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Technology and Income Distribution

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Abstract

Building on a Post-Keynesian theoretical framework, integrated with an analysis of technology, this article investigates the structural determinants of income distribution. We develop a simultaneous model on wage and profit dynamics identifying as key determinants productivity growth, capital-labour conflict, the relevance of trade unions and different strategies of technological change and offshoring. We perform an industry-level analysis on 38 manufacturing and service sectors for six major European countries from 1994 to 2014. Wage and profit dynamics is shown to be rooted in structural change, productivity growth and capital-labour conflict, with profits driven by product innovation and offshoring, and wages rising faster where new products are relevant and trade unions have a greater role.

Keywords:
Income distribution, innovation, offshoring, Europe, industries

JEL classification:
F15, J31, O33

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1. Introduction

The dynamics of wages and profits and the fall in the labour share have been investigated by a large literature mainly at the macroeconomic level. In this article we explore their complex determinants at the industry level, combining a Post-Keynesian approach on the conflictual nature of income distribution, a focus on structural change, and consideration of the patterns of technological change, offshoring and labour market institutions.

Our approach builds on the state of the art of this literature – that is reviewed in Section 2 below – and can be summarized as follows. First, labour productivity growth is the fundamental driver for increases in wages and profits in industries, as it summarizes the combination of supply and demand factors contributing to greater output.

Second, capital-labour conflict is a crucial determinant of the patterns of income distribution. Industries' value added is divided between wages and profits also on the basis of this balance of power.

Third, we adopt an evolutionary perspective on the technological trajectories of industries and their path-dependent nature. We distinguish between strategies of technological competitiveness and cost competitiveness, exploring their distributional implications.

Fourth, we consider how globalization has reshaped industries' activities in advanced countries; firms and industries are increasingly integrated in a global network of production built along transnational value chains with extensive offshoring of production activities. The search for greater profits is a key driver of this process and increases the power of capital over labour with the "threat effect" that delocalization exerts on workers' organizational capacity.

Fifth, the balance of power between capital and labour is fundamentally shaped by social norms, employment protection legislation, patterns of collective bargaining and the rise of precarious employment. The long run weakening of labour is reflected in the decline of unionization in most advanced countries and the share of trade union membership is considered as a relevant factor affecting wage dynamics.

The empirical investigation develops the model of Pianta and Tancioni (2008), in which the conflictual dynamics of wages and profits and the relationships between innovation, productivity and the distributive components are identified through panel data estimations. We develop a simultaneous two-equation model to investigate the determinants of the rate of growth of profits and wages. We perform an industry-level analysis using the Sectoral Innovation Database (SID) covering 21 manufacturing and 17 service sectors for six major European countries (France, Germany, Italy, the Netherlands, Spain and the United Kindgom) from 1994 to 2014.

Our results confirm that labour productivity growth is a key driver of both distributive components, while a systematic negative relation between wage and profit increases is detected. Product innovation is positively associated with both profit and wage growth; conversely, new processes lead to a reduction of wages. Offshoring is a clear driver of profits and a tool for reducing labour compensation. When distinguishing between high- and low-tech offshoring strategies we find that the former contributes to profits while the latter is detrimental for wages. Finally, union density is positively associated with wage dynamics.

The structure of the paper is the following. Section 2 summarizes the state of the art on the determinants of functional income distribution and presents the approach developed here. Section 3 offers a brief description of the SID database. Section 4 provides descriptive evidence on the relationships between technology, offshoring, union density and income distribution. Section 5 presents our simultaneous model on income distribution and Section 6 discusses the estimation results. Section 7 provides an interpretation of the main findings and draws some conclusions.

2. State of the art and proposed approach

Since the end of the Seventies a series of interrelated technological and structural factors – together with a fundamental turning point in economic policy – have led to a greater power of capital over labour resulting in major rise in income inequalities (Glyn, 2006; Franzini and Pianta, 2016).

Studies on the long-term decline of the labour share of income have provided different explanations. The neoclassical approach has identified technological progress and globalization as the most relevant factors affecting income distribution (Bentolila & Saint-Paul, 2003; Bassanini and Manfredi, 2014; European Commission, 2007; IMF, 2017a; Karabarbounis and Neiman, 2014; OECD, 2018a). According to these studies, Information and Communication Technology (ICT) has led to a capital-biased technological change, promoting both a decline in the price of capital relative to labour and a replacement of workers (in particular those who perform routine jobs that can be more easily automatized) with machines (Acemoglu and Restrepo, 2017, 2018). The consequence is an increase in the capital-output ratio, which in turn reduces the labour share to the extent that the elasticity of substitution between capital and labour is found to be larger than one (e.g. Bassanini & Manfredi, 2014; Karabarbounis and Neiman, 2014). Moreover, the impact of internationalization of production on the wage share emerges as crucial; in the neoclassical framework, capital-abundant countries offshore labour-intensive tasks in labour-abundant countries. This results in a growing capital-output ratio in the former ones and – whether capital acts as a gross substitute for labour – in a declining labour share (Bassanini and Manfredi, 2014; European Commission, 2007; IMF, 2017a). Moreover, technology and trade are interrelated, since the former may be induced by the latter (Bloom et al., 2013, 2016).

The Post-Keynesian literature pointed out the shift in the balance of power between capital and labour as the primary factor explaining the decline of the wage share in national income and the growth slowdown in last four decades (Onaran and Obst, 2016). Although the role of technological change is considered in the most recent empirical studies (Guschanski and Onaran, 2017, 2018; Stockhammer, 2017), major prominence is given to the role of labour market institutions, globalization, financialization and welfare state retrenchment (Stockhammer, 2009, 2013). According to this stream of research, the change of paradigm in economic policy occurred in the Eighties has led to new institutional arrangements harmful to workers; in particular, it resulted in a downsizing of the welfare state and a sharp reduction of union density and collective bargaining coverage, while labour market reforms reduced employment protection legislation and spread precarious work (Bengtsson, 2014a; Charpe, 2011; Stockhammer, 2013). Globalization has favored the most mobile (rather than the most abundant) production factor, i.e. capital, and has supported offshoring practices aimed at reducing labor costs (Jayadev, 2007; Rodrik, 1997; Stockhammer, 2017). Financialization enhanced the fall-back options of capital and increased the shareholder value orientation of firms, with major consequences in terms of corporate governance and workers' bargaining capacity (Dunhaupt, 2016; Kohler et al., 2018; Lin and Tomaskovic-Devey, 2013). One of the few studies at the industry-level is by Guschanski and Onaran (2017), who investigated the determinants of the wage share for 14 countries from 1970 to 2014, finding a key negative role played by offshoring (mainly to emerging countries and Eastern Europe), welfare state retrenchment, decrease of union density and rise in inequality. Moreover, they find that Total Factor Productivity and capital intensity have a negative impact on the labour share until the mid-Nineties, although the soundness of these relationships remains questionable (Felipe and McCombie, 2013).

Recent studies have addressed the personal income distribution documenting the rise in inequalities since the Eighties (Atkinson et al., 2011; Piketty and Saez, 2003; Tridico, 2018). As shown by Daudey and Garcia-Penalosa (2007) and Atkinson (2009), functional income distribution is a key determinant of the personal distribution of income and the rise in inequality. These findings are supported by Wolff and Zacharias (2013), who show the crucial role of inter-class inequality in explaining the increase of personal income inequality.

Other recent studies on the determinants of wage and profit dynamics (Abdih and Danninger, 2018; Bogliacino, Guarascio and Cirillo, 2018; IMF, 2017b) have considered the role of technology, offshoring and labour market institutions, issues that are examined below.

2.1 Innovation

Following an evolutionary perspective, the diversity in the patterns of technological change in industries are put at the centre of our investigation (Dosi, 1982, 1988; Breschi et al., 2000); we account for the technological trajectories of sectors by using the Pavitt (1984) taxonomy as revisited by Bogliacino and Pianta (2010, 2016).

Most important, we introduce a distinction between strategies of technological competitiveness, based on new products, and of cost competitiveness relying on new processes (Pianta, 2001). The former is conceived as the “high road” to competitiveness, aimed at improving the quality of goods, open up new markets, and match the evolution of effective demand (Pasinetti, 1981); such a strategy may provide room for an expansion of both profits and wages. Furthermore, at the firm level, a technological competitiveness strategy relies more on cooperation among workers, taking advantage of employees' cumulative knowledge and favoring their skill upgrading that are associated to a sharing of the rents from innovation and to higher wages (Buchele and Christiansen, 1999; Cantwell, 2005; Kleinknecht et al., 2016).

On the other hand, a cost competitiveness strategy that replaces labour with new machinery is likely to have a positive effect on profits due to the lower overall labour compensation and to the possibility of reducing prices expanding market shares. Moreover, this strategy can further depress workers' bargaining power and wages through the threat of automation and firing (Bogliacino, 2009; Cirillo, 2017; Vivarelli, 2014).

