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Monetary integration vs. real disintegration: single currency and productivity divergence in the euro area[#]

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Productivity slowdown plays a prominent role in the build-up of the euro area crisis. This phenomenon affected member countries asymmetrically, causing divergence in their productivity trends. Recent research traces this divergence back to monetary integration. After reviewing the arguments that link real "disintegration" of the euro area to its monetary integration, we assess them empirically by modelling the evolution of labour productivity using a panel of sectorial data. The results indicate that monetary unification may actually have fostered divergence in productivity trends, and suggest some economic policy measures that could prevent further divergence.

Keywords: total factor productivity; models of trade with scale economies; macroeconomic issues of monetary unions; labour productivity; labour contracts

JEL Classifications: D24, F12, F45, J24, J41

1. Introduction

European monetary integration has long been considered conducive to real convergence of member countries through two main mechanisms: firstly, by abolishing transaction costs, it would foster trade and therefore, synchronize member countries' business cycles (Frankel and Rose 1997); secondly, nominal convergence would drive interest rates to the lower levels experienced in core countries, thereby helping peripheral countries to consolidate their public finances and to catch-up through higher private investment. Interest rates convergence would not be a source of trouble because business cycle convergence would make a "one-size-fits-all" monetary policy viable. Financial integration would favour resource pooling: in the euro area, national investment would no longer be constrained by national saving. Market mechanisms would therefore favour convergence in economic structures, bringing saving where it was most needed, while preventing financial crises by financing "all viable borrowers" (Emerson et al. 1992).

This description of the benefits of monetary unification proved overly optimistic, confirming the criticisms expressed by a number of prominent economists, including Kaldor (1971), Sala-i-Martin and Sachs (1991), Thirlwall (1991) and Krugman (1993). While the theory of optimal currency areas focuses mostly on the ability of member countries to deal effectively with asymmetric shocks, historical experience shows that

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the on-going crisis of European integration started when Europe was hit by a symmetric exogenous shock: the global recession induced by the Lehman bankruptcy. This motivates Boltho and Carlin's (2013) remark that problems for monetary unification were caused by asymmetries in economic behaviours and structures across member countries, rather than in the shocks hitting them. In particular, divergence in productivity dynamics (see Table 1 and Figure 1 and 2 in the online Supplementary material) is increasingly seen as a major source of structural asymmetry between euro area member countries: those with relatively thriving productivity, like Germany, were able to withstand the Lehman shock much better than those with languishing productivity, like Italy (Darvas, Pisani-Ferry, and Sapir 2011).

Boltho and Carlin (2013) prompt a shift in perspective: the viability of a monetary union does not depend so much on the ability of monetary policy to deal effectively with asymmetric shocks in the short-run, as on the ability of monetary integration to promote real convergence in the long-run.

This paper focuses on the latter issue. The idea that monetary union could lead to real divergence has already been discussed in the literature. Lane (2006) identifies two mechanisms, both related to structural asymmetries between member countries: firstly, joining the euro has been a much larger shock for peripheral economies, since they experienced a much deeper fall in real interest rates, leading to lending and housing booms, the consequences of which are now apparent; secondly, the same variation in euro exchange rate has different impacts on the real economies of member countries, depending on their degree of openness to trade with non-member countries. Moreover, Lane stresses that different economic structures in euro area member countries would produce different trends in productivity, bringing about inflation differentials that might be seen as the result of market equilibrating forces.[1]

Two recent strands of literature suggest further mechanisms through which monetary integration may have adverse effects on productivity dynamics in the weakest members of a monetary union, thus fostering real divergence. The first focuses on the role of interest rates, pointing out that by lowering the cost of capital in weaker countries, monetary integration brings about capital misallocation, thereby undermining labour and total factor productivity growth. The second focuses on the role of exchange rate misalignments in the presence of economies of scale, arguing that by repressing external demand, an overvalued currency may reduce the scale of production and hence productivity (the converse is also true). This effect is stressed by the post-Keynesian growth model, where labour productivity depends on aggregate demand through the so-called Verdoorn's law (Verdoorn 1949), as well as by neoclassical models with heterogeneous agents (Tomlin and Fung 2010). Besides these two direct effects of monetary integration, which we call the "capital misallocation" and "scale" effect, the recent literature stresses an indirect "labour misallocation" effect linked to labour market reforms. Since Mundell (1961), it has been known that for a currency area to be viable, external devaluation (i.e. nominal exchange rate realignment) must be replaced with internal devaluation (i.e. price and wage flexibility). Over the last two decades, a number of reforms have been undertaken in the euro area in order to enhance labour market flexibility. These reforms have recently been criticized for two main reasons: firstly, by reducing labour cost they may have caused a misallocation of factors resulting in a fall in capital deepening (Gordon and Dew-Becker 2008); secondly, by increasing the number of temporary contracts, they discouraged investment in skills (Damiani and Pompei 2010). Both phenomena had adverse consequences for labour and total factor productivity.

