidities remain prevalent, further wage moderation could help improve competitiveness. But, in general, raising TFP growth is preferable to achieve adjustment over the medium term, as it has the scope to deliver continuing competitiveness gains while increasing income growth. In that case, structural reforms and productivity-enhancing investments to raise countries' growth potential are key, helping to foster convergence as well as potentially contribute to reductions in external imbalances.

Table 1. Trade Balance, Real Effective Exchange Rate and Its Components

Change in the Balance on Goods and Services (percent of GDP)

	(1)		(2)		(3)		(4)		(5)		(6)	
Explanatory Variable (log change)	EA	Other AE	EA	Other AE	EA	Other AE	EA	Other AE	EA	Other AE	EA	Other AE
Relative ULC	-0.145**	-0.0844**										
	(0.063)	(0.031)										
NEER			-0.105*	-0.0579*	-0.111*	-0.0656**	-0.141**	-0.0487	-0.160*	-0.0580*	-0.184**	-0.04
			(0.054)	(0.030)	(0.064)	(0.030)	(0.065)	(0.040)	(0.084)	(0.031)	(0.071)	(0.030)
Own ULC			-0.161**	-0.120**								
			(0.076)	(0.047)								
Foreign ULC			0.079	0.0586								
			(0.146)	(0.038)								
Own Wage					-0.278***	-0.161***	-0.227**	-0.149***	-0.232*	-0.180***	-0.175	-0.141***
					(0.084)	(0.043)	(0.092)	(0.042)	(0.119)	(0.055)	(0.124)	(0.042)
Foreign Wage					0.169	0.0807**	0.22	0.0573*	0.067	0.118*	0.26	0.114**
					(0.122)	(0.030)	(0.140)	(0.031)	(0.181)	(0.067)	(0.207)	(0.050)
Labor Productivity					0.117	0.0765			0.219**	0.169*		
					(0.089)	(0.068)			(0.085)	(0.091)		
Foreign Labor Productivity					-0.169	-0.0526			-0.561***	-0.279		
					(0.203)	(0.199)			(0.179)	(0.179)		
Own Real Output							0.0977	0.0478			0.195**	0.149
							(0.088)	(0.070)			(0.087)	(0.094)
Foreign Real Output							-0.132	0.0426			-0.513***	-0.11
							(0.217)	(0.188)			(0.156)	(0.148)
Own Employment							-0.231**	-0.333***			-0.337***	-0.489***
							(0.109)	(0.102)			(0.084)	(0.119)
Foreign Employment							0.221	0.398			0.317	0.0945
							(0.476)	(0.314)			(0.276)	(0.323)
Electricity Cost									0.00132	0.0108	-0.0019	0.00794
									(0.012)	(0.011)	(0.014)	(0.009)
Investment Profile Index (log level)									-0.0119	-0.0153*	-0.004	-0.0062
									(0.010)	(0.009)	(0.009)	(0.009)
Country FE	YES		YES		YES		YES		YES		YES	
Year FE	YES		YES		YES		YES		YES		YES	
Observations	940		940		940		940		637		637	
R-squared	0.138		0.152		0.165		0.196		0.28		0.33	

Note: Sample covers advanced economies as defined by the IMF's WEO (35 in total, including all current EA-19 member states). For specifications 5 and 6, local electricity cost data is missing for some countries, dropping the sample to 30 countries. The data are annual, spanning 1985-2015 (30 years). The euro area (EA) results are based only on those countries and years in which they were a member of the euro area (for the EA-11, from 1999; others joined later and in different years). Standard errors are in parentheses under the coefficient estimates and are clustered along two dimensions (country and year) to account for heteroskedasticity, autocorrelation within country, and cross-sectional correlation within year. Statistical signficance levels are denoted by * for 10 percent, ** for 5 percent, and *** for 1 percent.

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Appendix I. Data Definition, Sources, and Country Coverage

Data definitions

Balance on goods and services over GDP: (exports of goods and services – imports of goods and services)/GDP.

Electricity cost: total price per MWh, for industry, in current year PPP USD.

Investment profile index: An assessment of factors affecting the risk to investment that are not covered by other political, economic and financial risk components. The risk rating assigned is the sum of three subcomponents, each with a maximum score of four points and a minimum score of 0 points. A score of 4 points equates to Very Low Risk and a score of 0 points to Very High Risk. The subcomponents include: contract viability/expropriation, profits repatriation, payment delays. Log level is used.

Unit labor cost (ULC): The log ULC is constructed as the log labor share of income plus the log of the Penn World Table v. 9.0 (PWT) GDP price level plus the PWT PPP GDP deflator. That is, ln ULC = ln(*labsh*) + ln(*pl_gdpo*) + ln(*cgdpo*) - ln(*rgdpo*), using PWT variable names.[1] See Feenstra, Inklaar, and Timmer (2015) for further details.

- *labsh*: share of labor compensation in GDP at current national prices
- *pl_gdpo*: price level of GDP (USA = 1 in 2011), equal to the PPP (ratio of nominal GDP to cgdpo) divided by the nominal exchange rate
- *cgdpo*: real GDP at current PPPs (in mil. 2011 US$)
- *rgdpo*: real GDP at chained PPPs (in mil. 2011 US$)

[1] The equation is derived from the following: ln(ULC) = ln(wage per person, in USD) - ln(rgdpo) + ln(employment)
= {ln(wage per person) + ln(employment) - ln(nominal GDP)} + ln(nominal GDP) - ln(rgdpo)
= ln(labsh) + {ln(nominal GDP) - ln(cgdpo)}+ ln(cgdpo) - ln(rgdpo)
= ln(labsh) + ln(pl_gdpo) + ln(cgdpo) - ln(rgdpo).

Data Sources

Indicator	Source
Balance on goods and services	IMF Balance of Payments Statistics
USD per LCU bilateral exchange rate	Penn World Table 9.0 2015 data spliced from IMF World Economic Outlook database
Bilateral trade weights	IMF's Statistics Department's Information Notice System (INS) database
Electricity cost	The International Energy Agency (IEA) Energy Prices and Taxes database via the OECD
Employment	Penn World Table 9.0 2015 data spliced from IMF World Economic Outlook database
Hours worked per employed person	Penn World Table 9.0 2015 data spliced from the Conference Board Total Economy Database
Investment profile index	The PRS Group, the International Country Risk Guide (ICRG) rating
Net international investment position	IMF, External Wealth of Nations Mark II database (Lane and Milesi-Ferretti)
Nominal wage per hour	Penn World Table 9.0; the Conference Board Total Economy Database
Nominal wage per person	Penn World Table 9.0; IMF World Economic Outlook database
Real output per employed person	Penn World Table 9.0; 2015 data spliced from IMF World Economic Outlook database
Real output per hours worked	Penn World Table 9.0; 2015 data spliced from IMF World Economic Outlook database (real output) and the Conference Board Total Economy Database (hours worked)
Unit labor cost (ULC)	Penn World Table 9.0 2015 data spliced from EC DG ECFIN AMECO database; the Conference Board Total Economy Database

Country Coverage

Euro area countries (19)	Other advanced economies (16)
Austria	Australia
Belgium	Canada
Cyprus*	Czech Republic
Estonia	Denmark
Finland	Hong Kong*
France	Iceland
Germany	Israel
Greece	Japan
Ireland	Korea
Italy	New Zealand
Latvia	Norway
Lithuania*	Singapore*
Luxembourg	Sweden
Malta*	Switzerland
Netherlands	United Kingdom
Portugal	United States
Slovak Republic	
Slovenia	
Spain	

Note: Countries with an asterisk (*) do not have data on electricity cost.

Appendix II. Econometric Approach

In the first step, we assessed the stationarity properties in the estimation sample of all the variables in levels via a set of panel unit root tests, under the null that all panels (countries) contain a unit root, including:

- Im, Pesaran, and Shin (2003) test, accounting for country-specific AR parameters, panel means, and a time trend, based on the Augmented Dickey-Fuller test.
- A Fisher-type test due to Choi (2001), accounting for country-specific AR parameters, panel means, a time trend, and a single lag, based on the Phillips-Perron test.

Tests for the trade balance (balance on goods and services) relative to GDP, the key dependent variable, fails to reject the null. Similarly, tests of the log REER-ULC and its components in level terms generally fail to reject the null of unit roots. Consequently, we also tested for cointegration of the trade balance with the REER-ULC using the Westerlund (2007) suite of panel cointegration tests, which take no cointegration as their null. These tests generally fail to reject the null, leading us to specify the regression models in first differences. We also experimented with distributed lag and lagged dependent variable specifications for the change in the trade balance to GDP. The estimates generally revealed little statistically significant effect beyond the contemporaneous impact amongst the distributed lag terms (up to two years were considered) and little role for the lagged dependent variable, leading us to make the specification in first differences with the contemporaneous impact solely considered. A unit root for the log of the investment profile measure of institutional quality was rejected, so it was included in log level terms in the specification where it appears.

INEQUALITY OF OPPORTUNITY, INEQUALITY OF INCOME, AND LONG-TERM GROWTH[1]

Income inequality has increased in several euro area countries over the last few decades. We explore whether the relationship between income inequality and growth depends on equality of opportunity. This question is critical in the euro area where several countries exhibit higher levels of inequality of opportunities. Our econometric results confirm a robust negative effect of widening income disparities on growth in presence of high inequality of opportunity. Reducing income inequality can therefore accelerate growth in the euro area. Over the long-run, addressing the root causes of inequality of opportunity can make growth less sensitive to shifts in income distribution.

A. Income Inequality and Risks to Growth

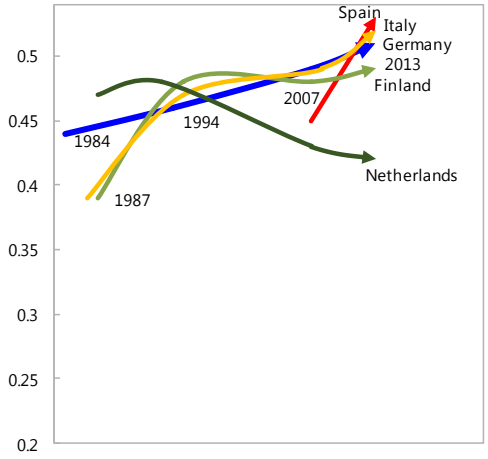
1. Income inequality has increased in a number of euro area countries over the last decades. The rise in market income inequality (measured by the Gini coefficient) explains almost all the increase in inequality in the region. Redistribution has offset only a fraction of this increase, putting a dent on public finances in a number of countries. The increase has been remarkable in several southern European countries which already face important macroeconomic challenges (Figure 1).

2. The rise in market income inequality is often cited as an important contributor to rising populism, societal stress and demands for protection (Alesina and Rodrik, 1994, Persson and Tabellini, 1994, and Alesina et al., 2017). There is a long literature in the social sciences on the tendency for economic insecurity to beget authoritarian and nativist political parties (see Ingleheart and Norris, 2016, for a survey). For example, this has underpinned classic accounts of the rise of fascism in Weimar Germany and Poujadism in France (Lipset, 1960, Bell, 1963, Sauer, 1967). The modern version of this politico-economic argument typically focuses on the growing gaps between winners and losers from global trade or on rising skill-premia due to the march of technology, both of which could drive demand for protectionism. Moreover, stagnant middle class wages and limited job mobility have been advanced as powerful motives for resentment of "outsiders" seen as competing for jobs and benefits (Inglehart, 2016), especially in an era where growing social fragmentation and secularization have eroded traditional collective structures (Inglehart and Norris, 2011). For these and many other reasons, high and persistent income inequality is intrinsically undesirable.

[1] Prepared by Shekhar Aiyar and Christian Ebeke (both EUR). We are indebted to Vito Peragine and Michal Brzezinski for kindly sharing their data on inequality of opportunity.

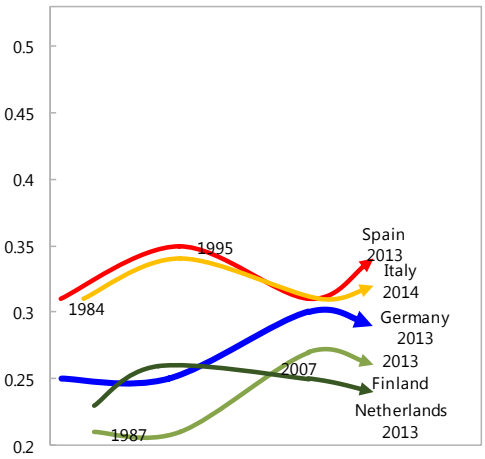
Figure 1. Rising Inequality and Economic Challenges

Market Income Gini, 1984-2014
(In Units)



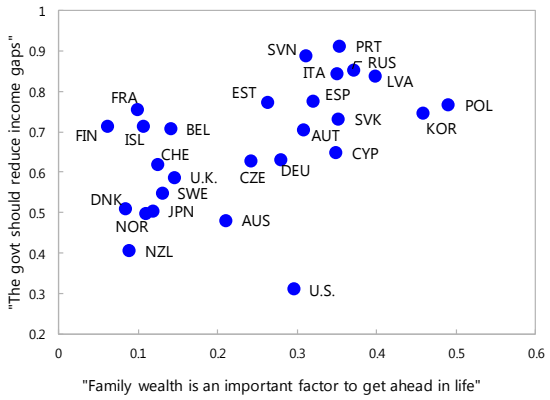
Source: OECD statistics.

Disposable Income Gini, 1984-2014
(In Units)



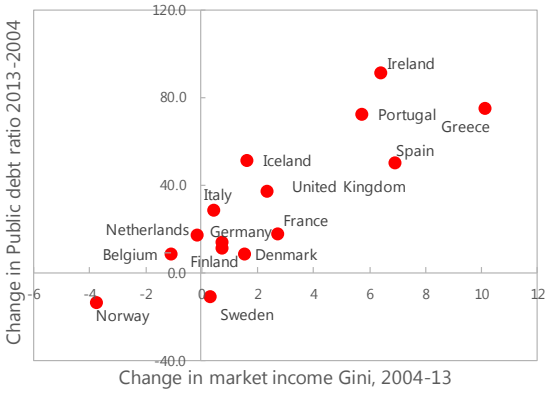
Source: OECD statistics.

Perception of Inequality of Opportunities and Demand for Redistribution
(Share of respondents agreeing with the proposition)



Source: 2009 International Social Survey Programme.

Market Income Inequality and Public Debt
(In percentage points)



Notes. Market income Gini are from the OECD and are based on market income before taxes and transfers. Calculations are based on the 2011 OECD income definition methodology. Due to data availability issues, changes in Gini, and consequently changes in debt are computed over the most available years as follows: Denmark (2011-2005), Finland (2012-2004), France (2011-2005), Germany (2011-2004), Netherlands (2012-2005), Norway (2011-2004), and United Kingdom (2010-2004).
Source: OECD statistics; and WEO.

3. However, assessing whether higher income inequality retards economic growth is much more challenging. The effect of income inequality on growth is ambiguous and much disputed in the literature. Theoretically, the effect can go either way. An increase in income inequality arising, say, from substantial rewards to risky entrepreneurship and innovation, could boost economic growth. By contrast, higher inequality could impair growth if low-income households are persistently less productive because of slower human capital accumulation and greater financial exclusion. Empirically, too, there is little consensus. Some studies have found a significant and negative effect of inequality on growth and its duration (Berg and Ostry, 2011, Berg et al., 2014, and Cingano, 2014). But others have found no systematic negative effect of inequality on growth (Forbes, 2000; Kraay, 2015) or a negative effect only at very high levels of inequality (Banerjee and Duflo, 2003).

4. A recent strand of the microeconomic literature has emphasized the influence of inequality of opportunity in driving bottom and top income growth. These studies exploit the variability of U.S. states data to demonstrate that inequality of opportunity affects negatively the future income growth of the poor and positively that of the rich (Marrero and Rodriguez, 2013; Hsieh et al., 2013; Bradbury and Triest, 2016; Marrero et al., 2016). The rationale is that inequality of opportunity may harm economic growth because it favors human capital accumulation by well-off individuals.[2] Moreover, perceptions of unequal opportunities, which affect individual aspirations, may also reduce investments in human capital. In a nutshell, it is mostly inequality of opportunity that is holding back the growth prospects at the bottom end of the income distribution in the United States.

5. We explore whether the relationship between income inequality and growth depends on equality of opportunity, using comparable cross-country data. Unequal opportunity represents inefficiency because barriers prevent the most productive use of human and other resources. This dimension has received less attention in the cross-country literature, in part due to the difficulty in measuring equality of opportunity in a comparable manner across countries.[3] At first, equality of opportunity can be measured using cross-country data on various indices of intergenerational mobility, such as the elasticity of son's income (or education) to father's income (or education). There are also broader measures of equality of opportunity defined as the inequality that arises due to circumstances outside the person's control such as parental education, race and country of origin.[4]

6. Our central hypothesis is that in economies characterized by low equality of opportunity, income inequality acts as a drag on growth. An increase in income inequality becomes entrenched across generations due to various market failures connected with social stratification. This retards growth, for example by holding back human capital development or causing talent misallocation. On the other hand, in countries with high equality of opportunity, an

[2] The theory behind this idea has been explored at length in the literature, dating back to the classic paper by Galor and Zeira (1988), where income inequality in the presence of financial constraints prevents poor families from investing optimally in schooling, thereby harming growth.