2.2 Offshoring

Since the Eighties, worldwide liberalization of trade and capital markets, along with the new global strategies ny multinational corporations on location of production and the sources of supply for intermediate goods (namely offshoring practices), has led to the emergence of hierarchical global values chains, marked by economic and technological asymmetries among the economic actors involved (Milberg and Winkler, 2013).

Stockhammer (2017) provides an empirical analysis for advanced and developing countries for the period 1970-2007 and detects globalization as a prominent determinant of the wage share. International trade has affected income distribution through a change in the bargaining position of capital and labour; these findings support a critique of the view of trade-distribution nexus proposed by Classical trade theory stemming from the Stolper and Samuelson (1941) theorem. However, in this country-level investigation, trade openness is used as a standard proxy for globalization (Harrison, 2005; Jayadev, 2007), not properly addressing the international fragmentation of production fostered by the rise of intermediate inputs trade (Feenstra and Hanson, 1996; Hummels et al., 2001).

The industry-level analysis that we carry out is particularly suitable for investigating the global flows of intermediate inputs and their effects on income distribution. First, we capture the impact of international fragmentation of production using different offshoring proxies developed by Feenstra and Hanson (1996, 1999). Second, we argue that the technological capabilities of industries represent a crucial factor defining their position in global value chains (Simonazzi et al., 2013). We distinguish between high- and low-tech flows of imported intermediate inputs according to the knowledge base of foreign industries which source the intermediate inputs (Guarascio et al., 2015), as their effects on profits and wages are likely to be different.

Offshoring processes might exert a positive impact on industries' profits for two main reasons. First, the engagement in global supply chains provides firms with cheaper intermediate inputs for production (especially through low-tech offshoring) and gives access to new supply sources of commodities and non-domestically produced varieties of goods. Second, the internationalization of business strategies may entail major organizational improvements, the availability of advanced technologies, the indirect access to foreign final markets and the possibility of taking advantage of international technological spillovers (especially in high-tech offshoring-intensive industries) (Campa and Goldberg, 1997; Colantone and Crinò, 2014; Pöschl et al., 2016; Tajoli and Felice, 2018).

On the other hand, the effect of offshoring on wages is likely to be negative. Firms with high organizational capabilities and located in capital-abundant countries joined global networks of production to localize strategically labour-intensive tasks in developing and newly industrialized countries (including Eastern European countries, China, Asian economies, etc.), where wages are lower and employment protection, fiscal and environmental regulations are far less stringent (Rodrik, 1997; Feenstra, 1998). For the same reasons, they can import low-priced intermediate inputs from abroad, ending domestic production and laying off workers. Offshoring is thus likely to represent a credible threat against workers' rights and claims for higher wages (Burke and Epstein, 2001; Choi, 2001; Kramarz, 2017).

Nonetheless, all the effects potentially exerted by offshoring activities on income distribution are conditioned by the technological and institutional characteristics of firms and industries (Freeman and Louca, 2001). While low-tech offshoring is likely to reduce wage growth, the foreign sourcing of high-tech inputs might instead be a signal of a more technology-oriented competitive strategy (Guarascio et al., 2015). As far as it triggers technological complementarities between domestic and foreign industries, of both static (i.e. as input-output links) and dynamic nature (i.e. as interdependencies and feedbacks), high-tech offshoring could entail a knowledge-based upgrading of firms' productive system, enhancing domestic workers' skills, with a positive impact on their remuneration. On the other hand, an increasing acquisition of high technology and external knowledge from abroad might be the signal of a technological dependence linked to the subordinated position occupied in the global value chain by a certain industry, thus restricting room for wage increases.

2.3 Union density

Labour market institutions represent a further element with major impact on income distribution. According to a Post-Keynesian perspective of labour market functioning, a strong employment protection legislation is a key factor shaping workers' bargaining power and thus distributive patterns (Stockhammer et al., 2014; Brancaccio et al., 2018). The limited availability of industry-level data leads us to consider industries' union density as a good proxy of the bargaining position of workers; the rationale is that more unionized industries are expected to be the ones in which coordinated collective bargaining is wider and pro-labour employment and social standards are more binding.

The evidence in this regard is significant. Bengtsson (2014b) estimated a panel model for 16 advanced economies over the period 1960-2007, finding an overall positive association between union density and wage share. Tridico (2018) made use of panel estimation techniques to assess the role of financialization, labour flexibility, trade union density and public social spending as determinants of personal income inequality for 25 OECD countries from 1990 to 2013, finding a significant negative relationship between unionization and the Gini index. IMF researchers Jaumotte and Buitron (2015) performed an empirical analysis for 20 developed countries over the period 1980-2010 and showed that the long-run decline of unionization inside and outside Europe has considerably reduced the ability of workers' organizations to increase wages. OECD (2018b) has recently confirmed these findings, highlighting that coordinated collective bargaining systems are linked with better employment outcomes and lower wage inequality.

Since the time period covered by our database starts in the mid-Nineties, i.e. after a couple of decades during which industrial relations have been reshaped and union density has experienced a major decline, the expected positive impact of sectoral union membership rate on labour compensation might be mitigated. A similar result would be consistent with the one by Pontusson (2013), who finds that – since the Seventies – OECD countries in which union density is declined strongly have experienced relatively higher increases in income inequality, but this relationship seems to be weaker since the early Nineties.

Finally, we argue that powerful trade unions and centralized collective bargaining systems may also have a separate negative effect on profits. Insofar as unions are able to monitor the unfolding of the working process – e.g. ensuring respect for the safety conditions of workers in the workplace with the aim of protecting their welfare and minimizing occupational accidents –, the "rigidities" within the production process become more binding and the monitoring and organizational costs for firms are likely to rise.

3. The Sectoral Innovation Database

The database we use in our analysis is the Sectoral Innovation Database (SID), which has been developed at the University of Urbino. This dataset includes industry-level data for six major European countries – France (FR), Germany (DE), Italy (IT), the Netherlands (NL), Spain (ES) and the United Kingdom (UK) –, which represent a very large part of the European economy (75% of the entire EU28's GDP). The time span covered by the dataset is 1994-2014.[1]

Data are available for the two-digit NACE Rev. 1 classification for 21 manufacturing and 17 service sectors (listed in Appendix) and refer to total activities of industries. To fulfill the requisite conditions for comparability, all data from 2008 onwards have been converted into NACE Rev. 1 using the conversion matrix provided by Perani and Cirillo (2015).[2] All the monetary variables have been converted in euros and adjusted for PPP using the index provided in Stapel et al. (2004, p. 5).

As regards the technological efforts of industries, we identify the following key innovation variables among those included in the SID: share of firms introducing product innovations, share of firms introducing process innovations, share of firms introducing innovations to open up new markets or increase market share and the expenditure in the acquisition of new machinery and equipment per employee. Data are drawn from the following five European Community Innovation Surveys (CIS) collected by Eurostat: CIS 2 (1994-1996), CIS 3 (1998-2000), CIS 4 (2002-2004), CIS 7 (2008-2010) and CIS 9 (2012-2014). The latter five survey waves are matched with economic, productive structure and labour market data at industry level. The monetary innovation variable, namely the expenditure in new machinery and equipment, has been deflated (base year 2000) using the aggregate value added deflator provided by OECD-STAN.

Concerning the economic and distributive dynamics of sectors, we focus on the growth pattern of wages, profits, employment and labour productivity. Wage and productivity variables are expressed in worked hours, whereas profits are gross operating surplus and employment is measured as the number of employees (in thousands) at industry level. Data are drawn from OECD-STAN and the Socio Economic Accounts (SEA) released by the World Input-Output Database (WIOD). Value added and demand variables – namely domestic final demand and exports – have been deflated (base year 2000) using the sectoral value added deflators provided by WIOD-SEA.

We use four different offshoring indicators built exploiting the World Input-Output Tables (WIOT) provided by the WIOD (Timmer et al., 2016). The first one is the 'broad' offshoring indicator, computed as the ratio between the expenditure for the intermediate inputs imported by a given industry from whatever foreign industries and the expenditure for the total intermediate inputs used by that industry. The 'narrow' offshoring indicator consists instead in the ratio between the expenditure of a given industry for the intermediate inputs imported from foreign industries of the same type (corresponding to the diagonal terms of the import-use matrix) and the expenditure for the total intermediate inputs used by that industry (Feenstra and Hanson, 1996, 1999).[3] Furthermore, we relate the international fragmentation of production with its technological dimension discriminating intermediate inputs according to their origin (domestic or imported) and their technological content (Guarascio et al., 2015). In this regard, we build on the Revised Pavitt Taxonomy provided by Bogliacino and Pianta (2010, 2016) and adopt the following criterion: Science based or Specialized suppliers industries are classified as high-tech industries (HT) and the imported intermediate inputs coming from these industries represent the numerator of the high-tech offshoring indicator; Scale and information intensive industries are classified as low-tech industries (LT) and the imported intermediate inputs coming from these industries represent the numerator of the low-tech offshoring indicator.

Finally, the role of labour market institutions is capture by union density – computed as the share of union membership at industry level – drawn from the ICTWSS database (Visser, 2016).