Table 1. Dependent variable: value-added per hour worked.

	All sectors					Manufacturing			Services		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Real interest rate	1.38 (13.23)	1.34 (12.84)	0.45 (10.38)	0.85 (11.71)	1.34 (12.38)	1.79 (9.27)	1.12 (8.44)	1.19 (8.27)	1.19 (6.92)	1.22 (7.12)	1.00 (6.32)
REER (ULC based)	−0.43	−0.46	−0.13 (−6.47)	−0.30	−0.41	−0.40	−0.40	−0.37	−0.51	−0.54	−0.56
	(−15.57)	(−16.25)		(−11.24)	(−13.91)	(−9.30)	(−12.27)	(−10.56)	(−11.16)	(−12.49)	(−12.75)
Labour protection index		0.46 (7.13)	0.03 (0.74)		0.34 (5.55)		0.65 (7.60)	0.52 (6.11)		0.28 (2.80)	0.36 (4.05)
Corruption indicator			−0.02 (−2.94)	−0.01 (−1.33)							
ICT investment					0.08 (5.72)			0.10 (3.89)			0.05 (3.74)
Trend	0.005 (7.11)	0.006 (8.45)	0.005 (3.47)	0.004 (3.99)	0.006 (7.71)	0.008 (8.89)	0.008 (5.88)	0.007 (5.35)	0.004 (4.58)	0.005 (4.05)	0.007 (3.88)
ϕ	−0.26	−0.27	−0.51	−0.42	−0.28	−0.40	−0.33	−0.32	−0.25	−0.29 (−7.94)	−0.31 (−7.57)
	(−18.91)	(−19.09)	(−13.87)	(−16.30)	(−19.73)	(−9.30)	(−13.15)	(−13.33)	(−10.66)		
Log-likelihood	5917.8	5817.9	4200.4	4253.1	5372.4	2329.2	2322.2	2270.9	2035.0	2008.2	1687.4
Number of observations	2999	2896	1816	1919	2622	1120	1188	1129	983	916	741

Notes: annual data from 1986 to 2014; *t*-statistics are reported in parentheses; *Trend* is a linear deterministic trend; ϕ is the error correction term.

The purpose of this paper is to assess the impact of these three effects on labour productivity: the "capital misallocation" effect, working through real interest rates, the "scale" effect, working through exchange rates and the "labour misallocation" effect, working through labour market reforms. The closest empirical reference to our work is Cette, Fernald, and Mojon (2016), who measure the capital misallocation effect by estimating the long-run impact of real interest rate on the rate of growth of productivity. Our work extends their analysis in three directions: we take into account the scale and labour misallocation effects, and check for robustness of the results by augmenting our model with other variables usually related to productivity development; we also extend the sample by considering a longer time span and a greater number of sectors; finally, we look for long-run relationships using the autoregressive distributed lags – pooled mean group (ARDL-PMG) estimator of Pesaran, Shin, and Smith (1999). Our results indicate areas where reform of the European policy framework should be undertaken in order to ensure viability of the monetary unification project.

The paper is organized in five sections. After this introduction, Section 2 surveys recent theoretical and empirical evidence on productivity convergence in a monetary union, summarizing the results of previous studies on the three effects outlined above. Section 3 describes the data and econometric methodology. The results are presented in Section 4. Section 5 draws some conclusions.

2. Productivity convergence in a monetary union: a survey of the recent literature

2.1. *The capital misallocation effect*

Low-interest rates are often mentioned among the main benefits of the euro, both because they alleviate the burden of public debt in heavily indebted countries, such as Italy, and because they foster investment and thereby productivity and employment (see e.g. Emerson et al. 1992; Blanchard and Wolfers 2000). This macroeconomic argument, focusing on the benefits of expansionary monetary policy in terms of aggregate demand management, is now challenged on microeconomic grounds. Recent explanations of the productivity slowdown in southern euro area countries suggest that low-interest rates may have led to misallocation of capital, across sectors or across firms, lowering aggregate productivity.