[3] As noted by Corak (2016), to accurately measure the intergenerational earnings elasticity requires estimates of the lifetime earnings prospects of both parents and their children in their adulthood. Good estimates of lifetime earnings require having several years of earnings data during a period in the life cycle when individuals are established in their career jobs (when they are 40 to 50 or so years of age), and these estimates must be available for both the parent and the child. As such the members of a family have to be followed and connected to each other over a period that easily spans several decades. Moreover, these estimates of the intergenerational earnings elasticity which are derived from published studies, must be adjusted for methodological comparability following the methodology described in Corak (2006). Our paper therefore takes advantage of recent estimates published by Corak (2016) which are comparable across a large number of countries.

[4] The procedure of decomposing total inequality into inequality of opportunity and inequality of effort components has gained great popularity in recent years. Using an *ex-ante* criterion, population is partitioned according to individuals' circumstances and inequality of opportunity is evaluated in terms of differences *between* individuals endowed with the same circumstances, so that inequality of opportunity is represented by the between-group component of the overall inequality.

increase in income inequality is easily reversed precisely because low-income people have access to the same opportunities as others. In such societies, therefore, an increase in income inequality is less harmful to growth.

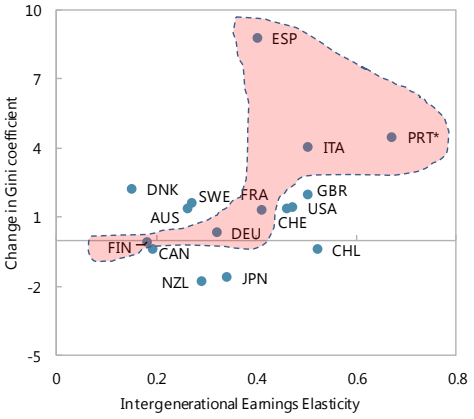
B. Inequality of Opportunity in the Euro Area

7. Intergenerational mobility is low in the euro area. Comparable cross-country data on intergenerational earnings and education mobility (Corak, 2013, 2016; Hertz, et al., 2007) show lower levels of intergenerational mobility in a number of euro area in countries, including large ones such as Italy, Ireland, France, Spain, and Germany.[5] In contrast, and consistently across various measures, Finland stands out as one of the most mobile society in the sample. Furthermore, there is a broad positive association between intergenerational mobility of earnings and of education in the sample, though some outliers exist (e.g., the United States).

8. Euro area countries also stand out in broader measures of inequality of opportunity. Inequality of opportunity (defined as the inequality that is due to circumstances outside the person's control such as parental education, race and country of origin) is particularly high in a number of euro area countries compared with the rest of EU countries with comparable data (Checchi et al., 2016 and Brzezinski, 2015). A number of large euro area countries fall above the EU sample average and this includes Greece, Spain, Italy and to a certain extent Portugal (Figure 2). Higher inequality of opportunity is also observed in new member states (Lithuania, Estonia, and Latvia).

9. Within the euro area, countries with low intergenerational mobility have experienced the largest increases in market income inequality. Three high-debt countries—Spain, Italy and Portugal—stand out in terms of registering particularly high increases in market inequality. In contrast, Finland, with a high degree of intergenerational mobility has not seen income inequality rise. While these are simply associations, they do suggest that low inter-generational mobility provides favorable conditions for rapid rises in income inequality, which are then difficult to reverse. Moreover, given that the sample period includes the global financial crisis and subsequent recession, the data suggest that growth collapses in low-mobility countries can disproportionally worsen the income distribution compared to other economies. The next section investigates the effect of income inequality and inequality of opportunities on long-term growth.

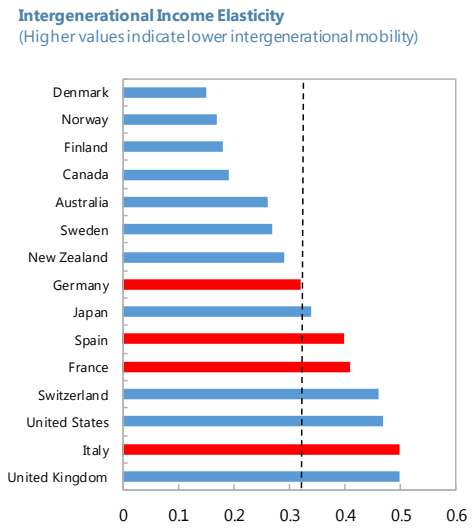
Change in Market Gini and Intergenerational Immobility
(Change in Gini expressed in percentage points; 2004-2013)



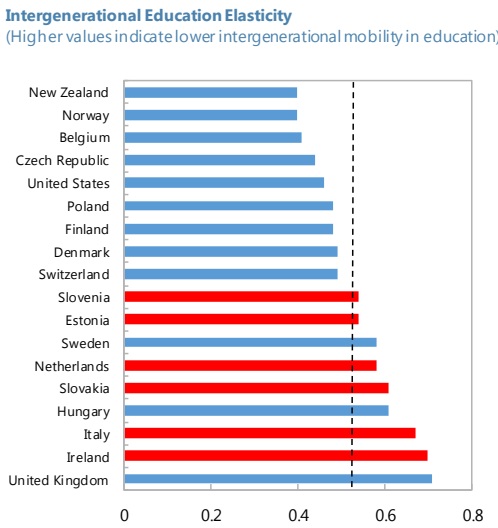
(*) Portugal's elasticity comes from OECD (2010).
Sources: OECD statistics and Corak (2015).

[5] Intergenerational earnings or education elasticity measures the elasticity of individuals' income and education levels with respect to their parent's income or education level.

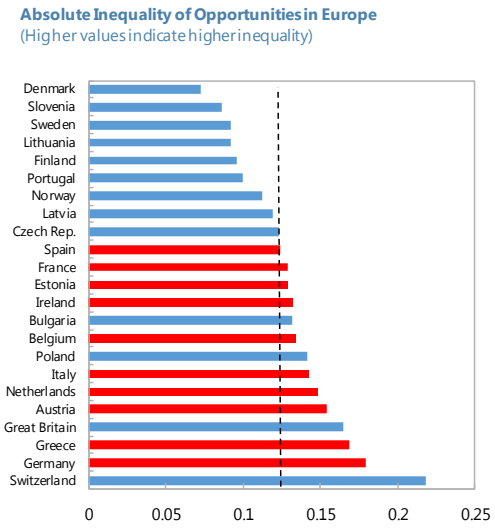
Figure 2. Intergenerational Mobility and Inequality of Opportunity



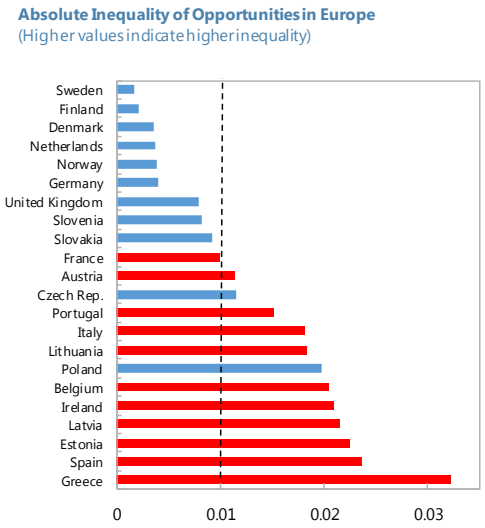
Source: Corak (2015).



Sources: Hertz, Jayasundera, and Piraino (2007).



Sources: Checchi et al. (2016).



Sources: Brzezinski (2015).

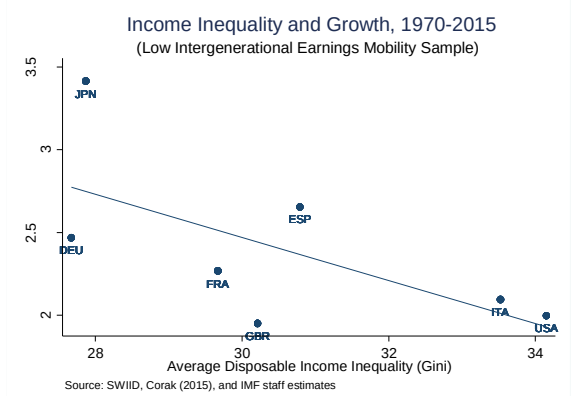
C. Baseline Specification and Results

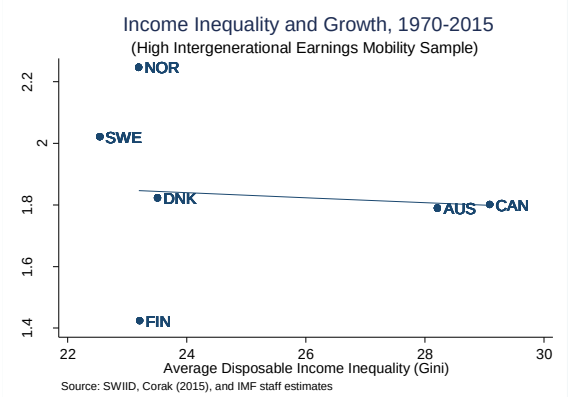
Baseline specification

10. No systematic relationship is evident between inequality and growth in our sample if we leave out inequality of opportunity. We first take a look at the raw data in an attempt to isolate basic correlations between income inequality and per capita GDP growth in our sample. We take a long-term view by averaging the disposable income Gini (from the SWIID database) and real per capita growth over the period 1970 to 2015. To ensure the homogeneity of the sample for this exercise, we focus on advanced OECD countries. We find no discernible relationship between long-

term income inequality and growth. However, after accounting for differences in inequality of opportunity (here approximated by the intergenerational earnings elasticity provided by Corak (2016)), a definite pattern emerges: that of a strong negative correlation among the sub-sample of countries with low intergenerational earnings mobility (Figure 3).

Figure 3. Income Inequality, Intergenerational Mobility, and Growth in the OECD





11. The chief innovation of our study is to model growth as a function of both income inequality and its interaction with measures of inequality of opportunity. A number of studies linking growth to income inequality have imposed a linear relationship between the two variables. However, some studies have recognized that the effect of inequality may not be linear, as the marginal effect of inequality can be conditional on the level of economic development (Brueckner and Lederman, 2015) or on the level of income inequality itself (Banerjee and Duflo, 2003). Other studies focusing on U.S. states have decomposed the inequality variable into a component approximating inequality of opportunity and a residual component measuring inequality due to effort, and have assessed their respective effects on growth (Marrero and Rodriguez, 2013; Marrero et al., 2016). These studies concluded that inequality of opportunity is the component which is negatively associated with growth. Our baseline specification takes the following form:

$$\mathrm{GROWTH}_{i\tau} = \rho y_{i\tau-1} + (\theta_1 + \theta_2 \mathrm{IM}_{i.}) \cdot \mathrm{GINI}_{i\tau-1} + \Gamma X_{i\tau-1} + u_i + \gamma_\tau + \epsilon_{i\tau} \ , \ (1)$$

where GROWTH denotes the 5-year nonoverlapping average of real per capita GDP growth in each country *i* observed at each sub-period τ with raw data starting from 1960 and y denotes (log) real GDP per capita u_i and γ_τ denote country-fixed effects and period-specific dummies that account for both time-invariant unobservable factors at the country level and common shocks to countries, respectively. Income inequality is measured by the Gini coefficient of net disposable income using data from Solt (2016). IM_i refers to the indicator of intergenerational immobility proxied by cross-country comparable estimates of intergenerational earnings (Corak, 2016) and intergenerational education (Hertz et al., 2007) elasticities. These indicators are time-invariant within countries.[6] X is a matrix of covariates which includes investment and trade openness (measured by exports) expressed in percent of GDP. We also control for the initial (lagged) per capita income level to capture beta

[6] We will later explore in the paper the robustness of our results to alternative measures of inequality of opportunity.

convergence. Real per capita GDP, investment and trade data come from Penn World Tables. The sample comprises all countries for which we have data on intergenerational earnings or intergenerational education elasticities. Given extensive data requirements needed to estimate indicators, the sample is dominated by OECD countries.[7]

12. The widening of income disparities is expected to worsen per capita growth mainly in countries exhibiting a high degree of intergenerational immobility. That is, we expect that $\theta 2 < 0$. If, in addition, $\theta 1 \geq 0$, so that the direct impact of income inequality on growth is positive, then a threshold arises for intergenerational immobility:

$$\partial \mathrm{GROWTH}_{i\tau} / \partial \mathrm{GINI}_{i\tau-1} = \theta_1 + \theta_2 \mathrm{IM}_i = 0 \rightarrow \mathrm{IM}_{\cdot}^{*} = -\theta_1 / \theta_2$$

where IM* measures the threshold of intergenerational earnings or education elasticities beyond which income inequality (*GINI*) unambiguously retards growth.

13. Estimating model 1 requires a number of adjustments. First, within-country changes in income inequality (*g*) are not necessarily independent of growth shocks. Higher growth could lower income inequality if it benefits the poor more than the rich; and it could raise income inequality if it does the opposite. By lagging the Gini variable in the model, we have reduced somewhat the likelihood of such reverse causality. However, endogeneity issues driven by measurement error and/or omitted variables could still bias the results. Moreover, the OLS estimator is inconsistent because the lagged per capita income variable is correlated with the error term in the presence of fixed effects (Nickell bias). We therefore implement an instrumental variables strategy. The equation in levels and the equation in first differences are combined in a system and estimated with an extended System-GMM estimator that allows for the use of lagged differences and lagged levels of the explanatory variables as instruments (Blundell and Bond, 1998). The number of lags of the endogenous variable has been limited to avoid the overfitting bias due to instrument proliferation (Roodman, 2009). Two specification tests are used to check the validity of the instruments. The first is the standard Sargan/Hansen test for overidentifying restrictions. The second test examines the hypothesis that there is no second-order serial correlation in the first-differenced residuals.

Results

14. The results show that income inequality reduces growth when intergenerational mobility is low. Regardless of the type of intergenerational elasticity (earnings or education), the coefficient associated with the additive term of income inequality is positive while the interaction term with intergenerational elasticity is negative. Thus, the marginal effect of income inequality on growth becomes negative at high levels of intergenerational immobility (Table 1). Threshold levels of

[7] For the intergenerational earnings elasticity, the regression sample includes the following 21 advanced and emerging market countries: Argentina, Australia, Brazil, Canada, Switzerland, Chile, China, Germany, Denmark, Spain, Finland, France, United Kingdom, Italy, Japan, Norway, New Zealand, Peru, Singapore, Sweden, and United States. The sample increases to 27 countries when we use data on intergenerational education elasticity.

intergenerational earnings and education immobility are computed as when corresponding intergenerational elasticities reach 0.3 and 0.9.

15. Several euro area countries fall above the earnings elasticity threshold, implying that income inequality has an unambiguously negative effect on growth. This includes countries such as Spain, France, Italy and to some extent Germany, which is very close to the threshold. Other countries also fall well above this threshold (United States, United Kingdom, Switzerland). The results suggest that an increase in income inequality by one standard deviation in the European sub-sample (corresponding to 2.7 units of Gini expressed in percentage points) will knock 0.2 percentage points off average growth in the next 5-year period for a level of intergenerational elasticity set at the level of Italy (0.5).

D. Robustness Checks

Endogeneity of income inequality

16. The baseline model is re-estimated by augmenting the system GMM with external instruments for income inequality. So far, the identification strategy was based on the use of the lagged Gini in the growth regression with the view that the 5-year lag of income inequality will not be directly affected by current growth realizations. To assess the robustness of our results, we resort to instrumental variables. We use the 10-year lagged level of the adolescent fertility rate to instrument the income inequality variable. The identification strategy is that a high fertility rate among adolescents is likely to weigh on their human capital accumulation and on their prospects in the labor market when they become adult. This would worsen income distribution under the assumption that higher fertility rates are likely to be more prevalent for adolescents in low-income households. Conditional on controlling for other determinants of growth such as lagged per capita income, investment, trade and overall fertility rate, lagged adolescent fertility rate is less likely to affect growth directly. We further instrument income inequality following the approach of a number of recent studies (Brueckner, 2013 and Brueckner and Lederman, 2015). The approach consists in constructing an income inequality variable that is adjusted for the impact that GDP per capita growth has on income inequality. This second instrument is "by construction" uncorrelated with the dependent variable, real per capita GDP growth.[8]

17. These alternative approaches to controlling for the endogeneity of income inequality yield similar results to the baseline regressions. The negative effect of income inequality on growth is confirmed at higher levels of intergenerational immobility. In Table 2, the estimates show that only the interaction term of income inequality crossed with the indicator of intergenerational immobility exhibits a negative sign. The key difference with previous results lies in the magnitude of the point estimates. The thresholds of intergenerational earnings immobility beyond which the

[8] The auxiliary equation used to "extract" the residual component of income inequality which does not depend on growth is itself estimated using a panel instrumental variable approach in which growth is instrumented by its two- and three-year lags. The residuals derived from this estimation are then used as instruments for income inequality in the growth regressions we are interested in.

marginal effect of income inequality on growth is negative are now relatively lower (0.26 for the intergenerational earnings elasticity and stable for the intergenerational education elasticity).

Alternative measures of income distribution

18. As a second robustness test, we investigate the growth consequences of inequality in different parts of the income distribution. Following previous empirical studies (Cingano, 2014), we replace the income Gini coefficient by a measure of inequality taking into account only "top" and "bottom" inequality. More precisely, we compute the ratio of mean disposable income in the top income quintile divided by the mean disposable income in the bottom quintile.[9] Unlike the Gini coefficient, which takes into account the full distribution of incomes, this measure focuses only on the gap between the richest and the poorest. An increase in the ratio of Q5/Q1 will indicate a worsening of the income distribution at the tails of the distribution.