The dataset is a panel over five periods covering a time span from 1994 to 2014. Economic, distributive and offshoring variables are computed for the periods 1996-2000, 2000-2003, 2003-2008, 2008-2012 and 2012-2014; this periodization effectively account for business cycles in European industries. For the economic and distributive variables we compute the compound annual growth rate that approximates the difference in logarithmic terms, while for the offshoring indicators we take the simple difference between the last and the first year of each period.

Innovation variables are taken from five waves of innovation survey: the first wave (CIS 2) refers to 1994-1996 and is linked to the first period of economic variables; the second wave (CIS 3) spans 1998-2000 and is linked to the second period of economic variables; the third wave (CIS 4) refers to 2002-2004 and is linked to the third period of economic variables); the fourth wave (CIS 7) spans 2008-2010 and is linked to the fourth period of economic variables; the fifth wave (CIS 9) refers to 2012-2014 and is linked to the fifth period of economic variables.[4]

Finally, union density refers to the first year of each of the five economic period, i.e. 1996, 2000, 2003, 2008, 2012, and are computed as the union membership rate at industry level.[5]

4. Descriptive evidence

In this section we summarize the main relationships between wages, profits and their key drivers using a set of figures where individual industries are aggregated on the basis of their technological intensity in four Revised Pavitt classes, defined by Bogliacino and Pianta (2010, 2016). The classes include Science based industries (SB), Specialized suppliers industries (SS), Scale and information intensive industries (SI) and Supplier dominated industries (SD).

In figures 2 to 5 the first two characters of each observation stand for the country (FR stands for France, DE for Germany, IT for Italy, NL for the Netherlands, ES for Spain and UK for the United Kingdom), while the last two ones identify the Revised Pavitt class.

4.1 The role of technology

Profits have always grown faster than wages. The role of technology is shown in Figure 1 where high and low technology industries are divided. Both gross profits and the wage bill have grown faster in industries with stronger technological activities, with a major gap in the case of wages. But different technological strategies have to be considered, and

Figure 2 highlights the positive relationship between the introduction of product innovation and the growth rate of profits per hour worked for the four Revised Pavitt classes in the six countries; profits growth is associated to the capability of industries to offer new products that capture potential demand, pursuing a technological competitiveness strategy. More technologically advanced economies (e.g. Germany) have greater product innovation and obtain higher profits than less dynamic economies (e.g. Spain) do. In Figure 3 we find a clear negative relationship between the growth of wages per worked hour and the intensity with which industries introduce process innovations, showing that sectors and countries that are mainly committed to pursuing a cost competitiveness strategy experience lower wage growth.[6]

[FIGURES 1, 2, 3 ABOUT HERE]

4.2 The role of offshoring

Figure 4 shows the empirical relationship between the rate of growth of gross profits and change in 'narrow' offshoring intensity (the share an industry's intermediate inputs imported from the same industry).[7] The graph shows a high heterogeneity and a broad positive relationship between international production and profits. Conversely, Figure 5 shows the opposite, negative relationship between the change in 'narrow' offshoring and the growth of wages per worked hour. Industries more exposed to international relocation of production have a lower wage dynamics in Europe, confirming the findings of the literature.

[FIGURES 4, 5 ABOUT HERE]

4.3 The role of trade unions

Figure 6 provides a summary of the effect of industries' union membership rates on profit and wage dynamics. For this purpose, we defined high- and low-union density industries as those above or below the median value of this indicator. Wage growth is significantly higher in industries characterized by a higher union membership rate, while in industries with low union density the growth of profits is twice as high as in sectors with above-median union density.

[FIGURE 6 ABOUT HERE]

5. A simultaneous model for the dynamics of wages and profits

In order to explain the drivers of wages and profits in European industries we build on the approach proposed by Pianta and Tancioni (2008) and develop a simultaneous model where changes in profits and wages are explained by labour productivity growth, capital-labour conflict, heterogenous innovation strategies, international fragmentation of production and labour market institutions.

- The dynamics of labour productivity is viewed as a major driver of industries' growth and decline (Pasinetti, 1981), capturing the effects of new capital investment, overall demand dynamics, as well as the organizational improvements carried out by industries (Pianta and Tancioni, 2008). In this regard, a robust labour productivity growth expands the 'cake' of value added that can then be divided between profits and wages; a higher growth of the 'cake' softens the distributive conflict as it allows room for expanding both distributive components.

- The growth of wages is expected to be negatively affected by the dynamics of profits and, conversely, profit growth is expected to be constrained by wages. This formulation allows to account for the conflictual nature of income distribution.
- We distinguish the separate effects of product and process innovation as they are likely to have different impact on wages and profits.
- The growing importance of transnational value chains and its impact on income distribution is captured by different offshoring proxies.
- The share of unionised workers in total industry employment is used to account for the role played by labour market institutions and for considering the bargaining power of workers that may support higher wage dynamics or contain profits.

In section 3 on data we have already defined in detail each variable used in the econometric analysis.

5.1 The wage equation

On the basis of the theoretical considerations provided in the previous sections, we set up the following log-linear equation for the determination of wage dynamics:

$$log(W_{ijt}) = \alpha_1 log(PROF_{ijt}) + \alpha_2 log(PROD_{ijt}) + \alpha_3\, log(NP_{ijt}) + \alpha_4 log(MACH_{ijt}) + \alpha_5 log(OFFSH_{ijt}) + \alpha_6 log(UD_{ijt}) + u_{ij} + \varepsilon_{ijt}$$

where *i*, *j* and *t* identify, respectively, industry at two-digit level according to NACE (Rev. 1) classification, country and time.

Wage per worked hour is indicated by *W*, while *PROF* stands for gross profits at sectoral level.[8] Industry labour productivity is indicated by *PROD*. The two main directions of technological change are represented by the importance of new products (*NP*) and by the expenditure in new process-related machinery (*MACH*). The measures of offshoring (*OFFSH*) include both the 'narrow' offshoring indicator (Feenstra and Hanson, 1999) and the technology-based offshoring proxy developed by Guarascio et al. (2015), distinguishing between high-tech and low-tech offshoring strategies. The role played by labour market institutions is captured by *UD*, which stands for union membership rate in industries. Finally, u controls for time-invariant fixed effects and ε represents the standard idiosyncratic error term.

By taking the first difference of the equation we get rid of time-invariant components, reducing potential endogeneity bias. Hence the final formulation of the wage equation is the following:

$$\Delta log(W_{ijt}) = \alpha_1 \Delta log(PROF_{ijt}) + \alpha_2 \Delta\, log(PROD_{ijt}) + \alpha_3 \Delta\, log(NP_{ijt}) + \alpha_4 \Delta log(MACH_{ijt}) + \alpha_5 \Delta log(OFFSH_{ijt}) + \alpha_6 \Delta log(UD_{ijt}) + \Delta\varepsilon_{ijt}$$

Variables regarding wages, profits and productivity at sectoral level are computed as compound annual average rate of change which proxies the difference in logarithmic terms. Our expectation is to find a negative relationship between profit growth and wage growth because of the distributive conflict between capital and labour, while we expect a positive impact of productivity growth on labour compensation.[9]

The innovation variables proxying technological and cost competitiveness strategy are measured, respectively, by the share of firms introducing new products (NP) and by expenditure for new machinery per employee ($MACH$) – an indicator of embodied technical change representing our process innovation proxy. We already stressed how these latter indicators can be conceived as intrinsically dynamic as they capture the changing innovative efforts of firms along the technological trajectories of industries. Consistently with the theoretical considerations provided in Section 2.1, we expect a positive impact of product innovation on wage growth, while the job destruction threat stemming from the introduction of process innovation is expected to exert a negative effect on labour compensation growth.

The variation of offshoring is computed as the simple difference in the value of the share of imported inputs between the last and the first year of each time period under observation.[10] As discussed above, we expect to find a negative impact on wages of 'narrow' offshoring and of foreign sourcing from low-tech industries, while the impact of high-tech offshoring on wages is more difficult to predict.

Finally, union density is computed as share of union members in total employment in each industry at the beginning (i.e. in the first year) of every time windows. As our proxy of workers' bargaining power, we expect it to have a positive impact on wages.

5.2 The profit equation

The second equation of our model concerns the determinants of industries' gross profits. In particular, we introduce the following log-linear equation of profit dynamics:

$$log(PROF_{ijt}) = \alpha_1 log(W_{ijt}) + \alpha_2 log(PROD_{ijt}) + \alpha_3 \, log(NP_{ijt}) + \alpha_4 log(MACH_{ijt}) + \alpha_5 log(OFFSH_{ijt}) + \alpha_6 log(UD_{ijt}) + u_{ij} + \varepsilon_{ijt}$$

where i stands for industry at two-digit level, j for country and t for time.

Profits ($PROF$) are expected to be negatively associated to wages (W), positively linked to labour productivity ($PROD$), driven by new products (NP) and new processes ($MACH$), and by offshoring strategies ($OFFSH$), while high union membership rates UD could depress profits. Lastly, time-invariant fixed effects and the error term are captured by u and ε, respectively.