Misallocation between sectors is stressed by Reis (2013), who analyses the slump in Portuguese productivity using a model in the spirit of Aoki et al. (2010). In Reis's (2013) model an increase in financial integration has a detrimental effect on aggregate productivity, because cheap foreign capital allows less productive firms in the non-tradable sector to enter the market. This perverse effect is amplified by frictions in the domestic financial market that prevents productive firms in the tradable sector from fully accessing abundant finance from abroad. Benigno and Fornaro (2014) highlight a different transmission mechanism, the "financial resources curse", whereby abundant access to foreign capital fosters a consumption boom, bringing about a shift in productive resources to the low-productivity non-tradable sector.[2]

Misallocation across firms within sectors is usually analysed building on Hsieh and Klenow (2009), who measure the dispersion in revenue productivity among firms (defined as the product of physical productivity and firm's output price). The rationale for this approach is that in the absence of market distortions, revenue productivity should be equated across firms and the dispersion in revenue productivity should accordingly be low. A number of studies have ascertained the existence of capital misallocation

across firms in southern Eurozone countries: see e.g. Gopinath et al. (2015, Figure 2) for Spain, Calligaris et al. (2016) for Italy, Dias, Robalo Marques, and Richmond (2016) for Portugal. The explanations of this stylized fact focus on the role of capital inflows, and hence on the role of monetary and financial integration.

According to Gopinath et al. (2015), capital inflows, fostered by the decline in real interest rates in southern countries, were diverted towards firms with higher net worth. These firms, while able to take on more debt, were not necessarily more productive, which caused capital misallocations and a fall in productivity in aggregate terms. The theoretical model considers these effects as "transitional dynamics", but in the empirical analysis on aggregate data the VAR impulse response function features a *persistent* slowdown in the rate of total factor productivity growth in response to a permanent fall in real interest rate. Gopinath et al. (2015) explicitly relate this fall in real interest rate, and hence in productivity, to the adoption of the single currency; moreover, they find no evidence of misallocation effects in northern countries such as France or Germany, thereby establishing an asymmetry between northern and southern European countries. Similar explanations are proposed by Challe, Lopez, and Mengus (2016) who also stress the role of low-interest rates in softening agents' budget constraints, thereby reducing the social cost of inefficient projects, and by Hoffmann and Schnabl (2016) who argue that the banking sector is unable to carry out its allocative function in a low-interest rate environment.

Calligaris et al. (2016) consider a large firm-level data-set of Italian firms grouped by size, sector and location. They find that "within" dispersion in marginal revenue productivity is larger than "between" dispersion. Contrary to previous studies (e.g. Faini and Sapir 2005), this outcome rules out misallocation across sectors or geographical areas, as well as small size, as a major source of inefficiencies. Another interesting finding is that misallocation has significantly increased since the mid-90s. However, in looking for possible causes of misallocation, they take into account variables whose behaviour has evolved quite smoothly (ranging from firm size, credit constraints and workforce composition, to cronyism), while ignoring two variables that show significant breaks in the same period: the real exchange rate and the real interest rate (Table 1 in the online Supplementary material).

The latter is considered by Cette, Fernald, and Mojon (2016) who focus on the impact of real interest rate on TFP and labour productivity growth. They consider a panel of 18 sectors in 13 countries on a sample of annual data ranging from 1995 to 2008 and find a positive relation between the real interest rate and productivity growth (however measured). The same pattern emerges when the analysis is restricted to the four major area economies, which implies that the fall in real interest rates following adoption of the euro had an adverse effect on productivity.

If productivity was hurt most by "between" misallocation (such as housing bubbles), we would not expect interest rates to affect productivity in countries where evidence of such misallocation is lacking, such as euro area core countries.[3] The results of Gopinath et al. (2015) are consistent with such an interpretation. Instead, if "within" misallocation provides a better explanation, as in Caligaris et al. (2016) and Dias, Robalo Marques, and Richmond (2016), then in principle we cannot rule out the possibility that interest rates affect trend productivity even in countries where no bubbles (or consumption booms) were observed. Cette, Fernald, and Mojon (2016) estimate that the real interest rate has a significant and similar effect on productivity in both tradable and non-tradable sectors. However, since they conflate in the same panel countries from the euro area core and periphery, it is of some interest to check whether their results

are robust to the exclusion of either group of countries from the panel. If "within" misallocation prevails, we would also expect the interest rate to have a significant effect on productivity in a panel consisting of core countries only.