19. The results are again consistent with baseline estimates. Regardless of the measure of intergenerational elasticity (Table 3), there is a strong and statistically significant effect of the worsening of the income distribution on growth, mainly in countries characterized by low levels of intergenerational earnings (column 1) or education mobility (column 2). Thus, the mechanism at work here can be driven by changes at the extreme ends of the income distribution alone. This is consistent with the class of theories positing that the impact on growth arises from sub-optimal investment decisions by constrained people at the bottom of the income distribution, as described earlier.

Controlling for non-linearity in the level of the Gini

20. Our baseline results could be biased by the positive correlation between income inequality and measures of intergenerational immobility. Several papers have documented a positive association between intergenerational immobility and income inequality (Andrews and Leigh, 2009; Corak, 2013). A bias could arise if the interaction term (income inequality crossed with our measures of intergenerational immobility) captures instead the effect of inequality on growth at higher levels of income inequality. In other words, the bias is strong if one were to assume that intergenerational immobility measures are confounded with income inequality measures given the positive and strong correlation between the two. We could have ruled out this bias by controlling additively for measures of intergenerational immobility in the models, but this is clearly not possible with country-fixed effects. The strategy we adopt consists in controlling for income inequality in a quadratic fashion and assessing whether the coefficient associated with the interaction term of income inequality crossed with intergenerational immobility remains significant. This would be consistent with other studies that find pronounced negative effects of income inequality on growth when income inequality reaches high levels (Banerjee and Duflo, 2003).

21. The results are robust to controlling for additional non-linearities. More specifically, allowing income inequality to enter the estimating equation in quadratic form makes no qualitative

[9] Data on income by quintiles are drawn from Brueckner et al. (2015).

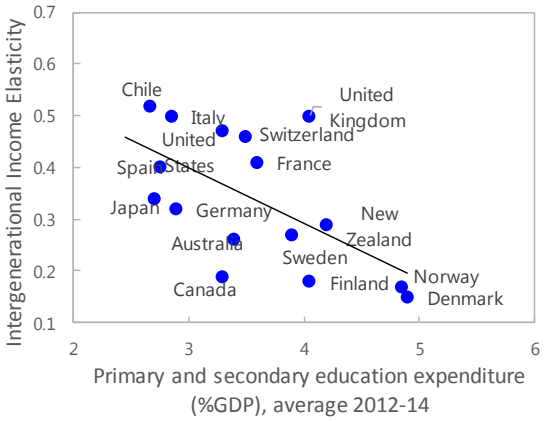
difference to the baseline result of a negative effect of inequality on growth in the presence of high intergenerational immobility (Table 4). The results remain significant regardless of the measure of intergenerational immobility (earnings or education). Interestingly, the quadratic term of income inequality is not significant in the presence of the interaction term. This could suggest that the non-linearities observed by previous studies could be capturing underlying differences in inequality of opportunity.

E. Policies to Level the Playing Field

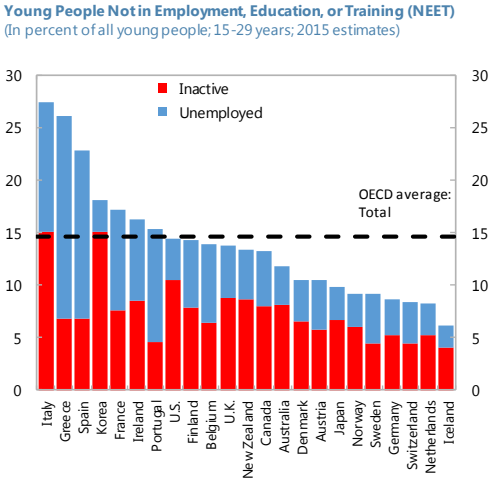
22. Our results suggest that reducing inequality can accelerate growth in the euro area. As several euro area countries exhibit relatively low levels of intergenerational mobility, policies that reduce income inequality can accelerate growth by reducing the burden on the most vulnerable and helping the disadvantaged to maximize their full potential. In particular, reducing high levels of unemployment is crucial in several European countries; our results suggest that the resulting fall in income dispersion could act as a powerful motor of growth.

23. Over the long run, addressing the root causes of inequality of opportunity is crucial. Our paper shows that equalizing individual opportunity may promote not only equity but also ensure stable growth even in periods of large swings in income inequality. International evidence suggests that leveling the playing field requires structural reforms. More precisely, reforms that encourage human capital investment, reduce barriers to labor markets and spur innovation are likely to be critical.

24. Investing in human capital, including at the early age is key. Previous studies have emphasized the key role played by lower constraints to human capital accumulation. For example, Corak (2016) recognizes the need to invest into high quality early childhood, primary and secondary schooling as it is likely to be of relatively more benefit to families lower in the socio-economic scale than if it was directed to the subsidization of tertiary education. Marrero and Rodríguez (2012) document a positive association between lower school dropout rates and higher equality of opportunities. The chart below shows the existence of a negative correlation between the amount of public expenditures in primary and secondary education and social immobility in the OECD. This implies that euro area countries will need to do more to level the playing field by keeping students in the education system for a longer period of time: recent data on the number of 15–29 year-old not in employment, education or training (NEET) remains very large in a number of euro area countries. As documented extensively in OECD (2016), this situation has significant social, political, and economic consequences, including social exclusion with adverse implications for intergenerational mobility. In sum, there is a strong case for public intervention to ensure equal access to high quality education across income strata, and to provide incentives to stay in the education system for longer.

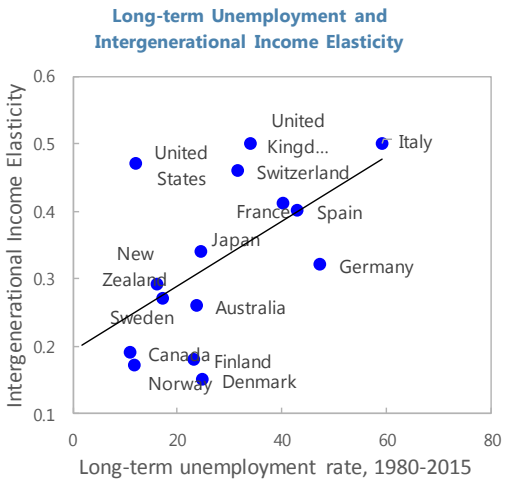


Source: Corak (2015) and OECD statistics.

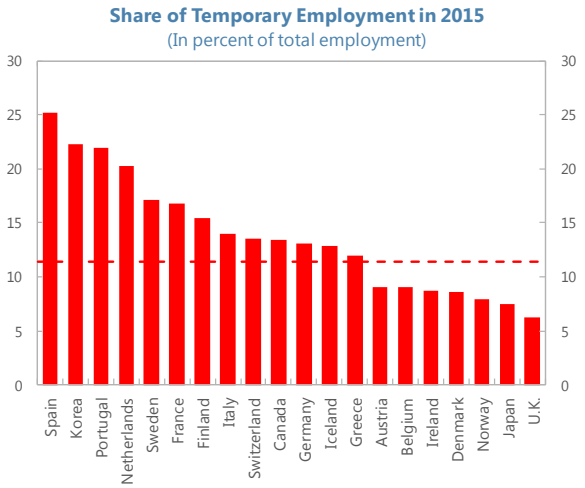


Sources: OECD statistics.

25. Labor market inequality should be addressed. The study by Marrero and Rodríguez (2012) has highlighted a positive association between long-term unemployment and inequality of opportunity in Europe. Hysteresis effects—such as skills-depreciation—related to protracted unemployment exacerbate the risk of social exclusion and social immobility. Hence labor market rigidities that keep structural unemployment high should be eliminated to ensure better equality of opportunity. Interestingly, the chart below shows a strong and positive correlation between long-term unemployment and social immobility in the OECD. Labor market inequality is also associated with a high prevalence of temporary contracts in total employment, which can weigh on social mobility through several channels. Precarious "outsiders" in the labor market cycle between temporary jobs and unemployment more frequently, which makes them more vulnerable to income shocks. Furthermore, higher reliance on temporary contracts can hurt productivity, as there is less investment in temporary workers and long spells in unemployment reduce human capital accumulation. In the euro area, long-term unemployment and labor market duality remain significant in a number of countries, thereby weighing on social mobility.



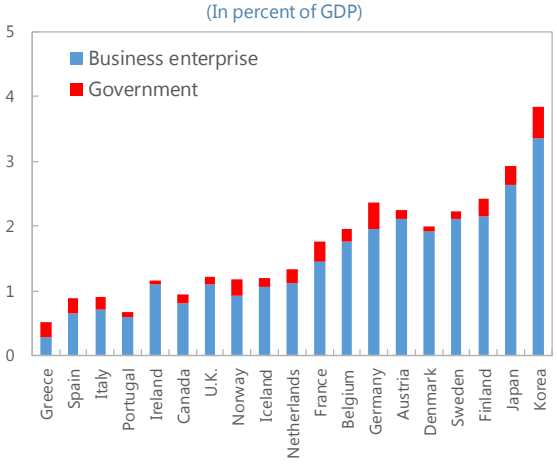
Source: Corak (2015) and OECD statistics.



Source: OECD statistics.

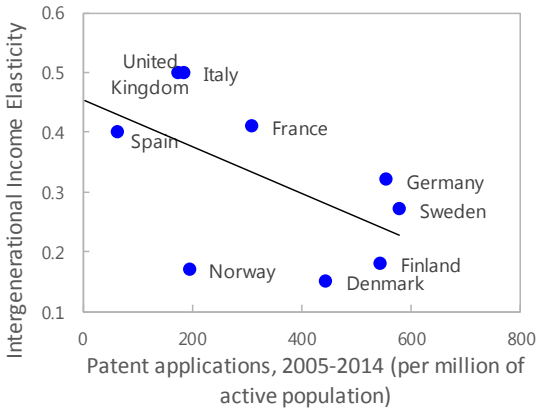
26. Promoting innovation can foster social mobility. A recent study by Aghion et al. (2015) finds a positive and significant relationship between innovativeness and social mobility in the United States. The authors argue that the two are connected by the nature of creative destruction, which arises when there is scope for having new innovators (entrants) replace current firm owners (incumbents). With the limited cross-country data at our disposal, we confirm the results of Aghion et al. (2015) using a sample of European countries: there is a positive association between innovation (measured here by patents applications per capita) and social mobility in advanced Europe. Innovation in part requires investment in research and development (R&D) which in the private sector is supported by financial widening, including non-bank financing alternatives such as venture capital. In the euro area, however, both R&D spending and venture capital investment ratios remain low compared to best practice in the OECD.

R&D Expenditures, 2014
(In percent of GDP)



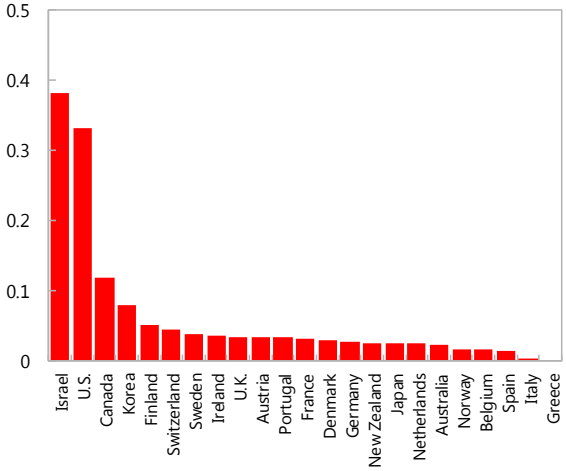
Sources: Eurostat and WEO.

European Patent Application and Intergenerational Income Elasticity



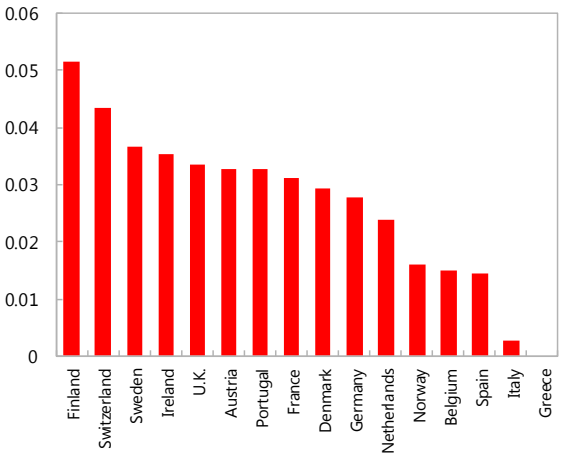
Source: Corak (2015) and OECD statistics.

Venture Capital Investments, 2015
(In percent of GDP)



Sources: OECD Entrepreneurship at a Glance 2016.

Venture Capital Investments in Europe, 2015
(In percent of GDP)



Sources: OECD Entrepreneurship at a Glance 2016.

F. Conclusion

27. Although income inequality is widely recognized as undesirable, its relationship to economic growth has been difficult to establish. We provide evidence that the relationship is mediated by equality of opportunity. Income inequality has a negative impact on growth in those economies characterized by low equality of opportunity, as measured by intergenerational mobility. Since most euro area countries in fact exhibit low intergenerational mobility, our results suggest that reducing income inequality could boost growth in the short run. Over the long run, it is crucial to level the playing field by equalizing opportunities. Policies such as creating equal access to high quality education, removing labor market rigidities and spurring innovation could help.

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Appendix

Table 1. Effect of Income Inequality on Per Capita Growth: System-GMM Estimates. Non-Overlapping 5-Year Periods		
Dependent variable: Real GDP per capita growth (in percent)	(1)	(2)
Gini	0.0946	0.101**
	(1.099)	(2.039)
Gini × Intergenerational elasticity (earnings)	-0.322***	
	(-2.752)	
Gini × Intergenerational elasticity (education)		-0.109***
		(-2.820)
Lagged real per capita GDP, log	-5.620***	-1.836**
	(-4.601)	(-2.545)
Lagged investment-to-GDP	5.499	-1.071
	(0.866)	(-0.215)
Trade openness	1.872	2.117
	(1.436)	(1.630)
Intercept	59.31***	18.44***
	(4.141)	(2.648)
Threshold of IE:	0.29	0.9
Period dummies	Yes	Yes
AR[1]: p-value	0.022	0.086
AR[2]: p-value	0.869	0.173
Hansen OID: p-value	0.430	0.404
No of instruments	16	18
Observations	179	187
Number of countries	21	27
z-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1		

Table 2. Effect of Income Inequality on Per Capita Growth: System-GMM-IV Estimates. Non-Overlapping 5-Year Periods

Dependent variable: Real GDP per capita growth (in percent)	(1)	(2)
Gini	0.0752	0.154***
	(0.596)	(2.619)
Gini × Intergenerational elasticity (earnings)	-0.282**	
	(-2.272)	
Gini × Intergenerational elasticity (education)		-0.169***
		(-5.342)
Lagged real per capita GDP, log	-4.665***	-1.495***
	(-3.008)	(-2.653)
Lagged investment-to-GDP	2.868	-6.419*
	(0.598)	(-1.743)
Trade openness	1.784	1.484
	(1.534)	(0.720)
Intercept	50.23***	16.14**
	(2.669)	(2.459)
External instruments for inequality	Yes	Yes
Period dummies	Yes	Yes
Threshold of IE:		
AR[1]: p-value	0.100	0.123
AR[2]: p-value	0.301	0.250
Hansen OID: p-value	0.519	0.339
No of instruments	17	17
Observations	137	134
Number of countries	21	27

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3. Effect of Income Inequality on Per Capita Growth: System-GMM Estimates. Alternative Measures of Inequality. Non-Overlapping 5-Year Periods

Dependent variable: Real GDP per capita growth (in percent)	(1)	(2)
(Q5/Q1)	0.495***	0.373
	(3.105)	(1.578)
(Q5/Q1) × Intergenerational elasticity (earnings)	-1.027***	
	(-3.786)	
(Q5/Q1) × Intergenerational elasticity (education)		-0.497**
		(-1.973)
Lagged real per capita GDP, log	-3.342***	-3.209
	(-4.430)	(-1.476)
Lagged investment-to-GDP	-3.337	-3.986
	(-1.438)	(-0.359)
Trade openness	2.100***	4.455
	(2.734)	(1.515)
Intercept	35.53***	32.99*
	(4.445)	(1.700)
	0.495***	0.373
Period dummies	No	No
AR[1]: p-value	0.026	0.065
AR[2]: p-value	0.276	0.247
Hansen OID: p-value	0.356	0.251
No of instruments	7	7
Observations	106	128
Number of countries	19	27

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4. Effect of Income Inequality on Per Capita Growth: System-GMM Estimates. Controlling for Squared Gini. Non-Overlapping 5-Year Periods		
Dependent variable: Real GDP per capita growth (in percent)	(1)	(2)
Gini	0.148	0.289**
	(0.624)	(2.236)
Gini × Intergenerational elasticity (earnings)	-0.325***	
	(-2.627)	
Gini × Intergenerational elasticity (education)		-0.0931**
		(-1.964)
Gini squared	-0.000235	-0.00271
	(-0.0551)	(-1.282)
Lagged real per capita GDP, log	-4.572***	-1.830***
	(-2.641)	(-2.620)
Lagged investment-to-GDP	7.104	-0.586
	(1.491)	(-0.120)
Trade openness	1.231	2.269**
	(1.077)	(1.977)
Intercept	46.76**	14.81**
	(2.567)	(2.182)
Period dummies	Yes	Yes
AR[1]: p-value	0.010	0.085
AR[2]: p-value	0.499	0.168
Hansen OID: p-value	0.682	0.299
No of instruments	17	18
Observations	180	187
Number of countries	21	27
z-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1		

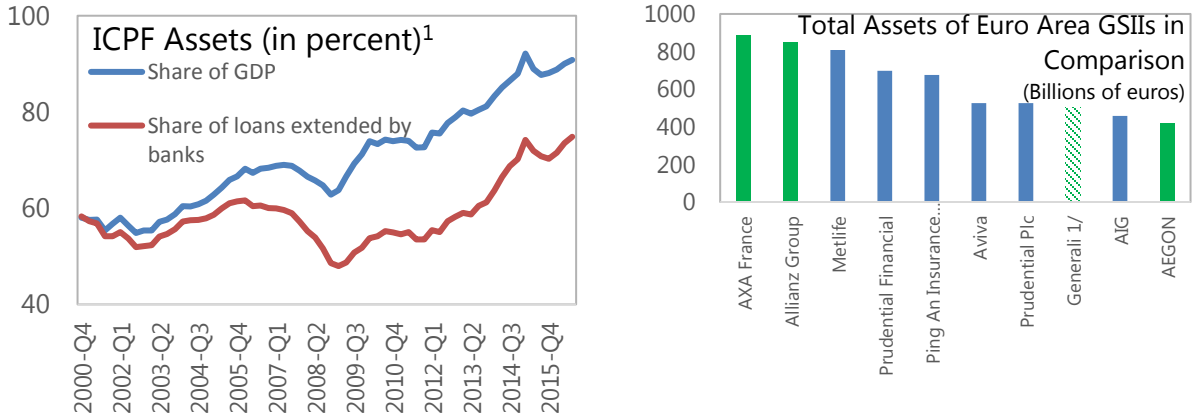
FINANCIAL STABILITY RISKS FROM EURO AREA INSURANCE AND PENSIONS SECTOR[1]

Insurance company and pensions fund (ICPF) assets have grown over time in the euro area and the sector has come under pressure due to the low interest rate environment. Given the dominance of insurers in this sector, the discussion in this note mostly covers the vulnerabilities of these institutions. Insurers in Germany, France and Austria are most vulnerable to market risks due to the prevalence of both guaranteed products and large asset-liability duration mismatches. But comfortable solvency buffers in France and Austria provide some protection. In some countries, the asset portfolios of insurers are concentrated in investments in their own sovereigns and banks, creating strong domestic interconnectedness. Even though the shortfall in buffers of a ¼ percent of euro area GDP arising from the severe downside scenario in the 2016 stress tests of the European Insurance and Occupational Pensions Authority (EIOPA) is modest, these shortfalls are higher for high-debt countries and could be even higher if shocks were amplified through domestic interconnectedness.