Differentiating the equation to get rid of time-invariant unobservable effects we obtain the following final specification for profits:

$$\Delta log\big(PROF_{ijt}\big) = \alpha_1 \Delta log\big(W_{ijt}\big) + \alpha_2 \Delta log\ (PROD_{ijt}) + \alpha_3 \Delta\ log\big(NP_{ijt}\big) + \alpha_4 \Delta log\big(MACH_{ijt}\big) + \alpha_5 \Delta log(OFFSH_{ijt}) + \alpha_6 \Delta log\big(UD_{ijt}\big) + \Delta\varepsilon_{ijt}$$

where the way in which the variables are computed is the same explained above.

5.3 Econometric strategy

The econometric strategy adopted to estimate empirically the wage and profit equation relies on panel data techniques suitable for dealing with datasets marked by a large cross sectional and relatively reduced temporal dimension.

First, the estimation procedure is performed after having differentiated the equations to get rid of any time-invariant individual effects. Considering that the latter may have a simultaneous impact on both the dependent variable and the regressors – leading to biased estimates – first differencing removes this source of endogeneity. Furthermore, we calculate long differences over two- to five-year periods, softening considerably the autoregressive character of variables.

Second, the temporal structure of the panel is designed to harmonize the different sources of data we exploit and to account for the time needed by innovation to unfold its economic effects. Except for the last period (for which the CIS data do not allow us to account for a time lag), innovation variables refer to a lagged period as compared to dependent variables. Similarly, union density refers to the first year of each period the dependent variables are computed on. This allows us to reduce the presence of simultaneity-related endogeneity and to account, at once, for the time required by technological advances to impact on distributional outcomes.

Third, we include a set of time, country and sectoral (i.e. Revised Pavitt industry groups and manufacturing) dummies as additional control, with the aim of reducing the potential endogeneity bias which may stem from other sources of observable heterogeneity. Primarily, time dummies are conceived as essential to control for the business cycle; otherwise, time-specific effects – that likely impact on all variables under observations – would be captured by the error term raising endogeneity problems. Nevertheless, country and sectoral dummies are fundamental tools to control for, respectively, national and sectoral systems of innovation (Freeman, 1995; Lundvall, 1992; Malerba, 2002). Regarding the former, the complex institutional features of countries represent a source of heterogeneity which is likely to shape deeply the distributive patterns between capital and labour. Revised Pavitt classes dummies account explicitly for the technological and structural patterns of industries avoiding the risk of multicollinearity that would be induced by the inclusion of a great number of sector-specific dummies; moreover, too many dummy variables may prevent the model to get a sufficient number of degrees of freedom for adequately powerful statistical tests. Finally, since manufacturing industries experience relatively greater involvement in global value chains than service ones (Agnese and Ricart, 2009), a manufacturing dummy is introduced when offshoring variables are considered, removing in this way another potential source of endogeneity.

Fourth, estimations are performed using the weighted least squares (WLS) estimator. The reason lies in the fact that industry data are grouped data of unequal size, thus their contribution in terms of information is asymmetric, affecting the consistency of the estimator (Wooldridge, 2002). Following Guarascio and Pianta (2016), we achieve consistency using the number of employees in the sectors (as observed in the first year of each economic period) as weights, rather than industries' value added; indeed, the latter depends on price variations and results in a more unstable measure of sectors' size.

Fifth, it is well known that industry-level data are usually affected by heteroskedasticity and, not unexpectedly, the results of the Breusch-Pagan test performed on baseline WLS regressions confirms that the variance of the error term differ across observations. Therefore, we carry out all the estimations applying heteroskedasticity- and autocorrelation-robust standard errors.[11]

Sixth, since industries' evolution is shaped fundamentally by their technological regimes and institutional setting, common factors impacting simultaneously on both dependent variables (i.e. rate of growth of profits and wages) may occur, affecting in this way regressions' stochastic disturbances. In other terms, the error terms of the two estimated equations might be correlated insofar as the equations have unobservable omitted variables in common. Hence, in the next section we also report estimations using the Seemingly unrelated regression estimator (SURE), which exploits correlation among regression equations' residuals to gain efficiency (Zellner, 1962).

Finally, we assess the resilience of our findings reporting in Appendix three tables with the results of robustness checks. Additional tests with different variables, leading to the same results, have been carried out and are available in Coveri and Pianta (2019).[12]

6. Results

6.1 The estimated wage equation

Table 1 shows the results of the wage equation, where technology variables, offshoring and union density are introduced separately. The expected relationships are confirmed by the findings. First, the negative impact of profit growth on wages is significant in all specifications. Second, labour productivity growth has a strong and significant impact on wage dynamics in all columns. Third, for the technology variables, a clear contrast emerges between the positive effect on wages of new products and the negative effect of expenditure in new machinery; these coefficients are significant in most specifications of the model. This finding emphasizes the relevance of distinguishing between technological and cost competitiveness strategies in explaining the wage dynamics. Fourth, the impact of offshoring on wages is always negative and significant. We first consider the impact of 'narrow' offshoring (columns 3 and 4); we then introduce simultaneously the change in imported intermediate inputs from high- and low-technology foreign industries. The negative effect on wage dynamics is consistent in all specifications, with stronger coefficients for low-tech offshoring; this confirms the role of international production in weakening labour compensation, especially when delocalization concerns low technology activity and fosters various forms of social dumping. Finally, union density supports the growth of wages with a positive and significant coefficient, although when dummies for countries and industry groups are introduced its significant is lost; nonetheless, the F-test controlling for the joint significance of Pavitt and country dummies does not reject the null hypothesis that their coefficients are not statistically different from zero. Therefore, we argue that results shown in columns 3 and 5 are not fundamentally challenged.

Controls for time, manufacturing, Pavitt industry groups and countries are introduced in turn in the different specifications reported in Table 1, without relevant changes in the results. Our findings appear therefore robust to the consideration of structural, temporal and national specificities. The findings of column 5, where all variables and the relevant controls only are included, are the most important ones, confirming the expectations of our model on the determinants of wage growth in European industries.

[TABLE 1 ABOUT HERE]

6.2 The estimated profit equation

Table 2 shows the results of the empirical estimation of the profit equation and tendentially confirms our expectations. A significant and negative coefficient is always associated to the dynamics of the dynamics of wages, while the impact of labour productivity growth on profits is always positive and significant. The introduction of product innovation increases profits, while expenditure in new machinery lacks significance.[13] The former finding highlights the ability of industries greatly committed in introducing new products to obtain "Schumpeterian" temporary monopoly profits. The labour saving and wage reducing effect of new processes appear to be captured by the wage growth variable, leading to the lack of significance of expenditure in new machinery.

As expected, offshoring is an important driver of profit growth both in the case of 'narrow' offshoring and in the case of imported intermediate inputs from high-technology industries. Conversely, the impact of imported intermediate inputs from low-technology sectors is not significant. Again, the acquisition of high-tech inputs contributes to the success of a strategy of technological competitiveness, while low-tech offshoring has an impact on wages only, as we have seen in Table 1. Finally, union density does not seem to play any role on profit dynamics; its impact is mainly on wages (see Table 1) and its effects in these estimations are already capture by the wage variable.

Again, controls for time, manufacturing, Pavitt industry groups and countries are introduced; they all appear to be relevant and have no major consequences on our estimation results. Columns 4 and 6, where all variables and controls are included, appear to be the most relevant ones. Again, our expectations on the drivers of profit growth are confirmed.

[TABLE 2 ABOUT HERE]

6.3 The wage-profit SURE model

Table 3 reports the empirical results of the simultaneous estimations of the wage and profit equations using the Seemingly Unrelated Regression Estimation (SURE) model. As previously mentioned, this estimation technique accounts for the common factors which might impact simultaneously on both dependent variables, namely the wage and profit growth rate, and exploits the correlation among them to gain efficiency (Zellner, 1962).

The baseline results of the wage-profit SURE model are reported in the first two columns of Table 3, include controls for time and manufacturing and largely confirm the results found for the separate estimations provided in the previous tables. The negative relationship between profit growth and wage growth is reaffirmed and labour productivity growth is confirmed as a major driver of both distributional variables. The coefficient related to the introduction of new products is positive and significant for the dynamics of both wages and profits; conversely, expenditure in new machinery is not significant, as we already found for the profit equation.

The first indicator we adopted as a proxy of international fragmentation of production, i.e. 'narrow' offshoring, confirms its positive effects on profits and its negative one on wages. The union density coefficient turns out to be significant for the wage equation only, as already found in the previous estimations. The overall results offer strong confirmation of our previous findings.

In the second pair of columns in Table 4 we include the variables on high- and low-tech offshoring, finding that the high-tech offshoring only has a negative and significant impact on wage growth. All other variables confirm the findings of the baseline model.

In the third pair of columns of Table 3, all dummies for time, manufacturing, Pavitt industry groups and countries are introduced, confirming previous results with the exception of union density, which loses significance due to the importance of national and structural factors.