2.2. *The scale effect*

The relation between real exchange rate and productivity through the operation of economies of scale is studied by two different strands of theoretical literature.

In post-Keynesian economics, Verdoorn (1949) and Kaldor (1966) established the existence of positive feedback of aggregate demand growth on productivity growth, caused by increasing returns to scale.[4] When this effect is introduced in an aggregate export-led model, the rate of change of real exchange rate affects the rate of change of productivity, through its impact on exports, and hence on aggregate demand (Thirlwall 2002). Recent empirical analyses confirm the validity of Kaldor's (1966) laws of growth, and hence the relevance of exchange rate regime for output and productivity growth (Marconi, de Borja Reis, and Araújo 2016). Returns to scale also play a major role in micro-founded models with heterogeneous agents à la Melitz and Ottaviano (2008). For instance, Tomlin and Fung (2010) argue that in the presence of persistent exchange rate appreciation, the scale effect (i.e. the reduction in productivity determined by a reduction in the scale of production) will prevail over the selection effect (i.e. the increase in average productivity determined by forcing less productive firms out of the market).

These models lend theoretical support to a number of exploratory analyses such as Ostry et al. (1995), who find that countries with pegged regimes experience lower productivity growth, or Rodrik (2008), who stresses the impact of exchange rate misalignments on long-run growth. A different strand of research (Levy Yeyati and Sturzenegger 2003; Edwards and Levy Yeyati 2005), observes that in developing countries, more rigid regimes are associated with less growth and more output volatility, and that the response to terms of trade shocks is larger for negative than for positive shocks. Building on this work, Bohl, Michaelis, and Siklos (2016) find that pegged regimes delay recovery after a financial crisis.

This literature suggests another possible cause for the southern countries' productivity slowdown. As a matter of fact, productivity in these countries flattens around 1997, the year in which the currencies of the euro candidate countries were pegged to the ECU at parities close to the irrevocable parities with the euro. Table 1 in the online Supplementary material shows that observance of this convergence criterion resulted in a major structural break, putting an end to a situation of persistent real depreciation (appreciation) in euro area southern (northern) countries. The shock was particularly relevant in Italy and, with an opposite sign, Germany. Although the coincidence of this shock with the productivity slowdown stands out as a major stylized fact, and despite the existence of theoretical literature, there has been little or no empirical research on this topic.

2.3. *The labour misallocation effect*

In the run-up to the euro, a consensus view prevailed that monetary unification could address the European unemployment problem by favouring a mix of area-wide expansionary demand policies (through low-interest rates) and coordinated supply-side policies

aimed at introducing "a substantially higher degree of flexibility" in the European labour market (Modigliani et al. 1998).

Almost two decades later this view is challenged: not only are low-interest rates seen as a potential source of capital misallocation, as mentioned in Section 2.1 above, but labour market reforms are also considered a cause of the productivity slowdown. Despite a number of potentially positive effects of labour flexibility on productivity, including increase in innovation and investment in R&D, increase in effort exerted by workers, reduction of labour hoarding, and improvement of the labour screening process by firms (Bardazzi and Duranti 2016), since Gordon and Dew-Becker (2008) a number of studies have argued that European labour market reforms had adverse effects on aggregate productivity through the "Ricardo effect" (Sylos Labini 1983), i.e. by lowering wage growth they encouraged entrepreneurs to adopt relatively more labour-intensive techniques.[5] Further evidence on this misallocation effect is provided among others by Vergeer and Kleinknecht (2010), who use a panel of 19 OECD countries and Tridico (2015), who uses a panel of 27 EU member states, as well as by country-specific analyses (e.g. Lucidi 2012; Addessi 2014).

Besides the misallocation effect, working basically through a distortion in the cost of labour, recent research focuses on another source of productivity loss: the increasing use of temporary contracts, which discourages investment in skills and may lower worker effort. Damiani and Pompei (2010) analyse productivity growth in 16 European countries from 1995 to 2005 and show that this effect is especially high in the more labour-intensive services sector. Parisi, Marelli, and Demidova (2015), using aggregate panel data on OECD countries from 1997 to 2010, show that this evidence is robust to the selection of countries.