A. Background

1. Euro area ICPFs have grown since the global financial crisis and their combined asset amount to 90 percent of GDP. ICPFs have also grown as a share of bank assets. With a balance sheet size of €9.7 trillion, the ICPF sector is dominated by the four systemically important insurance (SII) groups AXA (France), Allianz (Germany), Generali (Italy) and Aegon (The Netherlands) (Appendix I). Consequently, Germany, France, Italy and Netherlands are the largest ICPF markets. Insurance companies dominate the sector, with about €7 trillion in assets, and while most insurance companies offer both life and nonlife insurance business, 65 percent of gross written premia are for the life insurance business (EIOPA, 2016a).

Figure 1. Size of Insurance and Pensions Sector in the Euro Area



Source: European Central Bank (ECB); S&P Global Market Intelligence; IMF staff calculations.

Note: Generali (ITA) was removed from the GSII list in 2015, but have been included in the list due to its large size. ICPF assets are based on unconsolidated date. The GSII assets are based on consolidated group data.

[1] Prepared by Srobona Mitra.

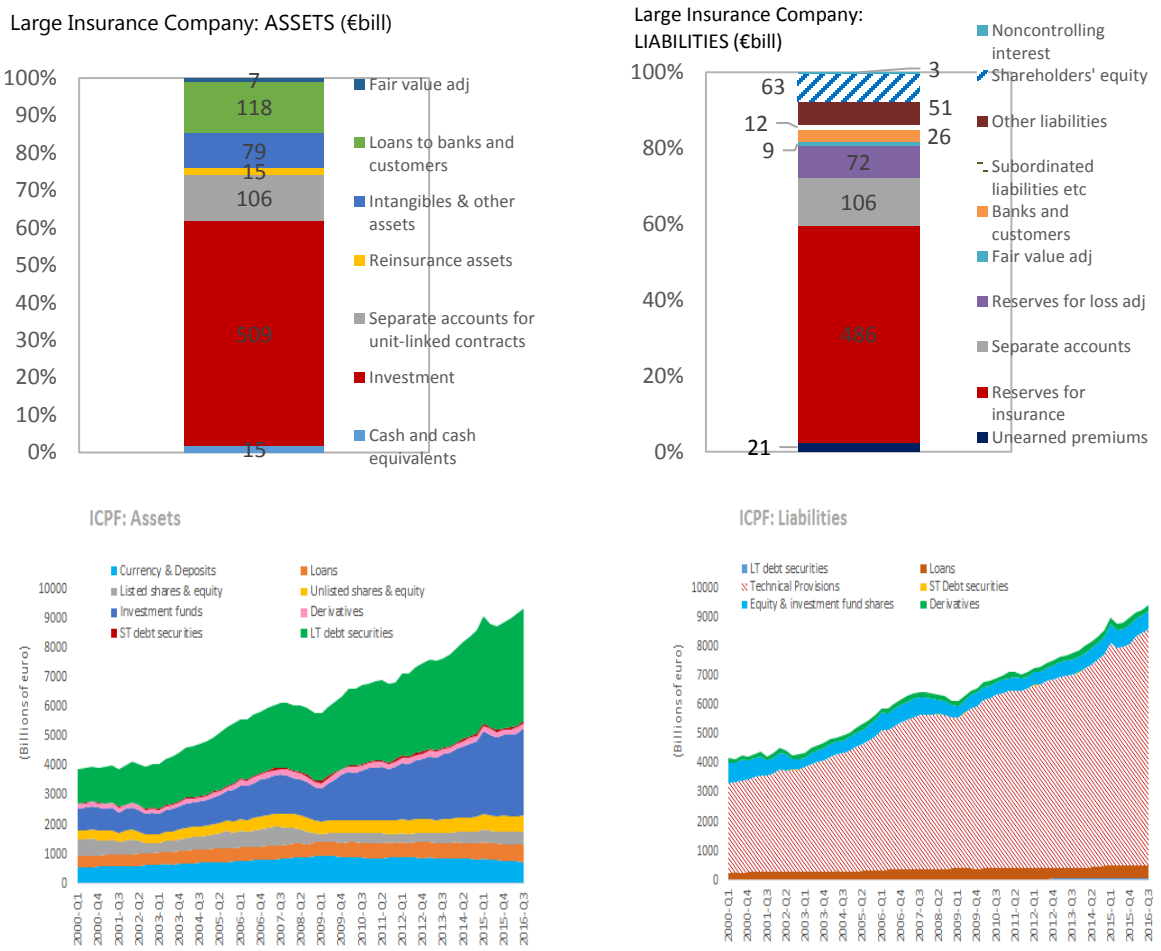
2. The two main types of insurance companies are related to life and non-life business. Insurance companies are funded by long-term policy holders and have to hold technical provisions or reserves against these policies. The largest share of the technical provisions in Europe belongs to life insurers. A pure life insurer would provide a lump sum payment to beneficiaries upon the death of the insured, in exchange for premium payments. Within this model: "term" life insurance provides financial protection for a specific period; "universal" life insurance is a permanent type of coverage through life but flexibly allowing the raising or lowering of premia or coverage amounts; and, "whole" life insurance is like universal life, but have fixed premia and could have a cash value that functions like a savings product. Sometimes, life insurers offer investment products (unit-linked to stocks and bonds) that are like mutual funds and where the insured usually bears the risk. Nonlife insurance companies span the spectrum of health, workers' compensation, property, automobile, fire, etc. About 55 percent of insurers in the EU are life, 43 percent offer both life and non-life, and only about 2 percent offer only non-life.

3. Insurance companies tend to be more exposed to market risk than banks. A large part of their balance sheet consists of marketable securities. For instance, 60 percent of Allianz assets (shown in Figure 2 as an example) consist of investments in government and corporate bonds, equities and other assets. For a typical bank, the share of such investments in total assets would be 15–20 percent. For insurers, since the duration (time-to-maturity, weighted by the present discounted value or PDV) of investments is usually less than that of liabilities, insurance companies profit from the duration mismatch when interest rates go up, as they can reinvest assets at higher rates.[2] Also, with their higher duration, the value of liabilities falls more than the value of assets when interest rates go up. Companies offering unit-linked products (that follow broad indices) have to hold separate accounts for their clients (shown in Figure 2 as equal (gray) quantities on both sides of the balance sheet), who bear the risk of such investments.

4. Pure insurance companies are usually a source of stability. With long-term liabilities, these entities provide stable long-term financing to the government, corporate, and infrastructure sectors. Since their investment strategies are opposite to banks'—funding long-term and investing short-term—they provide support to markets during distress (Appendix II). With diverse activities, the insurance sector as a whole had lower variability of stock market value than the banking sector during the global financial crisis and the European debt crisis (Figure 3).

[2] See Appendix II for stylized calculations of duration and the sensitivity of the PDV of assets and liabilities to interest rate declines.

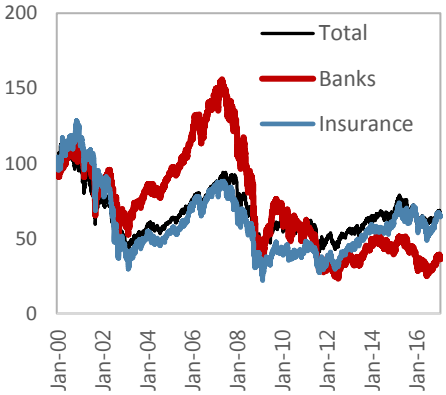
Figure 2. Balance Sheets: A Large Insurance Company and Euro Area ICPF Sector



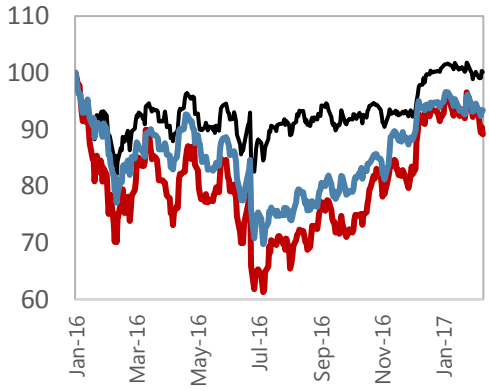
Source: Allianz from S&P Global Market Intelligence; ECB; IMF staff calculations.

Figure 3. Eurostoxx Indices: Overall, Banks, Insurance

Insurance stocks have moved more in line with the overall index since 2000...



...and underperformed less than banks in 2016



Source: Bloomberg Finance L.P.; IMF staff calculations.

5. However, certain activities, connections and macroeconomic conditions could contribute to financial stability risks. Historically, insurance companies that failed or had to receive government help typically traced their distress to problems on the liabilities side of the balance sheet (Sugimoto, 2016). Insurers with large duration mismatches between assets and liabilities, and with high rates and numbers of guarantees provided to clients are most vulnerable to falling interest rates (Appendix II, section B). Moreover, through investments on their asset side, insurers could be strongly interconnected with banks, corporates and governments, creating one conduit for systemic risk (section C). Finally, insurers may "gamble for resurrection" during low-rate periods by investing in risky and illiquid assets to seek higher yields:

- *Guaranteed rates.* Life insurance products with guaranteed rates of return above investment yields are especially vulnerable to a low-interest rate regime. There are instances in the United Kingdom (Equitable Life in 2000) and Japan (eight life insurers in 1997–2001) where a combination of high guaranteed rates and an environment of prolonged low interest rates ultimately led to fiscal transfers to the industry compensation schemes or to the policyholders' protection funds to make up for the deficit.

- *Links with banks and other sectors.* Conglomeration and intragroup transactions with banking entities can lead to spillovers from insurance to banks, and vice versa. Even without conglomeration, insurance companies have deposits in banks and invest in bank bonds, including convertible bonds. Insurance companies provide long-term funding to corporates and governments, and so stress in these companies can result in a funding shock. In fact, interconnectedness is an important consideration for designating insueres as global systemically important (GSII, Appendix I). Sectoral spillovers based on asset price movements have been shown to be high for banks and insurers in Europe (IMF, 2016).

- *Derivative trading and securities lending*. Selling credit default swaps without hedging these exposures or setting aside capital and reserves; reinvesting cash collateral received in securities lending operations into collateralized debt obligations (AIG in 2008, which was rescued by the U.S. government) are examples of risky strategies.

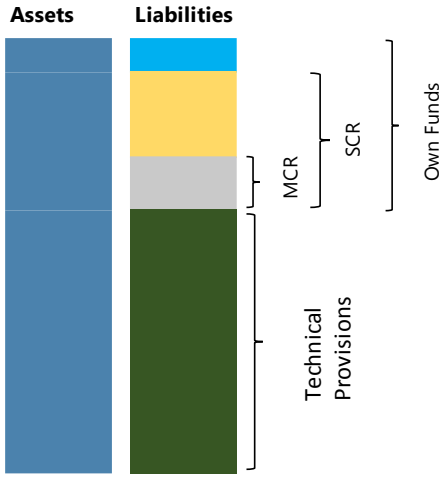
- *Yield-seeking behavior.* In low interest rate environments, ICPFs may venture into risky investments such as lending to customers, real estate (so that they benefit from illiquidity premia), or high-yield corporate bonds. For instance, euro area insurance portfolios are becoming riskier with a shift toward corporate and lower-rated bonds (ECB, 2016).

- *Lapse rates.* A high degree of withdrawals or cancellations of life insurance policies can give rise to liquidity risks, especially if penalty rates for early policy cancelation are driven down to zero amid competition.

6. The Solvency II Directive, introduced in 2016, requires insurance and reinsurance companies to hold capital and adequate provisions against adverse market conditions. The

new quantitative requirements include market-consistent valuation of assets and liabilities and risk-based capital requirements.[3]

- *Capital requirements*. Insurance and reinsurance companies have to hold own funds, the difference between assets and liabilities, to cover two types of capital requirements. The solvency capital requirement (SCR) is risk-based and is the amount of own funds needed to withstand the worst annual loss expected to occur over the next 200 years. The SCR ratio is the ratio of eligible own funds to SCR, and this ratio should be at least 100 percent. The minimum capital requirements (MCR) is between 25 and 45 percent of the SCR; and the minimum MCR ratio is the ratio of eligible own funds and MCR. If an insurer or reinsurer is not complying with the SCR, it has to take measures (increasing capital or lowering risk) to meet the SCR again within six months. A breach of the MCR could result in a withdrawal of authorization unless it is covered again in three months (EIOPA, 2016a). The SCR can be calculated with a standard formula or with an internal model. The standard formula consists of modules for the different risks that an insurance company is exposed to (market, underwriting, counterparty default, and operational risks). Most companies use the standard formula (EIOPA, 2016a).



- *Long-term risk-free rate for calculating technical provisions.* The main liabilities of insurance companies comprise technical provisions set up for the insurance and reinsurance obligations of the undertaking. Since the duration of these are longer than the availability of liquid risk free rate benchmark quotes in the market, there is technical guidance for the long-term risk free rate that insurers should use for high maturities. For instance, the EIOPA has determined that in certain countries, 20 years is the longest maturity with liquid markets and the valuation of liabilities up to 20 years could be based on the actual market interest rates. Beyond that, the EIOPA uses the ultimate forward rate (UFR)—defined as the long-term average of short-term real interest rates plus long-term inflation expectations—to extrapolate yields at longer maturities. The UFR is set at 4.2 percent until the end of 2016 for the euro area.[4] A new methodology for the calculation of the UFR on an ongoing basis was just published in April 2017 with a decrease in the UFR to 3.65 percent, phased-in at 4.05 percent in 2018. A lower UFR

[3] Insurance and pensions sectors are supervised by national authorities. EIOPA is an independent advisory body to the European Commission and one of the three European Supervisory Authorities that ensure an effective and consistent level of regulation and supervision across member states. EIOPA's powers include issuing guidelines and recommendations and developing draft regulatory and implementing technical standards. It conducts stress tests for EU insurers, in cooperation with ESRB, ECB and EBA on scenarios.

[4] Gourinchas and Rey (2016) predict that the global average real short risk-free rate for 2015–25 will be only -2 percent. With an inflation target of 2 percent, that implies that the nominal long-term rate would be about 0 percent for 2015–25. Moreover, the authors show that the average real rate for the U.S. over more than a hundred years has been around zero percent.

would reduce yields on 20+ year maturities and increase the PDV of liabilities, without necessarily increasing the PDV of assets.

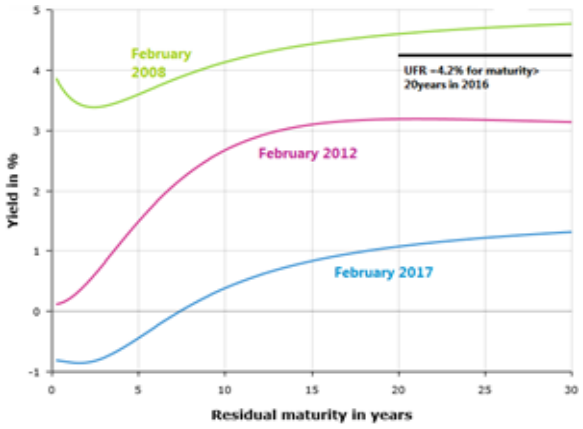
7. Since the risk-free rate is a crucial component in calculating technical provisions, insurance companies are allowed to make certain adjustments to the interest rate to prevent procyclical outcomes. Taken together, these measures are called long-term guarantee (LTG) measures that allow insurers mainly offering long-term guarantee products to adjust the risk-free rate for market volatility, for instance, to calculate technical provisions. These calculations would then affect own funds—a higher interest rate would decrease technical provisions and increase own funds, and hence increase the SCR and MCR ratios, amounting to capital relief under adverse market conditions.