The overall results offer a robust explanation of the key drivers of income distribution in European manufacturing and service industries. Wages and profits can grow together when labour productivity growth driven by the expansion of value added and new products improve the "Schumpeterian gains" of industries. For a given labour productivity, the capital-labour conflict remains a crucial factor shaping the distribution between profits and wages. Profits are supported by offshoring in general and by the acquisition of imported high-tech intermediate inputs in particular. Wage increases are weakened by process innovation and all types of offshoring, while greater union density provides support for labour compensation. Overall, the combination of all these dimensions and the ability to identify the different strategies related to technology change and offshoring provide a strong explanation of the major drivers of wages and profits in European industries.

[TABLE 3 ABOUT HERE]

7. Conclusions

The present work has combined a Post-Keynesian approach to the conflictual relationship between capital and labour income with a structural change perspective and attention to the dynamics of technological change, offshoring and labour market institutions in order to investigate income distribution at the industry level. We fully considered the diversity of technological trajectories of industries, with a distinction between a technological competitiveness strategy, which mainly relies on new products, and a cost competitiveness strategy aimed at reducing labour costs and gaining production efficiency through the introduction of new processes (Pianta, 2001). We have also explored the different offshoring strategies pursued by firms, considering the relevance of imported intermediate inputs from the same industry ('narrow' offshoring) as well as the sourcing of inputs from either high or low-technology foreign industries. Finally, we investigated the role played by union density at the industry level in shaping the power balance between capital and labour. Our two-equation structural model is able to effectively integrate all these drivers of income distribution and to simultaneously determine the dynamics of wages and profits in European industries. The main lessons we can draw from our results include the following.

First, labour productivity growth is found to have a positive impact on both wage and profit growth; it is the driver of the expansion of industries' value added, the 'cake' that can then be divided between capital and labour; higher productivity growth allows to weaken the conflictual nature of income distribution.

Second, the conflict over distribution does remain important; the profit growth rate of industries is always negative correlated with the rate of growth of wages, and viceversa, highlighting the relevance of capital-labour conflict and the possibility of getting close to a zero-sum game in income distribution.

Third, technology is not neutral in its income distribution effects. The introduction of new products is associated to relatively higher wages and profits, while the expenditure in new machinery and equipment shows a negative impact on labour compensation. The important distinction between technological and cost competitiveness strategies allows us to understand the logic of business strategies in innovation and the resulting – mainly pro-business - distributional outcomes.

Fourth, in parallel to technology, offshoring and international production have equally relevant distributional outcomes. Greater delocalization of production abroad weakens workers' wage claims; the 'narrow' offshoring indicator is closely associated to faster profit growth. When we distinguish offshoring on the basis of the technological level of foreign source industries, we find that wages suffer the negative effect of low-tech offshoring, as this intensifies worldwide competition among workers and is associated to various forms of social dumping. Conversely, foreign sourcing of high-tech inputs has a strong impact on profit dynamics, as industries acquire advanced intermediate products that are not domestically produced – this is typical of electronic components for European industries. This strategy gives industries access to new sources of knowledge and technology and can be complementary to the development of new products.

Lastly, union density tends to have a positive impact on wage dynamics at industry level, reasserting trade unions as relevant actors in shaping the bargaining power of workers.

Our findings strengthen the recent political economy literature on income distribution and the conflictual determination of the compensation of capital and labour (Dunhaupt, 2016; Guschanski and Onaran, 2017; Stockhammer, 2017). Moreover, drawing from evolutionary approaches, we have moved beyond the undifferentiated notion of technological change (usually proxied by partial and unconvincing measures such as R&D, patents, total factor productivity, ICT capital stock) and we have documented the contrasting impact of product and process innovation on wage and profit dynamics. The same differentiation has been applied to offshoring strategies, integrating them with technological strategies, leading to new insights on the distributional effects of international production. The role of labour market institutions has also been confirmed in our analysis, with a close link between trade union presence and higher wage dynamics.

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Appendix

Table A.1 and Table A.2 provide robustness checks related to the estimation results of the baseline wage equation and profit equation reported in the first and second column of Table 1 and Table 2, respectively.

The test proposed by Cumby and Huizinga (1990, 1992) and developed for STATA by Baum and Schaffer (2013) does not reject the null hypothesis of serially uncorrelated residuals of the estimated wage equation while rejects the null hypothesis for profit equation. Nonetheless, for the wage equation the p-value of the test is quite low (equal to 0,1146) while the Breusch-Pagan test and the White test strongly reject the null hypothesis of homoskedasticity for both equations. It follows that using Huber-White standard errors robust to heteroskedasticity and autocorrelation of residuals is the best choice.

Notwithstanding the inclusion of time, Pavitt and country dummies, the Variance Inflation Factor (VIF) value ranges from 2,31 to 2,77 for wage equation and from 2,43 to 2,86 for profit equation, below 4 and much below 10 (the thresholds usually taken as reference in the literature). Therefore, multicollinearity is not a cause for concern.

Finally, we apply a control function approach test the endogeneity of labour productivity growth in the wage equation. The F-test of the first step is equal to 60,81 – well above the "rule of thumb" of 10, which would be the minimum threshold above which the weakness of instruments can be considered not an issue (see Bound et al., 1995; Staiger and Stock, 1997) – and the p-value rejects the null hypothesis of weak instruments. In the second step we regress our wage equation including the residuals predicted in the first stage as additional covariate. A test on the latter becomes an endogeneity test under the null hypothesis of labour productivity exogeneity. The test returns a "borderline" result – as the p-value is equal to 0,082 – weakly supporting the exogeneity of labour productivity growth in the wage equation.

[TABLE A.1 ABOUT HERE]

[TABLE A.2 ABOUT HERE]

Table A.3 reports five post-estimation tests to check the exogeneity of labour productivity growth in the profit equation using as main instruments the share of workers belonging to four different occupation categories resulting from the aggregation of the ISCO professional classification (Cirillo, 2017). The first column shows the test performed, the second column the variable whose exogeneity has to be checked, the third column the variables used as instruments, the fourth column the estimator employed for the diagnostic test, the fifth column the results concerning the relevance and validity of the instruments, the sixth column the results of the endogeneity tests performed and the last column summarizes the final outcome.

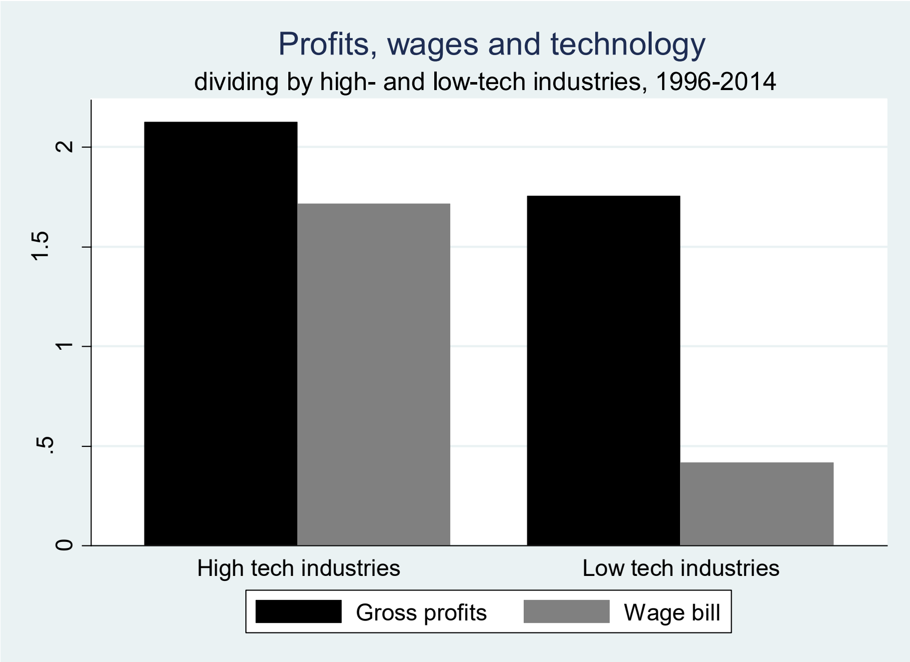
The F-statistic related to the first stage of the test performed following a control function approach is equal to 147,14 – again well above the "rule of thumb" of 10. Regarding the last four endogeneity tests, note that the F-statistic performed in the first stage always rejects the null hypothesis of weak instruments, while the Hansen (1982) test – which applies to estimation with robust standard error – does not reject the null hypothesis of valid instruments (i.e. uncorrelated with the error term).

The Wooldridge's (1995) robust score test performed using the third set of instruments (i.e. share of managers, share of manual workers and lagged growth rate of value added) is the only one over five tests that weakly rejects (at a significance level of

10%) the null hypothesis of exogeneity of labour productivity growth. Therefore, the overall outcome of Table A.3 provides fairly support to our econometric strategy.