3. Data and methodology

3.1. The data

Data on labour productivity (measured as value-added per hour worked) and total factor productivity[6] were extracted from the EU KLEMS database for a panel of 27 sectors observed in the four major euro area economies: France, Germany, Italy and Spain (see the online Supplementary material).[7] The "capital misallocation" effect was measured using the real interest rate, defined as the composite cost of borrowing indicator for non-financial corporations (ECB, 2016),[8] deflated by the sectorial value-added deflators; since lower interest rate may cause misallocation, and hence a fall in productivity, we expect this variable to enter the equation with a positive sign. The scale effect was measured by the real effective exchange rate (REER), which we expect to enter the equation with a negative sign.[9] Following Tridico (2015), the impact of labour market reforms was measured using the indicator of "strictness of employment protection" extracted from OECD (2017). Since a lower value indicates a more flexible (less protected) labour market, we expect this variable to enter the equation with a positive sign.[10]

In order to check the robustness of the estimates, we augmented our model with other variables commonly related in the literature to the long-run growth of output or productivity. In particular, we considered the "Control of corruption" indicator (extracted from the World Governance Indicator database; World Bank 2017), which since the influential studies of Mauro (1995), Tanzi and Davoodi (1997) and Lambsdorff (2003), is seen as an important determinant of long-run GDP and productivity growth

(through its impact on the quality of investment).[11] We also included in our equations the share of computing equipment, communication equipment and software over total gross fixed capital formation (extracted from EU KLEMS), following the literature that relates ICT investment to productivity gains (e.g. Cardona, Kretschmer, and Strobel 2013).[12]

Some descriptive statistics of the data are reported in Table 1 of the online Supplementary material.

3.2. The estimation methodology

Since productivity growth is an intrinsically long-run phenomenon, we used an estimation methodology that allows the existence of long-run relations between variables to be assessed. The panel cointegration approach would be inappropriate in this context, because it requires that all the variables involved are integrated of order one, whereas at least one variable in our panel, the employment flexibility indicator, cannot have a stochastic trend by construction. In order to cope with this feature of the data, we adopted the ARDL (autoregressive distributed lag) estimator proposed by Pesaran, Shin, and Smith (1999), which allows long-run relationships to be estimated using a panel of data, without requiring variables to be integrated of the same order.

Given a panel of N individuals, $i = 1, \ldots, N$, observed over T periods, $t = 1, \ldots, T$, the ARDL(p, q) model can be written as:

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{i,t-j} + \sum_{j=0}^{q} \delta_{ij}' \mathbf{x}_{i,t-j} + \alpha_i + \varepsilon_{it} \tag{1}$$

where y_{it} is the dependent variable measured for individual i at time t, p is the number of lags of the dependent variable, $\mathbf{x}_{it}$ is a vector of k regressors, q is the number of lags of the regressors, λ_{ij} are the (scalar) coefficients of the lagged-dependent variable, δ_{ij} is a vector of k coefficients, α_i is an individual fixed effect and ε_{it} is a well-behaved disturbance.[13] Equation (1) can be reparameterized as follows:

$$\Delta y_{it} = \phi_i y_{i,t-1} + \beta_i' \mathbf{x}_{i,t-1} + \sum_{j=1}^{p-1} \lambda_{ij}^* \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta'^*_{ij} \Delta \mathbf{x}_{i,t-j} + \mu_i + \varepsilon_{it} \tag{2}$$

where $\phi_i = 1 - \sum_{j=1}^{p} \lambda_{ij}$, $\boldsymbol{\beta}_i$ is the vector of the k coefficients $\beta_{il} = \phi_i^{-1} \sum_{j=0}^{q} \delta_{ijl}$, δ_{ijl} is the l-th element of the $\boldsymbol{\delta}_{ij}$ vector, $\lambda_{ij}^* = -\sum_{m=j+1}^{p} \lambda_{im}$ are scalar short-run coefficients and $\delta_{ij}^* = -\sum_{m=j+1}^{q} \delta_{im}$ are vectors of short-run coefficients. If $\phi_i < 0$, there are N individual long-run relationships $y_{it} = -(\boldsymbol{\beta}_i/\phi_i)'\mathbf{x}_{it} + \eta_{it} = \boldsymbol{\theta}_i'\mathbf{x}_{it} + \eta_{it}$, where $\boldsymbol{\theta}_i$ is the vector of long-run parameters for the i-th individual. The pooled mean group (PMG) estimation of Equation (2) is obtained by assuming long-run homogeneity across individuals, i.e. $\boldsymbol{\theta}_i = \boldsymbol{\theta}$. This leads to the restricted ECM parameterization:

$$\Delta y_{it} = \phi\left(y_{i,t-1} - \theta' \mathbf{x}_{i,t-1}\right) + \sum_{j=1}^{p-1} \lambda_j^* \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta'^*_j \Delta \mathbf{x}_{i,t-j} + \mu_i + \varepsilon_{it} \tag{3}$$

The maximum likelihood estimator of Equation (3) is defined as "pooled mean group" estimator, because it pools the sample information in a single vector of long-run coefficients, while taking the group means of the individual error correction and short-run coefficients (which therefore need to be estimated separately). Following Pesaran, Shin,

and Smith (1999) various applications of the panel ARDL methodology assess the existence of a meaningful long-run relationship among the variables by testing for the presence of a negative and significant error-correcting coefficient ϕ (e.g. Landon and Smith 2009; Lanzafame 2014; Couharde, Rey, and Sallenave 2016).