B. Vulnerabilities from Business Models

8. The yield curve is a key determinant of financial stability in the ICPF sector. Lower risk-free rates increase the PDV of cash flows of both assets and liabilities. But because the duration of assets is typically lower (average of seven years) than the duration of liabilities (average of 12 years), liabilities increase more than assets, thus lowering own funds (assets minus liabilities). But falling short-term interest rates also lowers interest income (and hence profits) from bond yields in addition to the adverse impact on own-funds as the shorter maturity of bonds have to be reinvested at lower yields. Falling yields since the global financial crisis (Figure 4) have, therefore, created concerns for the ICPF sector. Appendix II provides a simple example to illustrate the impact of changes in interest rates (especially falling yields) on the market value of assets and liabilities of insurance companies.

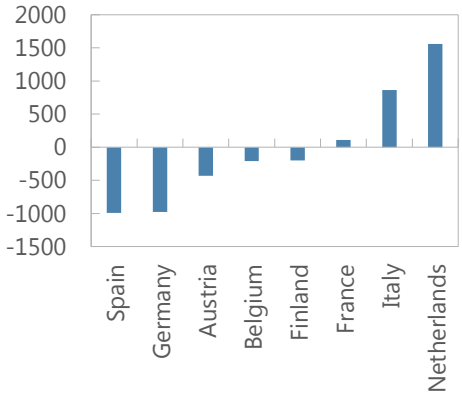
Figure 4. Lower Yields Partly Explain Falling Profits

Yield Curves on AAA rated bonds



Source: ECB.
Note: Estimates of zero-coupon bond yield curves for AAA rated bonds. The UFR is the Ultimate Forward Rate used by the EIOPA to extrapolate the yield curve for maturities greater than 20 years, that insurers use for discounting cash flow liabilities.

Return on Equity, 2012–15 (change, in basis points)

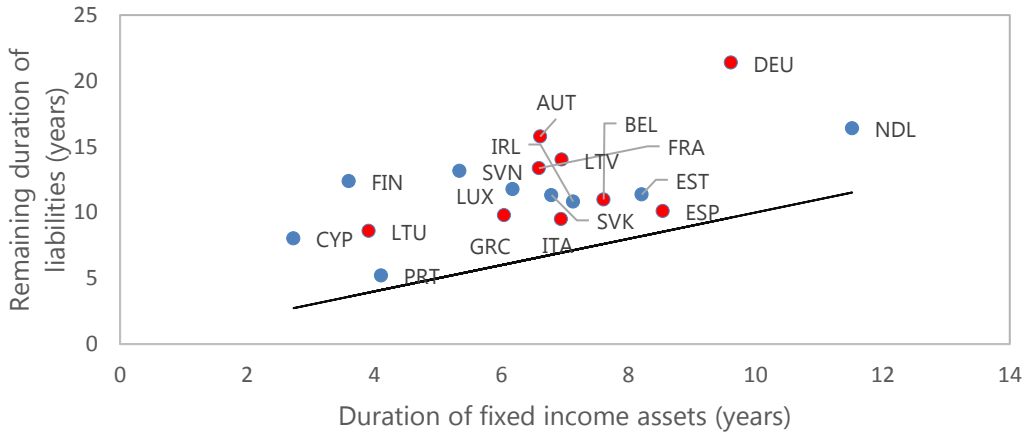


Source: S&P Global Market Intelligence; IMF staff calculations.
Note: Based on the insurers included in the EIOPA 2016 stress test sample for selected countries; country aggregates are derived by asset-weighted ROE changes.

9. Insurers that provide high guaranteed rates of return are more vulnerable to a scenario where interest rates remain low for long. Although there is no legal definition of guarantees, over 75 percent of life companies offer such guarantees in Austria, Belgium, Germany, Spain, France, Greece, Italy, Latvia and Lithuania (EIOPA 2016b). The most common are minimum guaranteed rates every year for the term of the product, or a guaranteed sum assured until maturity. However, a few also offer guaranteed yields on unit-linked investments, which are usually managed for clients in separate accounts. For life insurers, guarantees form part of their technical provisions and have come down over time. But the legacy guarantees that are much higher than the current yield will remain part of the technical provisions. In the EIOPA stress test sample, almost a third of the contracts guarantee interest rates between 3–4 percent for the next 12 years on average; another 10 percent of the contracts promise rates above 4 percent (EIOPA 2016b).[5] These rates contrast with the (early 2017) average 30-year AAA-rated yield-to-maturity of 1.3 percent and those on all bonds at 2.4 percent.

10. Countries with insurers that have large duration mismatches and a greater prevalence of guarantees are more vulnerable to prolonged low interest rates. Germany, Austria, France, and Latvia are among countries that fall under this category (Figure 5). The relatively low duration gap and the limited use of guaranteed products in Netherlands might explain increasing profits for Dutch insurers between 2012 and 2015 (Figure 4). The EIOPA stress tests showed that under a scenario where the yield curve moves down and flattens and the UFR falls from 4.2 percent to 2 percent, German, Austrian and Latvian insurers would have the largest differentials between changes in values of liabilities and assets, with the largest hit on own funds.

Figure 5. Asset-Liability Duration Mismatches and Prevalence of Guaranteed Products



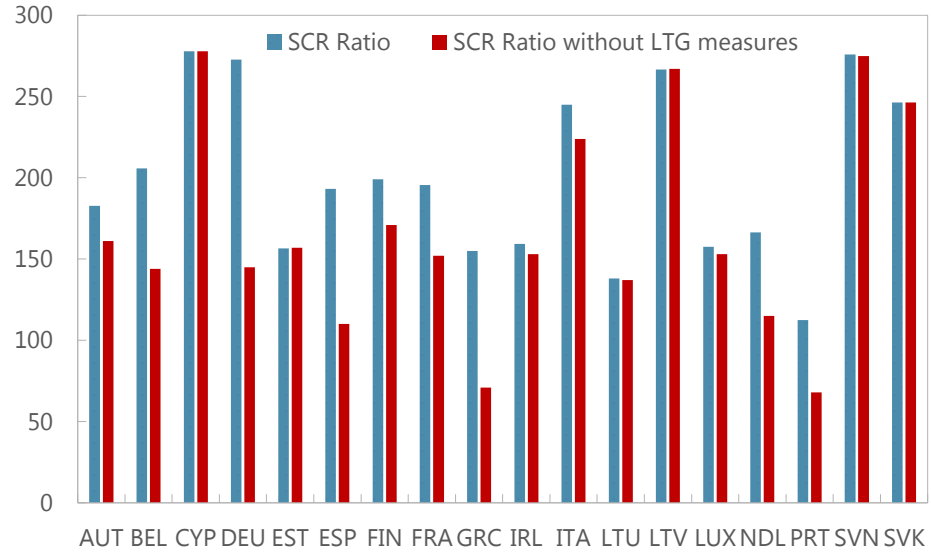
Source: EIOPA; IMF staff calculations.

Note: Macaulay duration of liabilities, and modified duration of assets. See Appendix II for pros and cons of using the Macaulay duration measure. Countries with 75-100 percent of insurers offering guaranteed products are marked in red. If guaranteed technical provisions as share of total technical provisions were used as a criterion, then Netherlands would be marked red.

[5] Other forms include traditional life insurance with profit contracts, savings products, endowment policies; health insurance with guarantees of wage maintenance in the event of illness, etc. Maximum guaranteed rates are under the capacity of the national regulatory authorities. Although these rates are adjusted in some countries, there is no fixed mechanism of such adjustments set at the EU level so far.

11. Solvency buffers such as the SCR look comfortable for now, but should be interpreted with caution. The baseline SCR ratio for the euro area in the EIOPA stress test was 200 percent (196 percent for the EU), which means that own funds covered almost twice the solvency capital requirements. However, life insurers can adjust the risk-free interest rate, used for discounting liabilities, for long-term guarantee and transitional measures.[6] Insurance and reinsurance companies covering more than 60 percent of the technical provisions in the EA use volatility adjustments (VA), an adjustment to the term structure of the risk-free rate to mitigate the impact of unusual market conditions that could increase bond yields temporarily. The SCR ratio without LTGs is about 168 percent for the euro area (136 percent for the EU). Although all SCRs were above 100 percent in the baseline for the EIOPA stress tests, SCRs shorn of LTGs and transitionals were lower than 100 percent for Greece and Portugal, and were lower by more than 50 percentage points for Belgium, Germany, Greece, Spain, and Netherlands (Figure 6).

Figure 6. Solvency Capital Requirements Ratios



Source: EIOPA; IMF staff calculations.

Note: LTG measures refer to Long-Term Guarantees measures that were introduced in the Solvency II Directive to ensure an appropriate treatment of insurance products that include long-term guarantees.

[6] The discussion on LTG measures in this note refer both to the long-term guarantee (LTG) package and transitionals. LTG measures aim to mitigate artificial volatility in balance sheets that does not reflect changes in the financial position or risk exposure of an insurer. These measures include volatility and matching adjustments to discount rates, the extrapolation of the long-term risk-free interest rate, transitional measures for the calculation of liabilities and the possibility for an extension of the recovery period under exceptional market conditions (EIOPA, 2016b, ECB, 2015). The transitional measures relate to the transition from Solvency I capital requirements to Solvency II requirements. Insurers apply a transitional adjustment to the risk-free rate for the valuation of insurance and reinsurance obligations based on the difference between discount rates of Solvency I and the risk-free rates. Over the 16-year transition period, these transitional measures would be reduced to zero.

12. Insurers were more adversely affected by EIOPA's "double hit" scenario. In this scenario, there is a sudden increase of risk premia combined with the low yields. Increases in government bond yields and credit spreads of corporate bonds coincide with fall in stock prices, property prices and commodity prices. While the low-for-long scenario mainly increases the PDV of insurers' liabilities more than assets, the "double hit" scenario decreases the valuation of assets more than that of liabilities.[7] The higher yields on government and corporate bonds, the main component of assets, lead to valuation losses. Lower asset values also allow those insurers without guaranteed payments to adjust the benefit payments (dependent on the performance of the assets), which reduces liabilities to some extent. For example, those with unit-linked business encounter erosion of values held in separate accounts on both the asset and liabilities sides. The LTG measures on the liabilities side provide a cushion against the asset volatilities; for instance, the volatility adjustment on risk-free rates begins to kick in during market turmoil, preventing fire sale of assets.

13. The maximum shortfall in the coverage of SCR by own funds implied by the EIOPA stress tests is about a ¼ percent of euro area GDP. The stress tests mainly identified Germany (and to some extent France) as having low buffers against the two specific shocks, with the highest impact for the "double hit" scenario. For countries with high guaranteed rates, duration mismatches and strong domestic interconnectedness, the government might want to step in (and refurbish policy protection schemes, for instance) to stave off spillovers to other sectors. Such contingent liabilities seem low for the overall euro area, but could be concentrated in a few countries. The maximum contingent liabilities coming out of the shortfall identified in the stress test would be about €14 billion for Germany (0.46 percent of GDP) and only about €310 million for France (0.01 percent of GDP) for the insurers to go back to an SCR ratio of 100 percent, without taking LTGs into account (Figure 7). The difference between France and Germany stems from lower baseline solvency buffers in the latter.[8] Even though the Portuguese and Belgian insurance sectors are small in the euro area, their own funds shortfall under the severe scenario are 1.5 percent of GDP and 0.8 percent of GDP, respectively, owing mainly to thin baseline solvency buffers.[9]

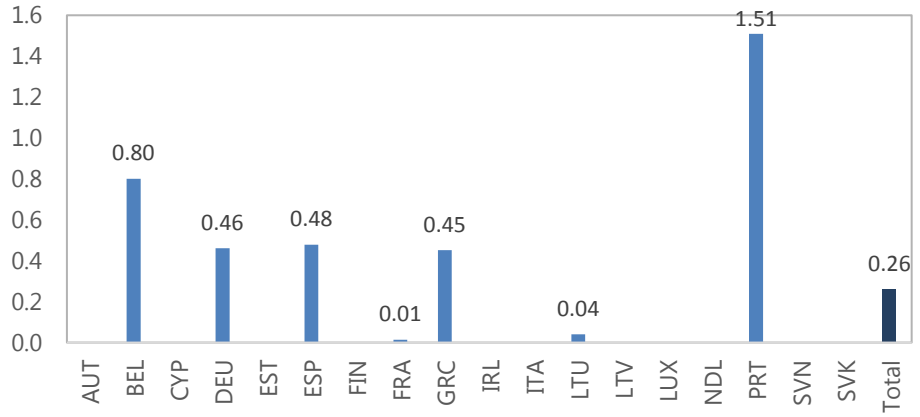
[7] Austrian, Dutch and German insurers were more impacted by the low-for-long scenario owing to large duration mismatches or long duration of liabilities, or both.

[8] Regulators, such as in Germany, recognize the insufficiency of the SCR-coverage and require insurers to present plans about how they intend to achieve a sufficient SCR-coverage at the end of the 16-year transitional period for the full adoption of Solvency II (European Commission, 2016).

[9] It should be noted that the 2016 EIOPA stress test results did not specify a pass-fail criterion. The calculations on SCR-coverage shortfall are based on the results of the two scenarios—changes in assets and liabilities—published by EIOPA. The more conservative threshold for the SCR ratio—the one without adjustments for LTGs—is used to calculate the SCR-coverage shortfall in this note.

Figure 7. Shortfall in Own Funds to Cover the SCR ("SCR-coverage")

(Percent of GDP)

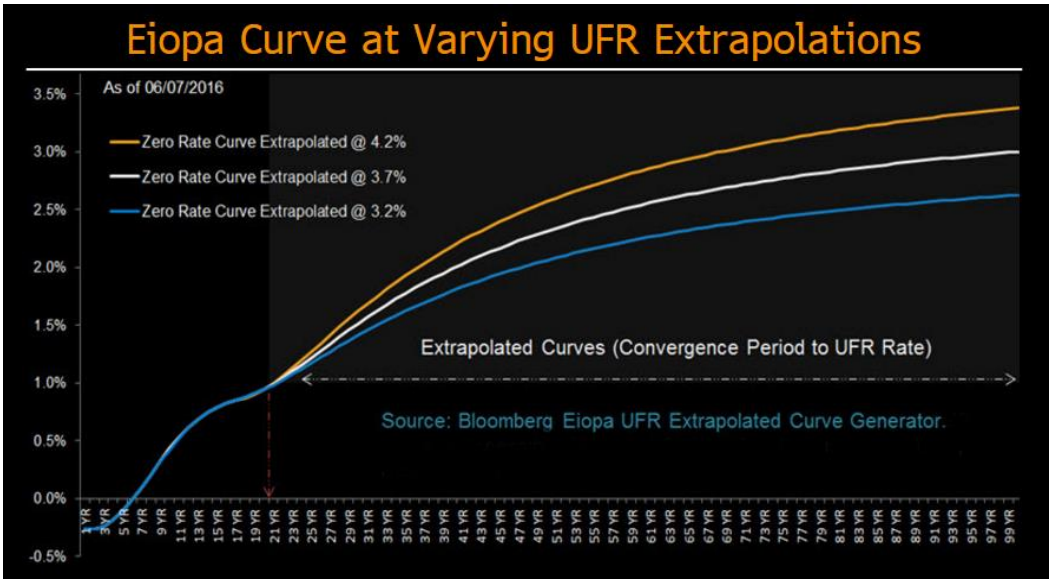


Source: EIOPA, 2016a; IMF staff calculations.

Note: Based on 2016 EIOPA Stress Test Results for the "Double Hit" Scenario. The SCR ratio of 100 percent, without LTGs, is taken as the threshold.

14. EIOPA's adjustment of the UFR could have a large impact on insurance technical provisions. At the current 4.2 percent, the UFR implies a yield of more than 1.5 percent for 30-year maturities (as of July 2016) (Figure 8). If the UFR were to be reduced to 3.65 percent (as was recently proposed), the 30-year yields would fall by about 50 bps, and 60 year yields by 75 bps. Countries where insurers have long duration liabilities—such as Germany, Netherlands, and Austria—would be the most adversely affected with lower SCR ratios. Indeed, EIOPA's impact analysis (EIOPA, 2017) suggest that a 50 bps reduction in the UFR would reduce the EU-wide SCR ratio by about 4 percentage points, with much greater impact on Germany (16 pp), Netherlands (15 pp), and Austria (8 pp).

Figure 8. Implications for the Yield Curve for Different UFR Assumptions



Used with permission of Bloomberg Finance L.P.

C. Vulnerabilities Due to Interlinkages

15. Systemic risks could be higher for those ICPFs that are strongly interconnected with other sectors. ICPFs provide long-term funding to banks (deposits and bonds), corporates (equities and bonds) and governments (bonds). Thus, problems with the ICPFs could increase fire sale risks or withdrawals of funding from other sectors. Ownership linkages through conglomerates or bancassurance groups could increase funding costs for banks if the insurance arm is in trouble. On the other hand, problems in banks could trigger conversion of convertible bank debt (held by ICPFs) to equity, making ICPF's investments more volatile. Corporate distress could increase the risk premia on ICPF investments, as in the "double-hit" scenario stress tested by EOIPA.