[TABLE A.3 ABOUT HERE]

Figure 1.



Source: Our elaboration on Sectoral Innovation Database.
Note: Profits and wages growth rate refer to the compound average annual rate of change over the period. Industries are grouped in high-tech (Science based and Specialized suppliers sectors) and low-tech (Scale and information intensive and Supplier dominated sectors) clusters according to the Revised Pavitt Taxonomy proposed by Bogliacino and Pianta (2010, 2016).

Figure 2.

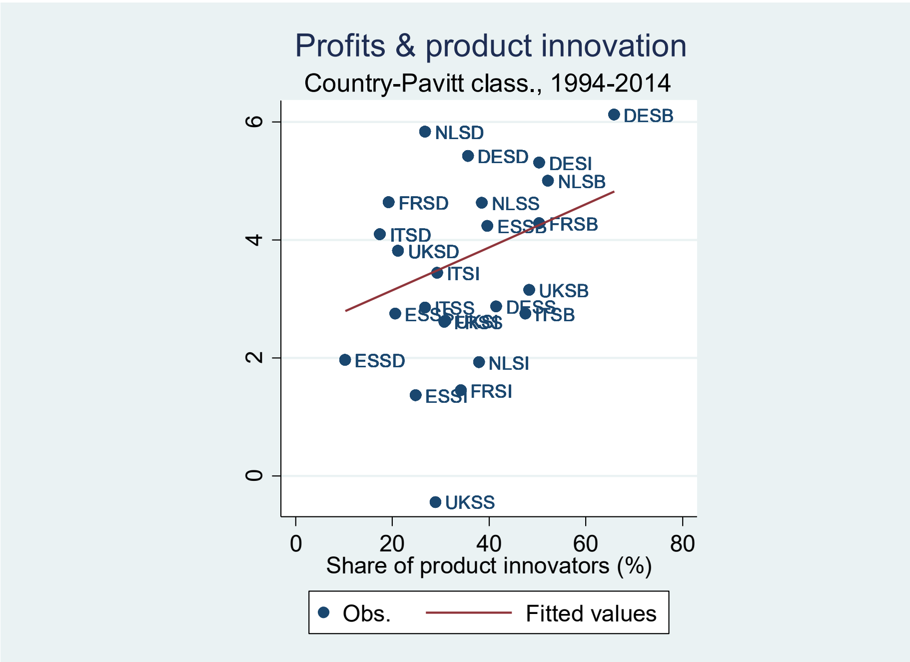
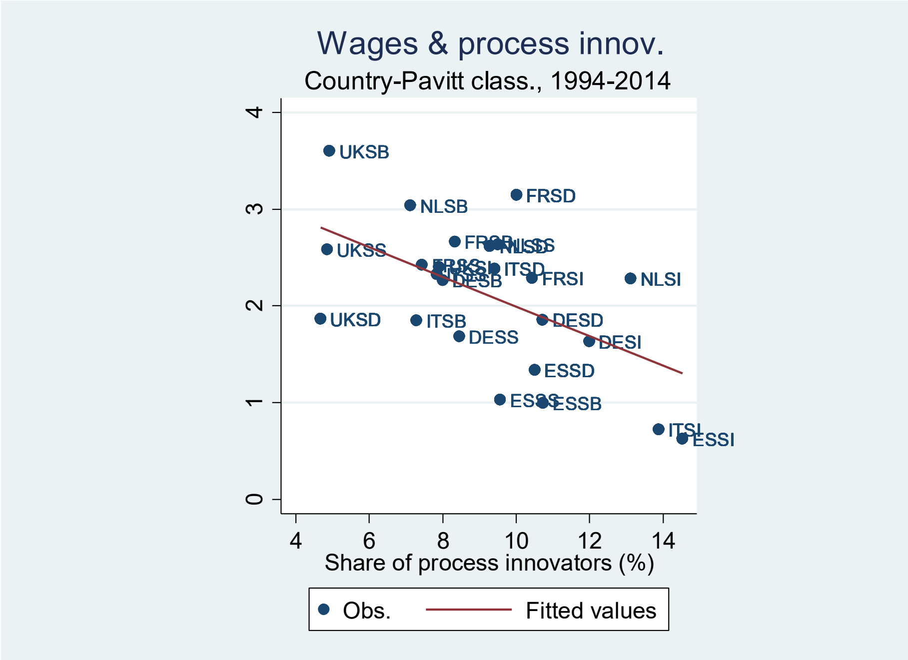


Figure 3.



Source: Our elaboration on Sectoral Innovation Database.
Note: Observations refer to the unweighted average values of industries grouped according to the country-Pavitt classification. Profit and wage growth rates refer to the compound average annual rate of change while the share of product (process) innovators reflects the average share of firms introducing product (process) innovation at sectoral level over the period.

Figure 4.

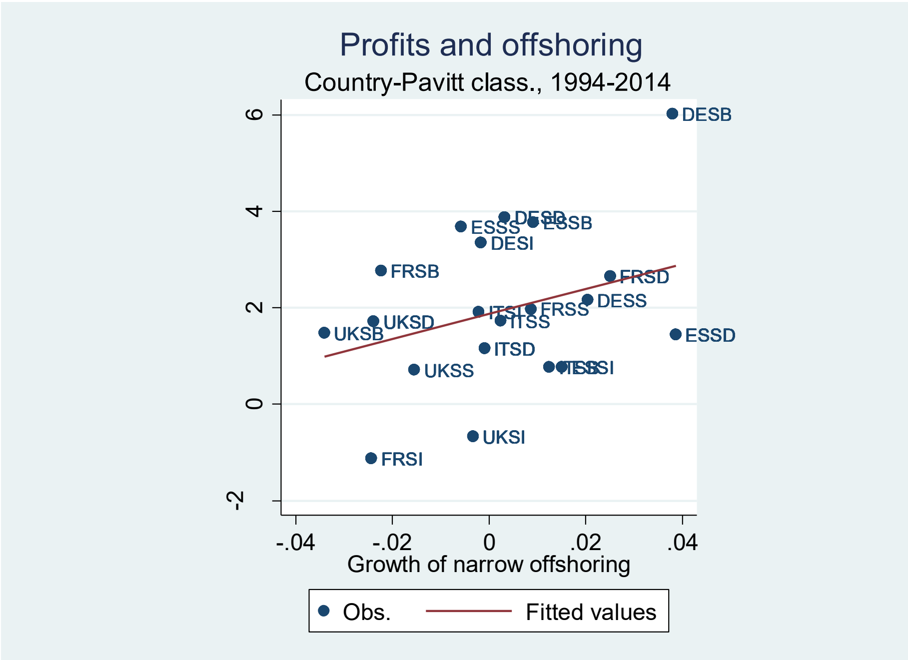
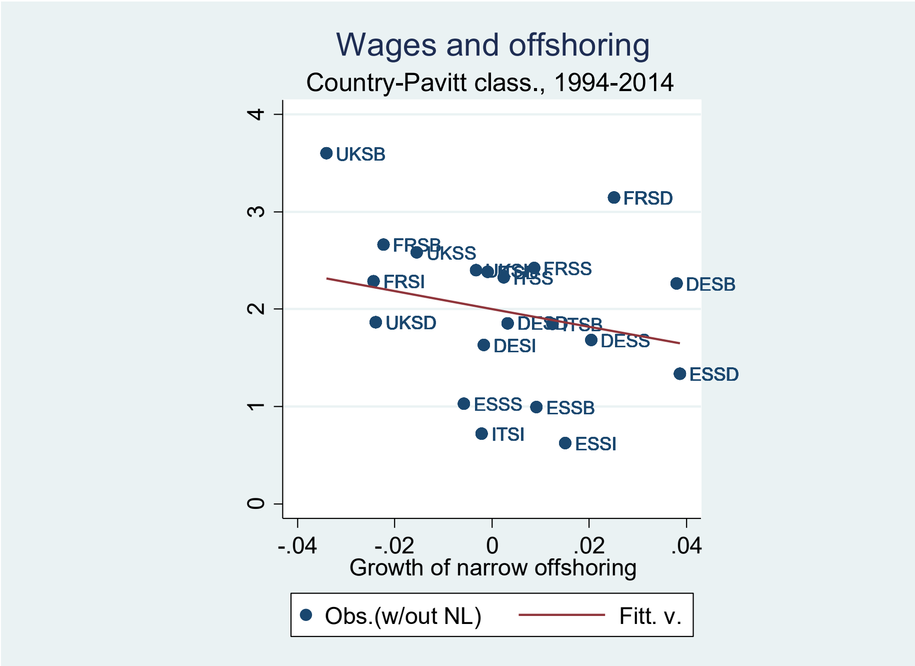
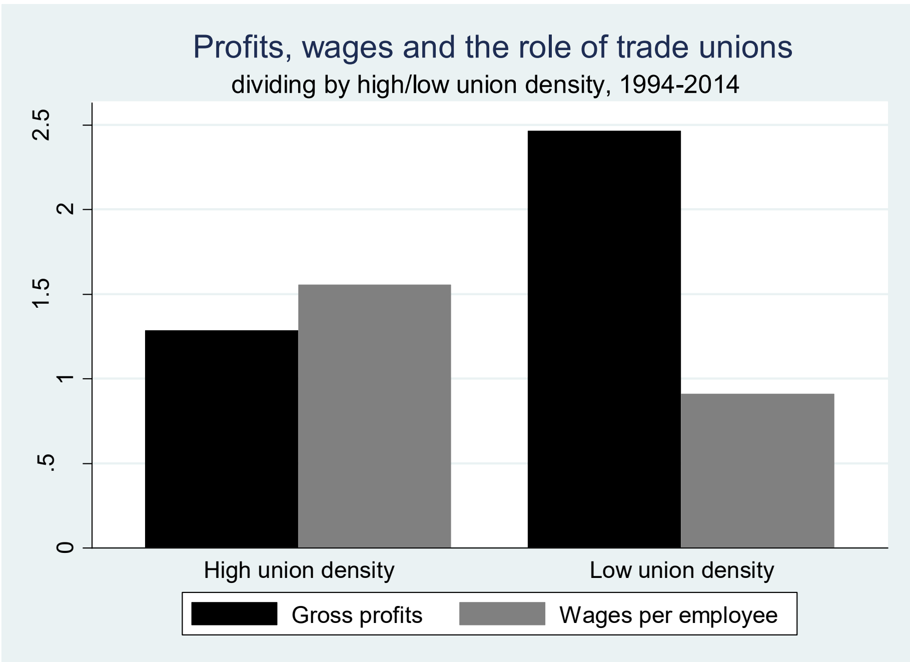