All the equation estimates include an individual trend, which accounts for other sector-specific determinants of productivity growth, and the dynamic specification was selected automatically using the Akaike information criterion starting from a maximum number of lags $p = q = 2$.

The three effects outlined in the previous section are expected to have different impacts on different sectors. For instance, it has been argued that labour market reforms had a larger impact in the productivity of the more labour-intensive services sector (Damiani and Pompei 2010); at the same time, it can be argued that the scale effect should be larger in the tradable sector, which broadly coincides with manufacturing. For this reason, we estimated each equation for three different groups of sectors: the whole sample (including the primary sectors), manufacturing and business services (see online Supplementary material for an exact definition of these groups).

4. Results and sensitivity analysis

Table 1 presents the results of estimation of Equation (3).

With a limited number of exceptions, the automatic procedure selected an ARDL (2,1) specification (i.e. a model with two lags of the dependent variable and one lag for each regressor).[14] While the EU KLEMS data starts in 1970, the employment protection index starts in 1985 and the control of corruption indicator in 1996. The sample length was determined accordingly.[15] In column (1), besides the trend, we include only the real interest rate and the log of the REER. The coefficients show the expected signs and the estimated equation has extremely significant error-correcting behaviour, indicating the existence of a meaningful long-run relationship. The coefficients are robust to the addition of the Labour protection index in column (2), the elasticity of which is positive and significant.

On the contrary, introduction of the Control of corruption indicator in column (3) affects the size of the capital misallocation and scale effects, and the significance of the Labour protection index. Moreover, the coefficient is negative, suggesting that an increase in corruption control has detrimental effects on productivity (a conclusion generally rejected by the empirical literature). However, this specification has some statistical issues. As mentioned above, the PMG method utilizes individual estimates. However, since World Governance Indicators are available from 1996 onwards, only 13 observations are available for individual estimation of the eight short-run parameters of the ARDL(2,1) specification selected by the Akaike information criterion. Furthermore, "Control of corruption" happens to be significantly correlated with "Labour protection", which may cause multicollinearity problems.[16]

In order to check these sources of bias, in column (4) we replicated the estimates of column (3) without the Labour protection index. In this case, corruption becomes statistically insignificant. We therefore decided to keep "Employment protection" in the equation, and we added the log-share of ICT over total gross fixed capital formation in column (5). This variable is strongly significant and with a positive sign, as expected. While improving the fit of the model, its introduction does not significantly alter the size of the capital misallocation, scale and labour misallocation effects.

A similar pattern is observed in the Manufacturing (columns (6) to (8)) and Services sectors (columns (9) to (11)), with some interesting differences. In particular, ICT investment has a larger impact in Manufacturing (with a coefficient of 0.10) than in Services (where its coefficient is 0.05).

These results are robust to a number of sensitivity analyses reported in the online Supplementary material. Using a CPI-based REER produces coefficients slightly larger in absolute value, but leaves the results substantially unaffected (Table 2 in online Supplementary material).[17] The same pattern emerges when total factor productivity is used as the dependent variable (Tables 3 and 4 in the online Supplementary material), the only difference being that in this case labour protection legislation seems to affect productivity in the services sector more than in the manufacturing sector. This confirms the hypothesis of Damiani and Pompei (2010) that loosening labour market regulation may be particularly detrimental to productivity in labour-intensive services.

In order to assess whether "between" or "within" misallocation prevails, as discussed in Section 2.1 above, we estimated the model in the two sub-panels including only Core (France, Germany) and Peripheral (Italy, Spain) countries. The results are reported in Table 5 of the online Supplementary material and show that in core euro area countries the coefficient of the real interest rate is consistently larger than in peripheral countries. In other words, the drop in interest rates also seems to have affected productivity in countries where evidence of "between" misallocation (leading to housing bubbles or consumption booms) was not observed. Moreover, the disaggregated analysis shows that the REER coefficient is larger in absolute value in the manufacturing sector of the peripheral countries, which implies that these countries have suffered more through the "scale effect" determined by real appreciation of their exchange rate in the pre-crisis period (see Table 1 in the online Supplementary material).