16. At the euro area level, ICPFs are less interconnected to other sectors, compared to banks, but could pose a funding risk to sovereigns. ICPFs are most connected to sovereigns, investing 19 percent of GDP or about €2 trillion (Figure 9). This is still less than the amount MFIs (including banks, ECB and NCBs) and the Rest of the World (ROW)'s invest in euro area sovereigns. But a funding shock from ICPFs would have to be absorbed by other players (possibly the ECB, subject to issuer limits and capital key). The ICPFs holdings of ROW assets and bank deposits and bonds are another 10–12 percent of GDP (as shown by the vertical column on ICPFs in Figure 9). Comparatively and unlike banks, ICPFs do not borrow heavily from the rest of the sectors (as shown by the ICPF row in Figure 9). The ECB's holdings of ICPF bonds through the Corporate Sector Purchase Program (CSPP) is included in the 1.3 percent of GDP borrowings from the MFIs.

Figure 9. Flow of Funds for the Euro Area

%GDP		Lender								
		MFI	OFC	NonMMF Asset Managers	ICPF	Govt	NFC	HH	ROW	
Borrower	MFI	95	17	7	10	8	20	67	42	266
	OFC	22	18	5	4	1	3	1	36	90
	NonMMF Asset Managers	1	0	0	0	0	1	0	0	2
	ICPF	1.3	0.8	0.4	1.4	0.2	0.1	0.4	1	6
	Govt	40	5	9	19	9	1	3	26	113
	NFC	40	17	10	6	4	23	6	31	137
	HH	50	5	0	2	1	0	0	1	59
	ROW	40	24	38	12	2	14	3	0	134
	TOTAL	289	87	70	53	25	63	82	137	**807**

Source: ECB; IMF staff calculations.
Note: MFI: Monetary Financial Institutions (banks and central banks); OFC: Other Financial Corporations; Non MMF: Non-Money Market Funds; ICPF: Insurance and Pension Funds Sector; Govt: Government; NFC: Nonfinancial Corporates; HH: Households; and, ROW: Rest of the World.

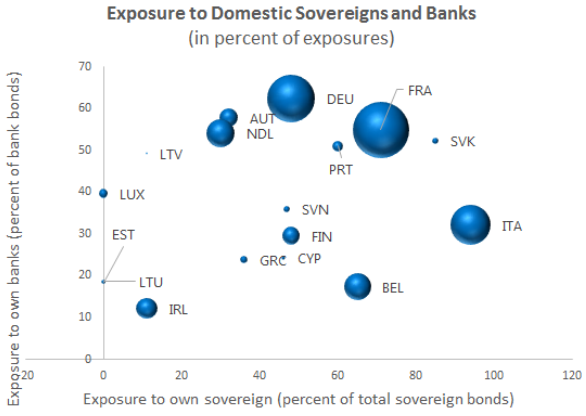
Figure 9. Flow of Funds for the Euro Area (concluded)

EUR bn		Lender								
		MFI	OFC	NonMMF Asset Managers	ICPF	Govt	NFC	HH	ROW	
Borrower	MFI	10096	1785	766	1099	899	2158	7149	4434	28387
	OFC	2322	1949	507	381	91	309	123	3882	9563
	NonMMF Asset Managers	64	9	16	1	6	107	0	17	220
	ICPF	136	87	44	146	17	13	47	140	630
	Govt	4309	582	959	2009	949	141	327	2746	12022
	NFC	4259	1790	1043	610	434	2468	684	3319	14607
	HH	5353	505	21	169	75	20	20	78	6240
	ROW	4304	2546	4080	1228	240	1540	363	0	14300
	TOTAL	30842	9253	7436	5641	2712	6756	8714	14614	

Source: ECB; IMF staff calculations.
Note: MFI: Monetary Financial Institutions (banks and central banks); OFC: Other Financial Corporations; Non MMF: Non-Money Market Funds; ICPF: Insurance and Pension Funds Sector; Govt: Government; NFC: Nonfinancial Corporates; HH: Households; and, ROW: Rest of the World.

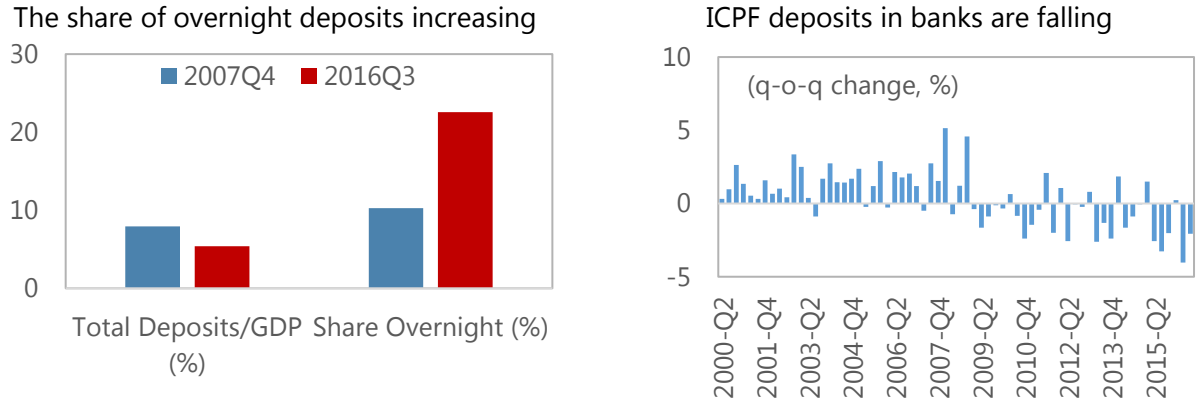
17. Systemic risks are greater in countries where ICPFs invest mainly in domestic sovereign and banking sectors. Problems with ICPFs could easily spill over to domestic banks and sovereigns if insurers do not diversify into non-domestic banks and sovereigns. For instance, more than 70 percent of the sovereign bond portfolios of French insurance companies, among the largest in the sample, are concentrated in French sovereign bonds, and 55 percent of their bank debt holdings are in French banks (mainly through bancassurance linkages) (Figure 10). More than half of the bank bonds held by German insurers are for domestic banks. In fact, German insurers allocated 68 percent of their assets in domestic financial sector in 2014, compared to a euro area average of 49 percent (European Commission, 2016). Countries where insurers are large and domestically interconnected contribute to and are conduits of systemic risk.

Figure 10. Domestic Systemic Risk from Linkages



Source: EIOPA; IMF staff calculations.
Note: The bubble size is proportionate to the size of the insurance sector in the country.

Figure 11. ICPF Deposits with Banks

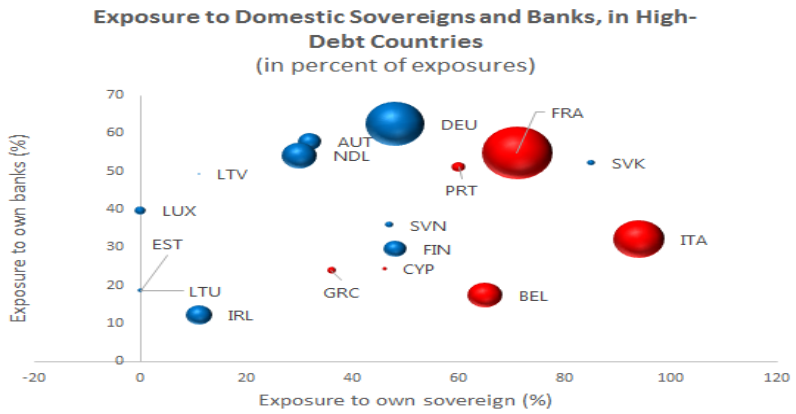


Source: ECB; IMF staff calculations.

18. ICPFs have been withdrawing their bank deposits and, within their remaining bank deposits, shifting to shorter term deposits since the global financial crisis (Figure 11). At the euro area level, these withdrawals are small, but are concentrated in Germany, Cyprus, Spain, Greece, and Slovakia. In some countries, there is a shift from banks to money market mutual funds. Bank stress tests in these countries need to specifically look at the liquidity risks of banks from ICPF deposit outflows against the liquidity coverage ratio (LCR). LCR requires that banks hold enough high-quality liquid assets to withstand 30-day run of liabilities. The run-rates differ by type of liability. If the run rate for insurers is taken to be the same as that for unsecured wholesale funding from large corporates and sovereigns, it is 40 percent (if not fully covered by deposit insurance). That is, an LCR of 100 percent (that banks are required to meet) needs to take account of a 40 percent run rate of ICPF deposits. So far, the deposit reduction at the euro area level has been only 7 percent for 2016Q3 over 2015Q3, meaning that the monthly run-rate is considerably lower than the 40 percent rate.

19. Sovereign-ICPF linkages could add to vulnerabilities, especially in high-debt countries. This is especially so in countries where insurers are heavily invested in the domestic sovereign debt market. More than 60 percent of insurers' sovereign debt exposures are in domestic sovereigns in Italy, Slovakia, France, Belgium and Portugal (Figure 12). Among these countries, public debt in France, Belgium and Italy is above the EA-average of 90 percent of GDP (shown as red bubbles in Figure 12). Problems in ICPFs, for example those struggling with the low-interest environment or market volatility with high guaranteed rates amid low solvency buffers, could trigger a fire sale of government securities and bring a stop to rolling over government funding. Moreover, there are limits to the ECB's ability to step in to substitute for insurers' sovereign debt holdings, because its Asset Purchase Program is subject to various constraints, including the capital key.

Figure 12. Domestic Systemic Risk from Linkages



Source: EIOPA; IMF staff calculations.
Note: The bubble size is proportionate to the size of the insurance sector in the country; red bubbles represent countries with government debt higher than 90 percent of GDP, the euro area average in 2016.

D. Summary Indicator of Vulnerabilities

20. Countries can be ranked based on a summary indicator of ICPF vulnerabilities. Four sets of vulnerabilities are considered: *interest rate risk* due to duration mismatches (z-scores for duration mismatch) and prevalence of guaranteed products (1 or 0); *domestic interconnectedness* with own sovereigns and banks (z-scores for the fraction of bond-holdings exposed to own sovereigns and banks); *low solvency buffers* (z-scores for the 2016 EIOPA stress test baseline SCR ratios without LTGs); and finally, *size* of the insurance sector (z-scores based on the size of own funds). Thus, the z-scores based on the four sources of vulnerabilities can be summed up to create an overall index of systemic vulnerabilities from ICPFs (Figure 13). In addition, the EIOPA stress test results are captured by red bars in Figure 13, showing countries where insurers fell below the 100 percent SCR ratio in at least one of the two stress scenarios. Countries can also be ranked by their z-scores on each of the four sources of vulnerabilities (Figure 14).

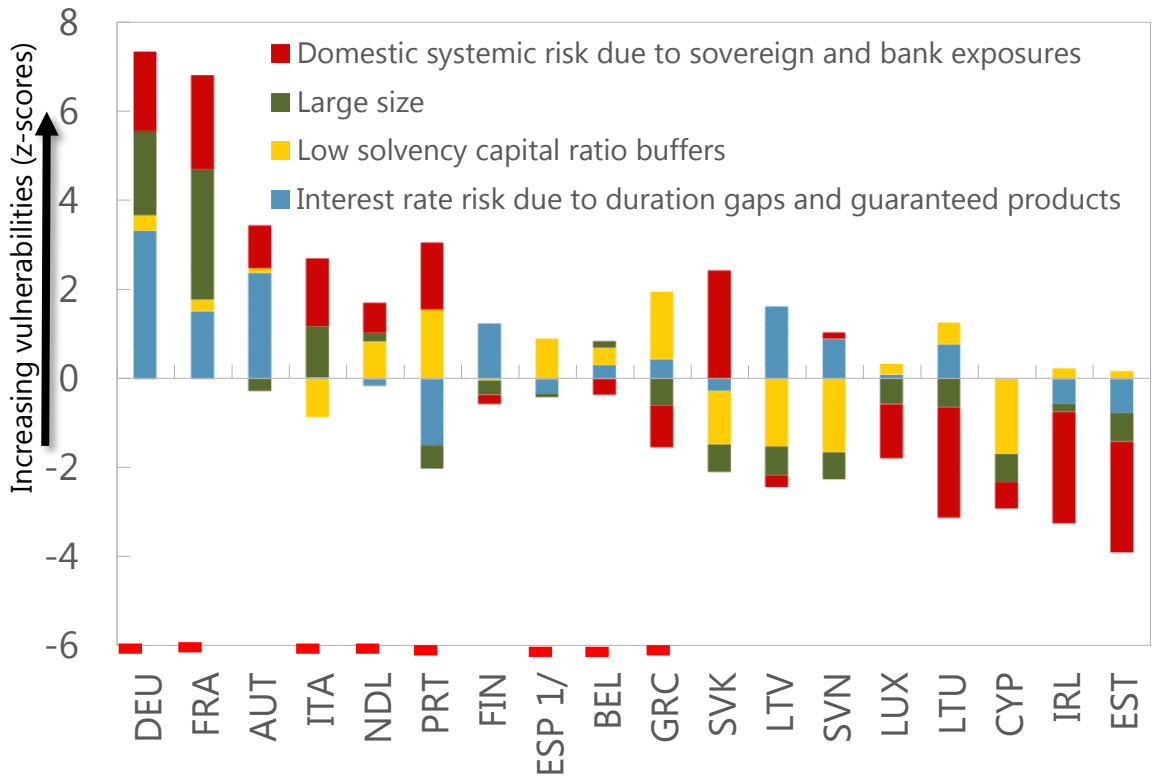
21. Germany and France stand out as being especially vulnerable, followed by Austria (Figure 13). The biggest source of risks for these countries come from interest rate risk (Germany and Austria) and large size (Germany and France). The more disaggregated scores (Figure 14) show that Germany, Austria and Latvia are the most vulnerable to interest rate risk from both duration mismatches and prevalence of guaranteed products. Greece, Portugal and Spain had the least baseline SCR-coverage buffers (for the EIOPA stress tests), and so would have the least ability to withstand shocks. Slovakia, France, and Germany score high on domestic interconnectedness, although Italy and Portugal come close behind.

22. The results of the EIOPA stress tests can be seen to test the insurers on the combination of interest rate risk and low solvency buffers. The overall SCR-coverage shortfall of a ¼ percent of GDP for the euro area for the "double hit" scenario assumes a generalized market turmoil. Some of the countries with higher-than-average SCR-coverage shortfalls—Portugal

(1.5 percent of GDP), Belgium (0.8 percent of GDP), and Spain-Greece (around 0.45–0.48 percent of GDP)—also have high sovereign debt that are partly funded by the ICPF sectors.

23. The EIOPA stress tests do not address the additional SCR-coverage needs potentially arising from interconnectedness of the domestic sovereign-bank-insurance markets. Problems in insurance sectors could increase sovereign bond yields, which could affect wholesale funding cost of banks (sovereign-bank linkages). Intense problems in banks could lead to bail-ins, which could, in turn, lead to haircuts on insurers' holdings of bank-bonds, reducing the SCR ratio even further. Thus, the impact of amplification of shocks could see even higher SCR shortfalls, especially in countries that already have high debt.

Figure 13. Summary of Vulnerabilities

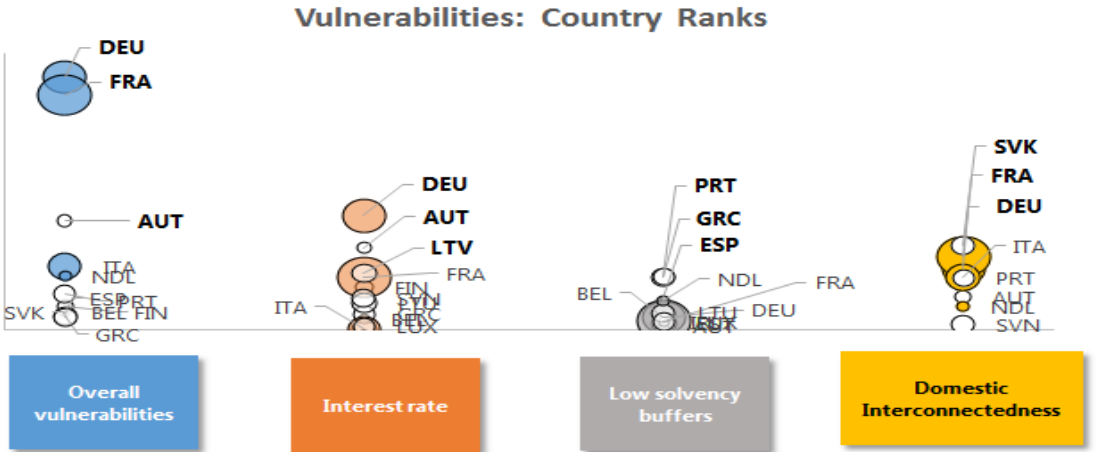


Source: EIOPA; IMF staff calculations.

1/ There is no data on interconnectedness for Spain.

Note: Countries are ranked based on the following indicators: duration gap, prevalence of guaranteed products (together "interest rate risk"), relative size of net asset positions ("large size"), relative SCR ratios based on reported SCR without LTGs ("low solvency buffers"), and exposures to domestic banks and sovereigns ("domestic systemic risk"). Positive (negative) numbers are "higher (lower) than average" on each risk. The red horizontal markers identify countries in which assets/liabilities fell below 1 for at least one of the two 2016 EIOPA stress scenarios.