Figure 5.



Source: Our elaboration on Sectoral Innovation Database.
Note: Observations refer to the average values of industries grouped according to the country-Pavitt classification. Profit and wage growth rates refer to the compound average annual rate of change while the growth of 'narrow' offshoring is computed as the average simple difference over the period.

Figure 6.



Note: Profit and wage growth rates refer to the compound average annual rate of change over the period. The values for individual industries are aggregated in high- and low-union density clusters according to the median criterion.

Table 1. The wage equation

	(1) ΔWages	(2) ΔWages	(3) ΔWages	(4) ΔWages	(5) ΔWages	(6) ΔWages
ΔProfits	-0.0410***	-0.0421***	-0.0373**	-0.0420***	-0.0400***	-0.0437***
	(0.0142)	(0.0143)	(0.0146)	(0.0151)	(0.0146)	(0.0152)
ΔProductivity	0.524***	0.521***	0.514***	0.514***	0.508***	0.508***
	(0.0492)	(0.0514)	(0.0499)	(0.0520)	(0.0500)	(0.0524)
Share of firms introducing product innovation	0.00901	0.00957	0.0199**	0.0247***	0.0226***	0.0258***
	(0.00655)	(0.00722)	(0.00780)	(0.00896)	(0.00793)	(0.00913)
Expenditure in new mach. and equipment per emp.	-0.321**	-0.278**	-0.279**	-0.197	-0.278**	-0.217
	(0.127)	(0.137)	(0.133)	(0.148)	(0.132)	(0.146)
ΔNarrow offshoring			-0.250***	-0.238***		
			(0.0872)	(0.0845)		
ΔOffshoring HT					-0.184*	-0.186*
					(0.103)	(0.105)
ΔOffshoring LT					-0.196**	-0.200**
					(0.0886)	(0.0871)
Union density			0.0288**	0.00907	0.0277**	0.0108
			(0.0114)	(0.0198)	(0.0113)	(0.0199)
Time dummies	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***
Manufacturing dummy	No	No	Yes**	Yes**	Yes**	Yes**
Pavitt dummies	No	Yes	No	Yes**	No	Yes**
Country dummies	No	Yes	No	Yes	No	Yes
F-test Pavitt & country dummies	-	0.1694	-	0.4102	-	0.3653
Observations	845	845	833	833	831	831
R-squared	0.505	0.516	0.519	0.528	0.522	0.532

Note: Weighted least squares (WLS) with robust standard errors in brackets and weighted data (weights are sector- and time-specific number of employees). * significant at 10%, ** significant at 5%, *** significant at 1%. Variables referring to product innovation and expenditure in new machinery present a lag (except for the last period) according to the time structure of the panel; union density is lagged as it refers to the first year of each time period.

Table 2. The profit equation

	(1) ΔProfits	(2) ΔProfits	(3) ΔProfits	(4) ΔProfits	(5) ΔProfits	(6) ΔProfits
ΔWages	-0.270***	-0.272***	-0.244***	-0.269***	-0.267***	-0.284***
	(0.0890)	(0.0875)	(0.0938)	(0.0930)	(0.0941)	(0.0938)
ΔProductivity	0.404***	0.433***	0.402***	0.427***	0.414***	0.433***
	(0.103)	(0.103)	(0.105)	(0.102)	(0.108)	(0.106)
Share of firms introducing product innovation	0.0562**	0.0403	0.0626**	0.0541*	0.0628**	0.0536
	(0.0272)	(0.0293)	(0.0266)	(0.0313)	(0.0284)	(0.0332)
Expenditure in new mach. and equipment per emp.	0.277	0.390	0.494	0.628	0.507	0.667
	(0.735)	(0.755)	(0.752)	(0.773)	(0.763)	(0.783)
ΔNarrow offshoring			0.821***	0.787***		
			(0.253)	(0.254)		
ΔOffshoring HT					0.547*	0.549*
					(0.282)	(0.283)
ΔOffshoring LT					-0.0714	0.0172
					(0.187)	(0.189)
Union density			-0.0227	0.00166	-0.0199	0.00621
			(0.0334)	(0.0541)	(0.0334)	(0.0547)
Time dummies	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***
Manufacturing dummy	No	No	Yes*	Yes**	Yes	Yes**
Pavitt dummies	No	Yes***	No	Yes***	No	Yes***
Country dummies	No	Yes***	No	Yes*	No	Yes*
F-test Pavitt & country dummies	-	0.0002	-	0.0003	-	0.0004
Observations	845	845	833	833	831	831
R-squared	0.109	0.146	0.132	0.170	0.123	0.163

Note: Weighted least squares (WLS) with robust standard errors in brackets and weighted data (weights are sector- and time-specific numbers of employees). * significant at 10%, ** significant at 5%, *** significant at 1%. Variables referring to product innovation and expenditure in new machinery present a lag (except for the last period) according to the time structure of the panel; union density is lagged as it refers to the first year of each time period.

Table 3. The simultaneous wage-profit model (SURE model)

	(1) SURE		(2) SURE		(3) SURE	
	ΔProfits	ΔWages	ΔProfits	ΔWages	ΔProfits	ΔWages
ΔWages	-0.516***		-0.555***		-0.637***	
	(0.0829)		(0.0833)		(0.0829)	
ΔProfits		-0.0876***		-0.0935***		-0.107***
		(0.0141)		(0.0140)		(0.0140)
ΔProductivity	0.506***	0.321***	0.524***	0.322***	0.509***	0.311***
	(0.0581)	(0.0224)	(0.0586)	(0.0225)	(0.0587)	(0.0227)
Share of firms introducing	0.0998***	0.0353***	0.101***	0.0373***	0.119***	0.0430***
product innovation	(0.0187)	(0.00774)	(0.0191)	(0.00788)	(0.0205)	(0.00846)
Expenditure in new mach.	-0.0842	-0.132	-0.0553	-0.101	0.168	0.0216
and equipment per emp.	(0.248)	(0.102)	(0.252)	(0.103)	(0.263)	(0.108)
ΔNarrow offshoring	0.398***	-0.115*				
	(0.147)	(0.0607)				
ΔOffshoring HT			0.130	-0.127*	0.0919	-0.133*
			(0.175)	(0.0716)	(0.175)	(0.0715)
ΔOffshoring LT			0.135	-0.0570	0.121	-0.0661
			(0.138)	(0.0568)	(0.139)	(0.0570)
Union density	0.0122	0.0345***	0.0154	0.0325***	-0.0108	0.00202
	(0.0279)	(0.0114)	(0.0279)	(0.0114)	(0.0450)	(0.0185)
Time dummies	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***
Manufacturing dummy	Yes***	Yes***	Yes**	Yes***	Yes***	Yes***
Country dummies	No	No	No	No	Yes	Yes***
Pavitt dummies	No	No	No	No	Yes***	Yes***
Observations	836	836	834	834	834	834
R-squared	0.141	0.327	0.135	0.329	0.162	0.350

Note: Seemingly Unrelated Regression Equations (SURE) model; * significant at 10%, ** significant at 5%, *** significant at 1%. Variables referring to product innovation and expenditure in new machinery present a lag (except for the last period) according to the time structure of the panel; union density is lagged as it refers to the first year of each time period.