The estimation results thus confirm that the capital misallocation, scale and labour effects are statistically significant, sizeable and robust to changes in model specification. It may be useful to give some rough orders of magnitude for these effects, taking as reference the two extreme cases of Germany and Italy, and applying our panel estimates to aggregate data, in order to check their consistency with the stylized facts. We performed this exercise using the "All sectors" estimates reported in Table 1 (column 5).

Regarding the capital misallocation effect, the average fall in real interest rate from 1997 (when national currencies were pegged to the ECU) to 2007 (the year before onset of the global financial crisis) was −0.02% in Germany and −3.85% in Italy. With an estimated semi-elasticity around 1.3, this implies a negative long-run impact on average labour productivity of −0.03% in Germany and −5% in Italy, thus, confirming Lane's (2006) intuition that asymmetry in the size of the shocks determined by joining the monetary union could have been a cause of real divergence.

The long-run elasticity of labour productivity to real exchange rate is around −0.4, confirming prevalence of the negative scale effect on the positive selection effect in firms' productivity. Once again, this may have been an important source of real divergence. In the 1997–2007 period, the ULC-based REER depreciated by −7.3% in Germany and appreciated by 27.3% in Italy. According to the model estimates, this brought about a long-run improvement in labour productivity of 2.92% in Germany and a long-run decrease of −10.92% in Italy.

Finally, the labour protection index has an elasticity of about 0.3. Since the "Employment protection indicator" fell by −8.5% in Germany and by −9% in Italy, this

implies that labour market reforms depressed productivity by −2.55% in Germany and by −3.0% in Italy.

While these are very rough calculations, which do not take differences between sectors into account, they square with the aggregate stylized facts (in the same period, the spread between German and Italian GDP per hour worked increased by about 13%), and point out that monetary unification may actually have fostered some degree of real divergence by affecting labour productivity trends.

5. Conclusions

The persistence of economic crisis in the euro area has revived the debate on the real consequences of monetary unions, shedding new light on the hypothesis that monetary integration would foster real convergence. In this paper, we aimed at assessing three possible sources of real divergence among members of a monetary union: the capital misallocation effect, related to distortions in the costs of capital; the scale effect, determined by misalignment of the real exchange rate; and the labour misallocation effect, induced by labour market reforms. The recent literature has shown that these three effects work asymmetrically by depressing productivity more in weaker member countries, and depressing it less or enhancing it in stronger ones.

After reviewing the recent literature on these topics, we measured the extent and robustness of these effects using a panel of data ranging from 1986 to 2014 and covering 27 ISIC rev. 4 sectors in the four largest euro area countries, two of which belong to the core (France and Germany) and two to the periphery (Italy and Spain). The estimation was carried out using the ARDL-PMG estimator, which allows estimation of long-run relationships among variables with different orders of integration. The results confirm that these three sources of potential divergence in productivity are sizeable and significant, and may have played a role in determining the productivity slowdown which occurred, at different paces, in the core and peripheral countries of the euro area before the last financial crisis.

These preliminary results leave many avenues for future research. To mention a few: the analysis should be extended to a larger number of countries; the impact of labour market reform could be measured by taking the share of temporary workers in the different sectors into account; the impact of technological progress could be measured using other variables mentioned in the literature (such as R&D personnel or expenditure by industry); institutional quality could be measured using a synthetic index as in Nifo and Vecchione (2014).

As far as the reform of European economic governance is concerned, three messages seem to emerge from our estimates: firstly, the strategy of restoring competitiveness by enhancing labour market flexibility through "structural reforms" is confirmed to be counterproductive, because on average it depresses labour and total factor productivity. Secondly, persistently loose monetary policies might have unintended consequences on productivity by fostering capital misallocation both in peripheral and core countries of the euro area. Thirdly, these adverse effects may be coped with, among other things, by increasing the share of ICT investment. For instance, bringing the Italian share into line with the German one would result in a 4% long-run increase in labour productivity in Italy. Taken together, these three prescriptions indicate a consistent package of policy measures, where aggregate demand should be stimulated by targeted fiscal, rather than monetary, policies. This reversal in austerity policies would naturally determine an increase in real interest rates, as well as a fall in unemployment, without necessarily

undermining fiscal sustainability in distressed countries. Indeed, the recent literature on fiscal multipliers in recession (Charles, Dallery, and Marie 2015; Canzoneri et al. 2016) implies that austerity policies may have counter-intuitive effects on fiscal sustainability. This prompts wider reflection on the role of fiscal rules in relation to the public investment policies needed in member countries.