Figure 14. Vulnerabilities: Top-3 Countries



Source: EIOPA; IMF staff calculations.
Note: Bubbles are proportional to the size of the insurance sector. The placements of the bubbles under each category of vulnerability is based on the z-scores used to depict Figure 13.

E. Summary and Policy Implications

24. Countries with large insurance sectors and those with high government debt are also exposed to the risk of erosion of SCR-buffers due to the low interest rate environment. Germany, France and Austria stand out with a combination of interest rate duration mismatches on assets and liabilities and the prevalence of guaranteed products. Among these countries, the 2016 EIOPA stress tests revealed capital shortfalls from a severe version of the scenarios primarily in Germany, at about 0.46 percent of GDP. These shortfalls are higher in some countries with above-average government debt-to-GDP ratios: Portugal (1.5 percent of GDP), Belgium (0.8 percent of GDP), and Spain (0.48 percent of GDP).

25. The ability of insurers to adjust guarantees provides them with a policy lever against interest rate risk and protects policy holders. As shown in Appendix II, keeping constant the long-term cash flows or liabilities would only erode buffers when the interest rate falls. Guaranteed rates of return at 3–4 percent for the next 12 years far exceed rates of return on assets of 1.3–2.5 percent on 30-year products. As a rule of thumb, guaranteed rates should be 2 percentage points below market rates (Sugimoto, 2016). While it is difficult to adjust guarantees on legacy products, there should be rules against promising guaranteed returns on new products. Importantly, there should not be any guaranteed returns on unit-linked products, which were originally designed to pass on market risks to clients.

26. Stress tests should assess risks that can arise from domestic interconnectedness of the insurance sectors. The EIOPA stress tests currently do not address the additional shortfalls in SCR-coverage buffers that could be coming from interconnectedness of the domestic sovereign-bank-insurance markets. For instance, some countries with a higher-than-average buffer shortfall also have high sovereign debt that are partly funded by the ICPF sectors. The impact of amplification of shocks through sovereign-financial linkages could lead to higher SCR-coverage shortfalls.

27. Insurers' deposits in banks have been falling, especially in Germany, Cyprus, Spain, Greece, and Slovakia. Liquidity risk stress tests of these banking systems should assess the ability of banks to withstand the continued withdrawal of such deposits. While the overall, run-rate of these deposits was only 7 percent for the year in 2016Q3, these rates could be higher in specific banking systems.

28. Insurers should diversify their businesses and consolidate to reduce vulnerabilities. It would be difficult for insurers to adjust to low rates by changing the asset mix alone. Changing the asset portfolios to cover solvency margins in a low for long environment entails taking unacceptable levels of risk (IMF, 2017). Solvency II risk weights on risky assets are higher than those required for the U.S. and Japan (Appendix I). For instance, investments in real estate (and earning illiquidity premia) carry a risk weight of 25 percent under Solvency II, unlike in the U.S. (15 percent) and in Japan (10 percent). Competition is growing for assets such as infrastructure debt that combine relatively attractive returns with low capital charges. But liquidity and issuance is low and it is tougher for smaller insurers to access the market. While some insurers are expanding their unit-linked businesses (ECB, 2016), there is stiff competition from ETFs. Large insurance companies are adjusting through cross-border mergers, as seen by increased M&A activities in 2015 and 2016. This trend needs to continue especially in countries with SCR-coverage shortfalls, with M&As for smaller insurers as well.

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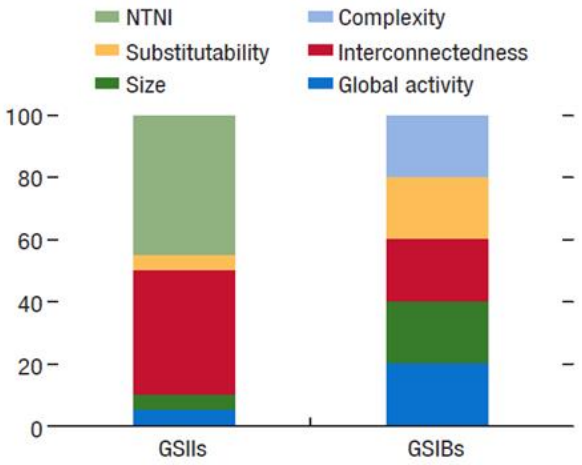
Appendix I. Designation of GSIIs and Comparison of Risk Weights

Figure 1. Attributes of being globally systemically important institutions (GSIIs): differences between insurers and banks (IMF, 2016)



Sources: Basel Committee on Banking Supervision 2011; International Association of Insurance Supervisors 2013a; and IMF staff calculations.
Note: GSIBs = global systemically important banks; GSIIs = global systemically important insurers; NTNI = nontraditional non-insurers.

Table 1. Capital Charges for Risky Investment of Insurers, (IMF, 2017)

	Solvency II (Standard Approach)	U.S. Risk-Based Capital Requirement	Japanese Solvency Margin Ratio
Listed Equity	22%	15%	20%
Private Equity	49%	30%	20%
Non-investment grade corporate bonds	Up to 37.5% (5 year)	30% (Class 6)	30%
Real Estate	25%	15%	10%

Appendix II. Impact of Interest Rate Changes on Financial Institutions' Balance Sheets: An Example

The impact of interest rate changes can be illustrated with hypothetical balance sheets of a life insurance company and a bank. As discussed in Section I, the example insurance company's liabilities are longer-dated than its assets, and a bank's liabilities are shorter-dated than its assets. For illustrative purposes, both have zero capital. They earn income from fair value (or the present discounted value) changes in their assets and liabilities. The yield curve as of April 2012 is taken as a benchmark and it is assumed that the yield curve has now shifted down in a parallel way by 2 percentage points. This is not an unreasonable assumption, given that the 20-year yield-to-maturity on AAA zero coupon bonds (as estimated by the ECB) has indeed shifted down by 2 percentage points.

	Life Insurance		Bank		Yield to Maturity 1/	
Years to maturity (t)	Asset Cash Flow	Liability Cash Flow	Asset Cash Flow	Liability Cash Flow	In April 2012	Parallel Shift in Yields = -2%
1	200	10	10	200	0.149	-1.851
2	200	10	10	200	0.369	-1.631
3	200	20	20	200	0.668	-1.332
4	200	30	30	200	0.996	-1.004
5	200	100	100	200	1.32	-0.68
7	50	180	180	50	1.892	-0.108
10	50	200	200	50	2.486	0.486
15	50	250	250	50	2.924	0.924
20	50	400	400	50	3.013	1.013
	1200	1200	1200	1200		

1/ Based on ECB's Zero-coupon yield curve for AAA bonds in the euro area, April 4, 2012.

A useful concept of capturing the impact of interest rate changes on assets and liabilities, and the net impact on income through fair value changes, is "duration". Duration measures the maturity of assets or liabilities by taking into account the size and timing of payments between now and maturity. What matters is the time remaining to maturity rather than the original maturity. It is a direct measure of the interest rate sensitivity or elasticity of an asset or liability to changes in interest rate. Macaulay Duration, a simple measure of duration, is given by:

$$D = \frac{\sum_{t=1}^{N}[(Cash\ flow\ at\ t)*\left(\frac{1}{(1+R_t)^t}\right)*t]}{\sum_{t=1}^{N}(Cash\ flow\ at\ t)*\left(\frac{1}{(1+R_t)^t}\right)}$$

The larger the numerical value of duration (in years), the more sensitive the market value of the assets or the liabilities is to the changes in interest rates.[1]

The duration of assets and liabilities for the hypothetical life insurance company is given in Table 1 below. For a positively sloped yield curve, the PDVs of liabilities get smaller the longer the maturity. In contrast, shorter dated assets are discounted much more.

Table 1. Duration of Assets and Liabilities of the Insurance Company

Interest Rates: as of April 2012

Assets

Years to maturity (t)	Asset Cash Flow (CF)	Yield Curve= R (%)	Discount factor (DF) = $1/(1+R/100)^t$	Discounted Cash Flow	Discounted Cash Flow * time to maturity
	[1]	[2]	[3]	[4] = [3]* [1]	[5] = [4]*t
1	200	0.149	0.999	199.7	199.7
2	200	0.369	0.993	198.5	397.1
3	200	0.668	0.980	196.0	588.1
4	200	0.996	0.961	192.2	768.9
5	200	1.32	0.937	187.3	936.5
7	50	1.892	0.877	43.9	307.0
10	50	2.486	0.782	39.1	391.1
15	50	2.924	0.649	32.5	486.8
20	50	3.013	0.552	27.6	552.3
				1116.8	4627.5
Duration D_A = Σ [5]/Σ [4] years					**4.1**

Liabilities

Years to maturity (t)	Liability Cash Flow (CF)	Yield Curve= R (%)	Discount factor (DF) = $1/(1+R/100)^t$	Discounted Cash Flow	Discounted Cash Flow * time to maturity
	[1]	[2]	[3]	[4] = [3]* [1]	[5] = [4]*t
1	10	0.149	0.999	10.0	10.0
2	10	0.369	0.993	9.9	19.9
3	20	0.668	0.980	19.6	58.8
4	30	0.996	0.961	28.8	115.3
5	100	1.32	0.937	93.7	468.3
7	180	1.892	0.877	157.9	1105.1
10	200	2.486	0.782	156.5	1564.5
15	250	2.924	0.649	162.3	2433.8
20	400	3.013	0.552	220.9	4418.2
				859.5	10193.9
Duration D_L = Σ [5]/Σ [4] years					**11.9**

When interest rates fall (Table 2), the PDV of liabilities rises more than assets. In this example, the PDV of liabilities increases by 233 [=1092.7 – 859.5], whereas, the PDV of assets increases by only 99 [=1216.3 – 1116.8]. So, the insurance company makes a loss.

[1] See IMF's Financial Soundness Indicators' Compilation Guide at https://www.imf.org/external/pubs/ft/fsi/guide/2006/, Appendix VI, for a more discussion of duration. The Macaulay duration concept is usually used for fixed income assets and may not be fully suitable for ICPFs. This is because this (or other duration measures) do not account for the fact that some cash flows can be adjusted with interest rates—such as, with-profit guarantees—and the duration of some classes of assets, like equities, is difficult to define.

Table 2. Duration of Assets and Liabilities of the Insurance Company, Lower Yields

Interest Rates: Parallel Shift down by 2 percentage points

Assets

Years to maturity (t)	Asset Cash Flow (CF)	Yield Curve= R (%)	Discount factor (DF) = $1/(1+R/100)^t$	Discounted Cash Flow	Discounted Cash Flow * time to maturity
	[1]	[2]	[3]	[4] = [3]* [1]	[5] = [4]*t
1	200	-1.851	1.019	203.8	203.8
2	200	-1.631	1.033	206.7	413.4
3	200	-1.332	1.041	208.2	624.6
4	200	-1.004	1.041	208.2	833.0
5	200	-0.68	1.035	206.9	1034.7
7	50	-0.108	1.008	50.4	352.7
10	50	0.486	0.953	47.6	476.3
15	50	0.924	0.871	43.6	653.3
20	50	1.013	0.817	40.9	817.4
				1216.3	5409.2
Duration D_A = Σ [5]/Σ [4] years					**4.4**

Liabilities

Years to maturity (t)	Liability Cash Flow (CF)	Yield Curve= R (%)	Discount factor (DF) = $1/(1+R/100)^t$	Discounted Cash Flow	Discounted Cash Flow * time to maturity
	[1]	[2]	[3]	[4] = [3]* [1]	[5] = [4]*t
1	10	-1.851	1.019	10.2	10.2
2	10	-1.631	1.033	10.3	20.7
3	20	-1.332	1.041	20.8	62.5
4	30	-1.004	1.041	31.2	124.9
5	100	-0.68	1.035	103.5	517.4
7	180	-0.108	1.008	181.4	1269.6
10	200	0.486	0.953	190.5	1905.3
15	250	0.924	0.871	217.8	3266.7
20	400	1.013	0.817	327.0	6539.5
				1092.7	13716.8
Duration D_L = Σ [5]/Σ [4] years					**12.6**

The larger impact on liabilities is also captured by the change in duration. For the same balance sheet structure, the duration of assets increases by [4.4 - 4.1] 0.3 year and the duration of liabilities increases by [12.6 - 11.9] 0.7 year. Thus, the larger the (negative) duration mismatch between assets and liabilities, the greater the impact when interest rates fall.

The approximate impact of changes in capital or own funds can be captured by a simple formula, where L is liabilities, A is Assets, D_L is duration of liabilities, D_A is duration of assets, R is interest rate in percent, ΔR is change in interest rate in percentage points:

$$\Delta Capital \cong [\, L.D_L - \, A.D_A] * \frac{\Delta R}{(1+R)}$$

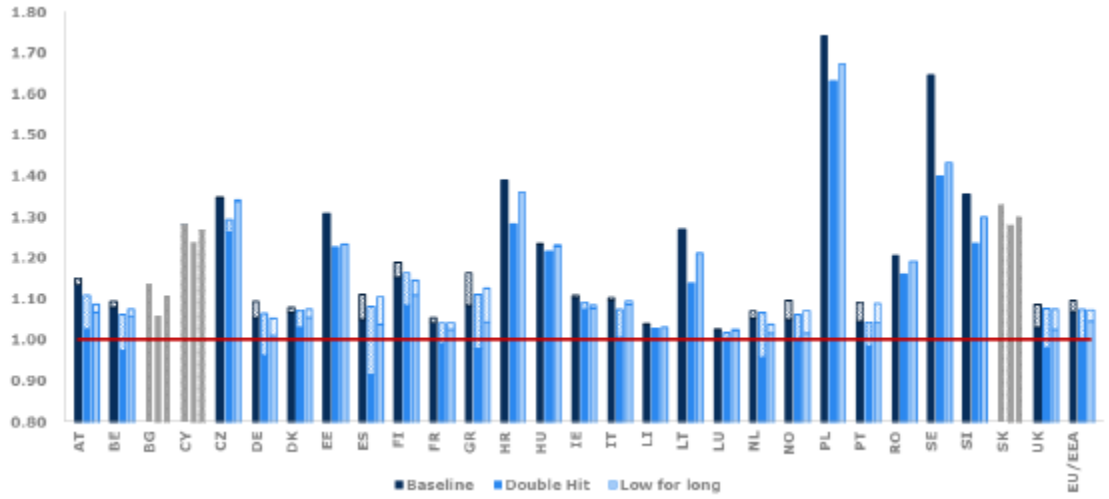
Thus, larger the duration mismatch between liabilities and assets, the larger is the impact on capital.

The hypothetical bank, with a profile of assets and liabilities that is mirror-opposite of the insurers', reaps gains with an interest rate fall. Its duration of assets increases by 0.7 and that of its liabilities increases by 0.4. Thus, the bank gains from the positive duration mismatch between assets and liabilities and its profits increase.

When interest rates fall, the insurance company can protect itself by being flexible on the payouts of its long-dated liabilities. The higher the prevalence of guaranteed returns to clients, which makes the long-term cash flow constant, the insurance company loses from the increase in duration mismatch.

Appendix III. EIOPA 2016 Assessment of Risks Under the "Low for Long" and "Double Hit" Scenarios

Figure 1. EIOPA Stress Test Results: Impact on Assets/Liabilities (Ratio)



Source: EIOPA.
Note: Shaded areas show the effect of the LTG and transitional measures.

MEETING EU CLIMATE PLEDGES: ASSESSING SOME POTENTIAL POLICY REFINEMENTS[1]

For the 2015 Paris Agreement on climate change, the European Union (EU) pledged to reduce greenhouse gas (GHG) emissions by at least 40 percent below 1990 levels by 2030. Policies envisioned to achieve this goal include: tightening the Emissions Trading System (ETS) covering large emitting firms; requirements for energy efficiency, vehicle CO_2 emission standards, and renewables; and policies to meet national-level targets for small-scale emissions sources outside of the ETS. This note analyses various refinements to the envisioned policy package that might meet the 2030 commitments with lower costs and greater fiscal and domestic environmental benefits (though implications for energy security are not considered). The results suggest potential economic and fiscal benefits from greater reliance on emissions pricing—for example, replacing tighter energy efficiency regulations with a higher ETS emissions price and use of carbon taxes (or tax-like instruments) for emissions outside the ETS sector. Other options, such as equating carbon charges across sectors and across countries, yield some economic benefits at the EU level, but do not raise revenue and, without compensating measures, impose uneven burdens across countries.

1. The EU is in the vanguard of climate mitigation policy. The EU launched the first ETS for GHGs in 2005 and submitted an ambitious pledge for the Paris Agreement to reduce GHG emissions at least 40 percent below 1990 levels by 2030. Various targets and objectives support this pledge, including reducing large-scale (e.g., power and industrial) emissions sources that are currently about half of EU emissions by 43 percent below 2005 levels by 2030 and reducing small-scale emissions (e.g., from vehicles, buildings) by on average 30 percent below 2005 levels by 2030. The European Commission's (EC) latest proposal also includes energy efficiency goals (at least a 30 percent improvement by 2030) and EU renewables target (at least a 27 percent share in gross final energy). EU member states are responsible for meeting country-specific targets for non-ETS emissions sources—which are more stringent for higher-income states—and to contribute to EU energy efficiency and renewable targets, though country-level targets for renewables are not yet set for 2030. Envisioned policy instruments for meeting the various targets include progressively tightening the EU ETS for large-scale emissions sources,[2] EU regulations for new vehicle CO_2 emissions, various energy efficiency standards and policies, as well as various national-level policies, like carbon taxes for non-ETS emissions, as in Ireland and France.