Table A.1 Robustness checks for the baseline wage equation

Heteroskedasticity (Breusch-Pagan test)
WLS regression (time, Pavitt and country dummies included) Ho: constant variance (homoskedasticity) F(16, 828) = 11,93 Prob > F = 0,0000
Heteroskedasticity (White test)
OLS regression (time, Pavitt and country dummies included) Ho: homoskedasticity Ha: unrestricted heteroskedasticity chi2(121) = 335,34 Prob > chi2 = 0,0000
Autocorrelation of residuals (Cumby-Huizinga test)
WLS regression (time dummies included) Ho: variable is MA process up to order q (with q = 0: serially uncorrelated) Ha: serial correlation present at specified lags >q chi2 = 2,490 p-value = 0,1146
Multicollinearity (Variance Inflation Factor)
WLS regression (time, Pavitt and country dummies included) Mean VIF = 2,31
Endogeneity of labour productivity growth (Control function approach)
WLS with robust standard errors (time, Pavitt and country dummies included) Endogenous: labour productivity growth Instruments: first lag of labour productivity growth, share of managers, share of manual workers First stage: test F(3, 726) = 60,81 Prob > F = 0,0000 Second stage: significance of residuals predicted in the first stage p-value = 0,082
Multicollinearity for specification of Table 1, column 6 (Variance Inflation Factor)
WLS regression (time, manufacturing, Pavitt and country dummies included) Mean VIF = 2,77

Table A.2 Robustness checks for the baseline profit equation

Heteroskedasticity (Breusch-Pagan test)
WLS regression (time, Pavitt and country dummies included)
Ho: constant variance (homoskedasticity)
F(16, 828) = 6,52
Prob > F = 0,0000
Heteroskedasticity (White test)
OLS regression (time, Pavitt and country dummies included)
Ho: homoskedasticity
Ha: unrestricted heteroskedasticity
chi2(121) = 202,79
Prob > chi2 = 0,0000
Autocorrelation of residuals (Cumby-Huizinga test)
WLS regression (time dummies included)
Ho: variable is MA process up to order q (with q = 0: serially uncorrelated)
Ha: serial correlation present at specified lags >q
chi2 = 6,248
p-value = 0,0124
Multicollinearity (Variance Inflation Factor)
WLS regression (time, Pavitt and country dummies included)
Mean VIF = 2,43
Multicollinearity – specification of Table 2, column 6 (Variance Inflation Factor)
WLS regression (time, manufacturing, Pavitt and country dummies included)
Mean VIF = 2,86

Table A.3 Baseline profit equation: endogeneity tests

Test	Endogenous variable	Instruments	Estimator	Test F (first stage) and overidentification tests	Final test (second stage) and endogeneity test	Result
Control function approach	**Productivity**	QCLE, QCWO, QMWO (same results with lagged SIZE as instrument)	WLS, robust s.e.	F(9, 719) = 147.14 Prob > F = 0.0000	Ho: variables are exogenous P-val > |t| = 0.37 (test on the residuals predicted in the first stage)	***exogenous***
Wooldridge's (1995) robust score test and robust regression-based test after 2sls	**Productivity**	QCLE, QCWO, QMWO	2SLS weighted, with robust s.e. (*ivregress 2sls* Stata's command)	F(10, 695) = 119.95 Prob > F = 0.0000 ——— Test of overidentifying restrictions: Hansen's (1982) J statistic: Score chi2(1) = 0.738166 P-val = 0.6914	Tests of endogeneity Ho: variables are exogenous Wooldridge's (1995) robust score test = 0.613604 P-val = 0.4334 Robust regression-based test F(1,696) = 0.492114 P-val = 0.4832	***exogenous*** ***exogenous***
Wooldridge's (1995) robust score test and robust regression-based test after 2sls	**Productivity**	QMAN, QMWO, lagged RVA	2SLS weighted, with robust s.e. (*ivregress 2sls* Stata's command)	F(10, 598) = 128.92 Prob > F = 0.0000 ——— Test of overidentifying restrictions: Hansen's (1982) J statistic: Score chi2(1) = 1.8427 P-val = 0.3980	Tests of endogeneity Ho: variables are exogenous Wooldridge's (1995) robust score test = 2.767 P-val = 0.0962 Robust regression-based test F(1,696) = 2.39478 P-val = 0.1223	**weakly endogenous** ***exogenous***

Note: QMAN=share of managers; QCLE=share of clerks; QCWO=share of craft workers; QMWO=share of manual workers; RVA=growth rate of value added; SIZE=average firm size. Variables referring to the share of managers, clerks, craft and manual workers over the total number of employees in the sector, as well as size, present a lag as they refer to the first year of each time period. Growth rate of value added of sectors is computed as the compound average annual rate of change over five periods (1996-2000, 2000-2003, 2003-2008, 2008-2012, 2012-2014) according to the time structure of the panel.

Endnotes

[1] The selection of countries and sectors has been made in order to avoid limitations in access to data (due to the low number of firms in a given sector of a given country, or to the policies on data release by National Statistical Institutes).

[2] Since the conversion procedure might result in some data distortions, implausibly large values (in absolute terms) which appeared for some industries have been excluded.

[3] It is worth noting that Feenstra and Hanson (1999) stress the reliability of 'narrow' offshoring indicator since it is conceived to capture better the definition of production fragmentation, an event which mostly occurs within industries.

[4] The variable related to the expenditure for new machinery and equipment contains missing values for the first two CIS waves by construction. However, missing values are homogeneously distributed across countries in service industries.

[5] The temporal structure of the database is firstly due to the frequency according to which Eurostat collects the innovation surveys and makes them available. Secondly, the surveys' innovation-related questions are partially changed over the time, forcing us to select consistently the CIS containing the variables of our interest. Finally, we matched the economic and innovation variables so that the latter are lagged relative to the former, bearing in mind the time needed by technological efforts to display their effects.

[6] Nonetheless, it is worth noting that in Figure 3 Germany observations are below the fitted values line, providing evidence about the slow German wage growth and pointing out a limited sharing of the rents generated by innovation. It should be also noted the poor performance of Spain in terms of technological capabilities and related low growth of labour and capital compensation compared to the other European countries.

[7] Figure 7 and 8 exclude the Netherlands from the sample. From a descriptive point of view, the Netherlands' offshoring observations are misleading because of the small dimension of this country (compared to the others) and for the "seaport effect" which stems from being a trade hub.

[8] Following Pianta and Tancioni (2008), we use total sectoral profit as a proxy of capital compensation, although the investigation of rate of return on capital would be the most proper variable for our analysis. Unfortunately, missing data on industries' capital fixed assets makes such analysis unfeasible. However, considering that capital stock does not change rapidly at industry level, assuming total profit as a good

return of capital proxy appears to be reasonable. Conversely, sectoral wage bill depends directly on the number of workers or, more accurately, on the working time performed by employees (given the widespread use of precarious and part time jobs nowadays). Hence, wage per worker hour is considered a more appropriate measure to capture the distributional impact of our covariates and the relationship between labour and capital remuneration.

[9] Along the structural change process of the economies, we observe sectors that experience high growth rate alongside others which decline. We might thus witness a contemporary growth of both profits and wages in the former and the opposite dynamics in the latter.

[10] Values of all offshoring variables have been multiplied by 100.

[11] An extensive diagnostic concerning variables endogeneity and specifications' robustness is provided in Appendix, Table A.1-A.3. Our robustness checks confirm the appropriateness of our estimation strategy, the only reason which might raise concerns being the one regarding the endogeneity tests on labour productivity growth.

[12] We also accounted for another potential omitted variable bias in the wage equation controlling for the employment structure of industries as a factor which might reasonably impact on the level of wage in the sector. For this purpose, we included the share of managers and the share of manual workers – classified according to the ISCO professional groups (Cirillo, 2017) – as covariates in the wage equation. The introduction of the share of managers and of manual workers in the wage equation does not change considerably our estimation results insofar as their effects do not turn out to be significant in explaining the wage dynamics. Furthermore, we tested the robustness of our findings even using a different product innovation variable, namely the share of firms which innovate with the aim of opening new markets in the sector, whose design and time structure is the same of previously employed innovation proxies insofar as it is likewise drawn from the CIS provided by Eurostat. The results stemming from both the equation-by-equation estimates and the simultaneous model estimation substantially confirm our present findings about the heterogenous impact of innovation, offshoring and union density on the growth rate of wages and profits. As regards these additional checks see Coveri and Pianta (2019).

[13] In column 6 our product innovation proxy turns out with a positive but not significant coefficient, while all the other coefficients do not change considerable their sign, significance and magnitude. This outcome stems from the inclusion of country dummies in column 6, as far as the inclusion of Pavitt dummies does

not turn out insignificant the coefficient related to product innovation (Coveri and Pianta, 2019). Whether the joint significance of Pavitt and country dummies is confirmed by the reported p-value of the F-test in column 6, it is worth noting that country dummies are very slightly significant; using Germany as reference (i.e. excluding the dummy for Germany to avoid multicollinearity), only the dummy for Italy results significant at 10%. Hence, we hold that the statistical relevance of the variable proxying product innovation in the profit equation is not fundamentally questioned.