These conclusions bring together and confirm the results of a number of previous studies. While their economic rationale seems sound, their political implementation is more troublesome, because it requires a renewed sense of European solidarity that the persisting crisis seems to have wasted. Decisive action is urgently needed before further real divergence threatens the sustainability of the monetary integration project, as foretold by Kaldor (1971).

Disclosure statement

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Supplemental data

Supplemental data for this article can be accessed at https://doi.org/10.1080/17487870.2017.1403755.

Notes

1. Canzoneri et al. (2002) give a less benign interpretation of inflation differentials, seeing them as a structural phenomenon that might be a source of conflict in the monetary union.
2. The sectorial composition of output plays a role in another strand of literature that relates the slowdown in productivity to structural change, and in particular to the increasing weight of low-productivity tertiary activities (e.g. Delli Gatti et al. 2012).
3. We are grateful to an anonymous referee for pointing this out to us.
4. In his productivity equation, Sylos Labini (1983) defines this as the "Smith effect", tracing it back to Chapter III, Book I of Adam Smith's *Wealth of nations*.
5. Besides the "Ricardo effect", a different rationale for the relation between wage level and productivity, working through worker effort, rather than labour misallocation, is provided by efficiency wage theories (Katz 1986). We are grateful to an anonymous referee for this observation.
6. Since our equation takes into account different channels of transmission, referring to different theoretical models and concepts of productivity, following Cette, Fernald, and Mojon (2016) we decided to estimate the model for average labour productivity and total factor productivity. The results do not differ qualitatively (those for total factor productivity are reported in the online Supplementary material).
7. Releases 2016 and 2012 (see O'Mahony and Timmer 2009; and Jäger 2016, respectively).
8. Since this indicator is not available before 2003, we reconstructed it using the National retail interest rates (NRIR) N5 series (medium and long-term loans to enterprises) previously published by the European Central Bank. Where this was missing, we used the Lending rate data obtained from the World Bank.
9. Following the advice of an anonymous referee, we used the ULC-based REER index provided by the IMF (2017). Previous results obtained using the CPI-based measure provided by BIS (2017) are reported in the online Supplementary material. The results are robust to this change.
10. More specifically, we used an average of the EPR_V1 and EPT_V1 indicators, measuring the strictness of employment protection against individual dismissals for regular contracts and temporary employment, respectively. The average was weighted with the shares of temporary and permanent employment extracted from the OECD Labour Force Statistics (LFS). We used version 1 of each indicator as this version is available for a longer sample.

11. An anonymous referee suggested we use a composite indicator of governance quality, constructed as the simple average of several indicators. Although this strategy has been followed in major studies (e.g. Rodrik 2008), estimates in Lambsdorff (2003) and Nifo and Vecchione (2014) show that different institutional quality indicators affect productivity with different coefficients. Taking their simple average would amount to imposing an equality constraint on their coefficients, which could result in potentially biased estimates. A more promising estimation strategy is to construct a synthetic institutional quality index, as in Nifo and Vecchione (2014). We leave this for future research.
12. We tried to account for innovation using variables such as Business enterprise R&D expenditure and personnel by industry. However, the data provided by the OECD did not allow us to reconstruct a panel with enough observations in each sector for the estimation to be performed.
13. The panel need not to be balanced (i.e. T can vary across individuals), and both p and q can vary across individuals. Moreover, q can vary across regressors. The model can include individual deterministic components (such as linear trends or dummies). We omit these further generalizations to avoid notational clutter. The only important restriction is that the number of parameters must be such as to allow separate estimation of the model for each individual.
14. In a limited number of cases in which the estimation procedure did not converge, this dynamic specification was imposed.
15. The total number of observations depends among other things on the measure of productivity considered (data on TFP is missing for Italy in 2014) and on the dynamic specification selected, and is reported for each estimated equation.
16. Their simple correlation coefficient is equal to −0.43 with a Student's t of −3.93.
17. An anonymous referee pointed out that using a ULC-based REER may indirectly account for the impact of labour market reforms on competitiveness through wage moderation. This could explain why in Table 1 the coefficients of EPL are generally smaller than in Table 2 of the online Supplementary material.

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AQ5