[1] Prepared by Ian Parry, Victor Mylonas, and Nathaniel Arnold. The authors would like to thank staff of the European Commission for helpful comments. The figures below are based on ongoing work that will be included in a forthcoming IMF working paper containing country-specific findings.

[2] Under the ETS, or cap-and-trade system, entities are required to surrender allowances to cover their emissions where the quantity of allowances is fixed at the EU level and trading among firms establishes a market price for allowances or emissions. At present, about half of the allowances are given away free to firms and half are auctioned.

2. There may be refinements to existing policies that meet emissions goals with lower economic costs and greater fiscal and domestic environmental benefits. Policy options considered here (as sequential adjustments from the currently envisioned policy package) include:

(i) *Greater reliance on road fuel taxes than vehicle emissions standards (i.e., CO_2 per kilometer driven)*. This policy promotes a greater range of behavioral responses for reducing emissions (including improving fuel efficiency and reducing vehicle use), raises revenue, and to some extent reduces traffic congestion and other externalities related to distance driven.

(ii) *National-level carbon taxes (or tax-like instruments) for small-scale emissions outside the ETS*. This results in the same effective price charged per ton of CO_2 emissions from vehicles, homes (e.g., using fuel oil for heat), and other smaller-scale emitters. The reform improves cost effectiveness by promoting, and striking the efficient balance across, all behavioral responses (improving energy efficiency, reducing use of energy-consuming products, shifting to cleaner fuels) for reducing emissions, while also raising revenue.

(iii) *Equating carbon tax rates across EU countries non-ETS emissions*. Under this reform, all EU countries set the same effective price (through carbon taxes or other pricing instruments) on emissions from smaller-scale emitters (e.g., vehicles, homes). This promotes a more cost-effective allocation of emissions reductions across countries, though with significant implications for burden sharing (e.g., emissions prices rise in countries with less stringent targets for non-ETS emissions).

(iv) *Relaxing required improvements in energy efficiency to rely more on pricing in the ETS sector*. This reform relies only on the ETS to meet emissions targets for large emitters rather than a combination of the ETS (with a lower emissions price) and energy efficiency regulations.[3] This reform raises revenue, and strikes a more cost-effective balance of behavioral responses (e.g., strengthening incentives for use of cleaner generation fuels while avoiding excessive reliance on investments in energy efficiency).

(v) *Harmonization of emission pricing across large-scale emitters (ETS sectors) and smaller-scale emitters (non-ETS sectors)*. This would entail the EU and national governments coordinating to calibrate emissions allowances or taxes such that the effective price per ton of CO_2 emissions is the same across sectors covered by the ETS and sectors that are not. This promotes a more cost-effective allocation of mitigation across ETS and non-ETS sectors at the EU level.

(vi) *Fully auctioning ETS allowances (compared with approximately 50 percent auctioning at present)*. This raises additional revenue.

[3] With part of the emissions reduction for the ETS sector already achieved through energy efficiency regulations, the required emissions reductions to meet the ETS cap are smaller, implying a lower emissions price.

3. Reforms would require a mix of actions at national and EU level, and in some cases would involve coordination challenges. Taxation is an area of shared competence—national authorities may legislate where the EU has not exercised its own competence and, even where the rules have been harmonized at EU level, countries usually have a number of options at their disposal. Nevertheless, the current EU legal framework poses certain limitations for introducing reforms (ii) and (v) in full. Relying less on EU vehicle CO_2 emission standards would require stronger policies from EU member states to meet their national-level targets for the non-ETS sector. The EC's proposed regulatory approach to reduce vehicle emissions may, however, provide more certainty over emissions outcomes, more directly addresses possible obstacles to adoption of fuel-saving technologies, and avoids the high fuel taxes otherwise needed to achieve CO_2 emissions reductions from transportation.[4] At the same time, the analysis in this paper shows it could be in countries own interest to rely more on fuel taxes than vehicle CO_2 emission standards, since there are cost savings and fiscal revenue benefits.

4. Policy options were evaluated using a flexible spreadsheet tool.[5] The model starts with data on fuel use by sector and by country and projects this forward (using GDP projections and assumptions about income elasticities for energy products, rates of technological change, and future energy prices) in a 'business as usual' (BAU) scenario, with current mitigation policies frozen. An 'envisioned policy' reference case is then developed with a simplified representation of the ETS, regulations (represented in the model by 'shadow prices') to meet energy efficiency, vehicle emission rate, and national-level targets for non-ETS emissions. Policy impacts are calculated using assumptions about fuel price responsiveness and the air pollution mortality, road congestions, and other local environmental effects associated with fossil fuel use.[6, 7] The model incorporates the 19 largest emitters in the EU with the focus on 2030, the target year for meeting the Paris emissions pledge, considering that policies to 2020 are already set.

5. While the model is simplified, it approximates the results of more detailed models. The model readily accommodates a wide range of policies, countries, parameter scenarios, and computations of economic welfare impacts—gross costs and costs net of domestic environmental benefits. This helps to guide efficient policy design and motivate further analysis with more detailed models, such as those used by the EC. For given long-run impacts of policies on fossil fuel use, the environmental, fiscal, and economic welfare impacts predicted by the model should roughly

[4] Prior EC studies (EC, 2011 and EC, 2016a) have found that a combination of regulatory and pricing measures would be needed to put the transport system on a sustainable path, lowering CO_2 emissions, oil dependency and congestion. Ongoing IMF work will attempt to reconcile these findings with the model results presented here.

[5] Similar tools have been used to evaluate a wide range of carbon mitigation and energy price reforms in China (Parry and others, 2016) and India (Parry and others, 2017).

[6] For example, a typical assumption is that each 1 percent increase in a fuel price reduces consumption of that fuel by 0.6 percent, with two-thirds of the response due to implicit adoption of more efficient technologies and one-third reduced use of products requiring that fuel.

[7] Updated from Parry and others (2014).

approximate those from more complex models, though there may be differences depending on assumptions and modeling choices.[8] Considerable uncertainty surrounds BAU projections and policy impacts (e.g., policy costs could be significantly lower with more rapid advancement of clean technologies), but the broad ranking of reform possibilities is robust to alternative assumptions. The model does not, however, include benefits from mitigating global climate change—which could be substantially more than the economic costs of mitigation measures—or greater energy security.

6. Currently envisioned policies reduce EU (energy-related) CO_2 emissions 36 percent below BAU levels in 2030—consistent with meeting the Paris pledge target—but have negligible fiscal benefits (Figure 1a and b). The ETS contributes most (14 percentage points) to CO_2 reductions, followed by various policies to improve energy efficiency in the household, industrial, and power sector, while vehicle CO_2 standards have a relatively modest effect. On net, fiscal benefits of the envisioned policy package are small (0.04 percent of GDP)—revenue from partial auctioning of ETS allowances is largely offset by erosion of road fuel tax bases from the increased fuel efficiency of vehicles that meet the vehicle emissions standards.

7. Average costs per ton of CO_2 reduced are high for vehicle emissions standards and energy efficiency regulations for the power sector and non-ETS sector. Combined total economic costs from all envisioned policies are 1.9 percent of EU GDP (€380 billion) in 2030 or €273 per ton of CO_2 reduced (Figure 1c and d). The average cost of vehicle standards exceeds €600 per ton of CO_2 reduced, reflecting in part high prior fuel taxes (equivalent, on average, to about €450 per ton of CO_2). Efficiency regulations for the power sector also have high average costs (as they do not promote switching to cleaner generation fuels, for example), as do energy efficiency regulations for the non-ETS sector. The ETS has modest average costs (below €50 per ton when combined with other policies). Local environmental benefits—mainly reduced air pollution mortality—offset a portion of costs in most cases, but for the ETS itself are large enough to imply negative costs overall (i.e., a net benefit of €33 per ton of CO_2 reduced, without even counting global climate benefits).

8. Implementing the alternative policy refinements considered here to achieve the same level of EU CO_2 emissions reduces costs in 2030 by 0.8 percent of GDP (or €160 billion). The largest cost reductions (0.4 percent of GDP—see Figure 2a) are from reducing ETS emissions through emissions pricing alone, rather than a combination of regulations and lower emissions prices. Relying on carbon taxes (or similar pricing instruments) for reducing vehicle and other non-ETS emissions reduces costs more modestly (by 0.1 percent—the bottom two policies combined in Figure 2a). Imposing the same carbon tax (or price) for non-ETS emissions across countries and across the ETS and non-ETS sectors each generate cost savings of about 0.15 percent each at the EU level, but, without compensation, the costs and benefits from harmonization of emissions prices would be unevenly distributed across countries. Domestic environmental benefits from all the reforms are smaller than the cost savings, amounting to about 0.1 percent of GDP.

[8] In particular, EC (2016b) provides state-of-the-art modelling on the impact of policies as adopted by end-December 2014. For the impact of prospective policies, the Impact Assessments accompanying the Clean Energy for All Europeans Package provide additional information.

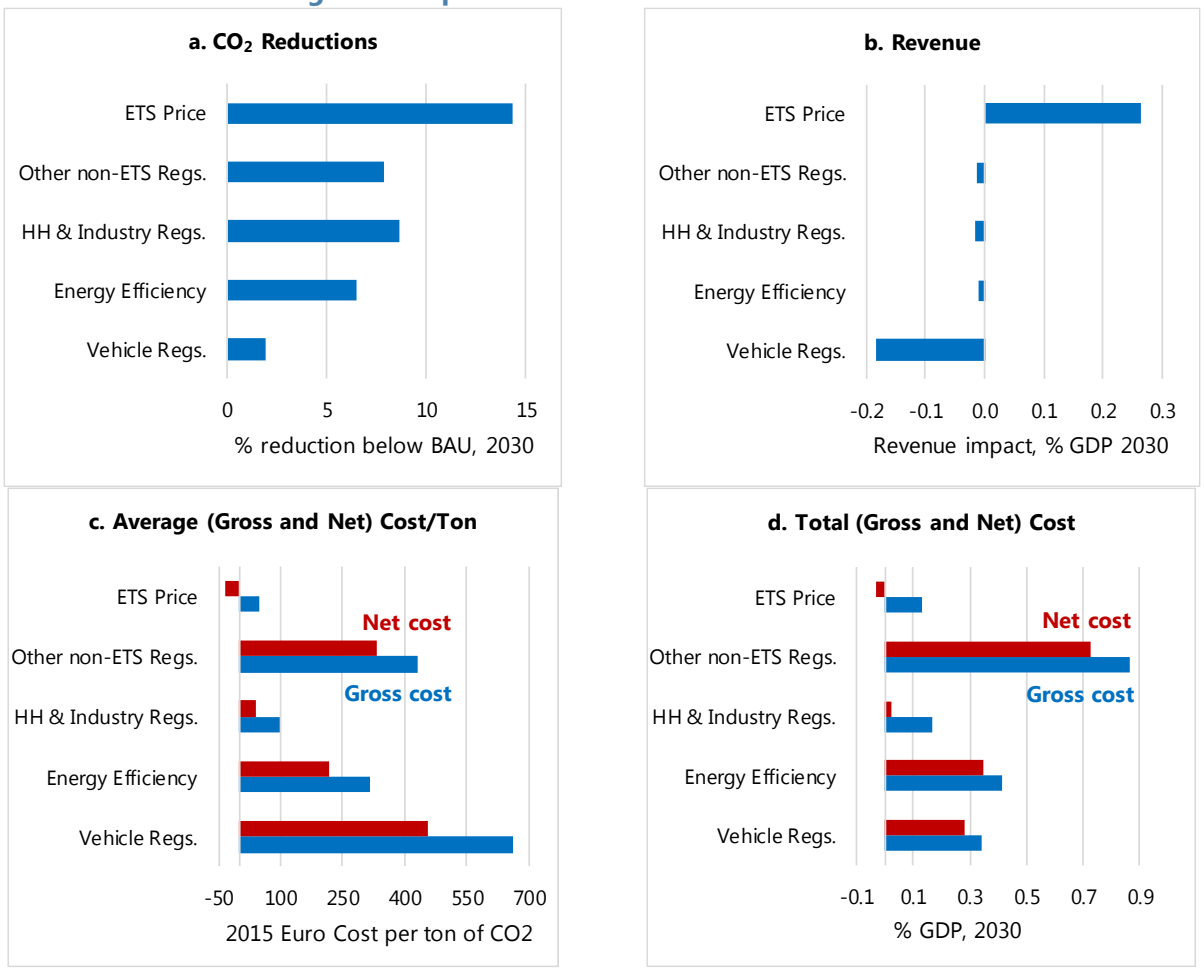
9. Some policy refinements also raise significant fiscal revenues. Increasing road fuel taxes raises almost 0.8 percent of GDP and transitioning to full ETS allowance auctions raises 0.25 percent of GDP. Other reforms have more modest revenue impacts, and some lose revenue overall.

10. Measures would be needed at the national level to help vulnerable groups adjust to higher energy prices.[9] Transfers to compensate low-income households would use only a fraction of the fiscal revenues that could be generated by the alternative policies discussed here, as most of the burden of higher energy prices is borne by households that are not in the bottom income quintile. Measures—such as worker assistance programs and transitory tax relief, for example—may also be needed partially mitigate the impact on energy-intensive firms competing in global markets. A particular concern is the potential for "carbon leakage"—where more carbon emissions intensive industries shift production outside the EU to avoid carbon pricing measures—and the related loss of EU industrial output. Such concerns need to be taken into consideration when designing policies

11. In sum, greater reliance on the ETS and carbon taxes or similar pricing instruments for other emissions sources generate the largest cost savings, and revenues, respectively. In contrast, the smaller economic benefits from equating emissions prices across countries and sectors, potential revenue losses, and redistributive effects (e.g., lower income countries would need compensation for higher non-ETS emissions prices given their less stringent targets for this sector), suggest any moves in this direction should be carefully considered before proceeding.

[9] Unlike regulations, pricing instruments involve a first-order transfer of revenue (e.g., to the government) which is reflected in higher energy prices.

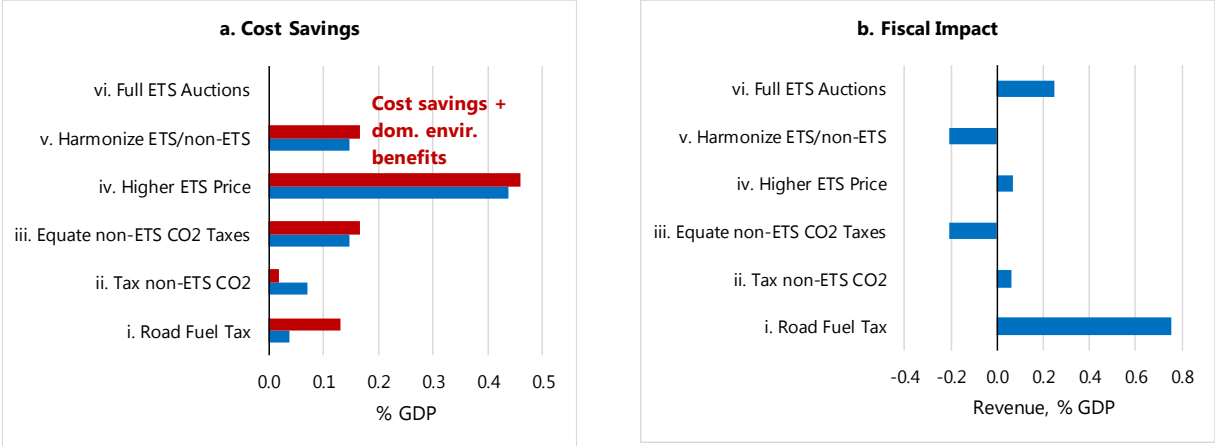
Figure 1. Impacts of Envisioned Policies for 2030



Source: Parry and Mylonas (2017).

Notes: Net costs subtract domestic (non-climate) environmental benefits from gross costs. *Vehicle Regs.* limits average (on-road) vehicle emission rates in 2030 to 30 percent below 2015 levels at the country level; *Energy Efficiency* limits the electricity consumption rates (per unit of capital) to 25 percent below 2015 levels by 2030; *HH & Industry Regs.* reduces energy consumption rates for the household and industrial sector to 30 percent below 2015 levels by 2030; *Other non-ETS Regs.* reduces energy consumption rates for households and small industry such that national level targets for non-ETS emissions in 2030 are met; *ETS Price* raises the ETS emissions price in 2030 to limit EU ETS emissions to 43 percent below 2005 levels.

Figure 2. Impacts of (Emissions-Neutral) Sequential Reforms



Source: Parry and Mylonas (2017).

Notes: Policies are numbered as in paragraph 2. *Road Fuel Tax* (imposed at the national level) replaces the vehicle emission rate standard while keeping road fuel emissions constant at the national level; *Tax non-ETS* imposes a uniform price on non-ETS emissions with taxes at the national level, removes other mitigation policies for this sector while keeping non-ETS emissions constant at the national level; *Equate non-ETS CO2 Taxes* imposes a uniform emissions price through national carbon taxes for the non-ETS sector across all countries keeping EU emissions for this sector constant; *Higher ETS Price* removes efficiency policies affecting the ETS sector and raises the ETS price to keep EU ETS emissions constant; *Harmonize ETS/non-ETS* equalizes emissions prices across ETS and non-ETS sectors keeping total EU emissions fixed; *Full ETS Auctions* increases the fraction of auctioned allowances for this sector from 50 to 100 percent.

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