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WEAKER JOBS, WEAKER INNOVATION.
EXPLORING THE TEMPORARY EMPLOYMENT-PRODUCT INNOVATION NEXUS

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Weaker jobs, weaker innovation. Exploring the temporary employment-product innovation nexus.*

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Abstract

In the last decades, labour flexibility has been introduced all across Europe with the aim of spurring jobs and productivity. This work explores the link between the use of temporary employment and the propensity to introduce product innovations by firms. The analysis performed at the sectoral level combines information on innovation, economic performance and employment for five major European economies observed over the period 1998-2012. Taking into account the variety of technological patterns, the authors find that industries using temporary employment more intensively are characterized by a weak product innovation propensity. The negative correlation between temporary employment and innovation is stronger in medium and high-tech sectors identified alternatively by Peneder classification and by the concentration of firms' intangible assets proxing different Schumpeterian regimes of accumulation.

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1 Introduction

In the last decades, (external) labour flexibility has been introduced all across Europe with the aim of spurring jobs and productivity. Favouring the adjustment of labour supply to changing market conditions, a greater external flexibility is expected to impact positively on employment. By easing workers entry and exit, labour flexibility is expected to foster productivity dynamics ensuring a better matching between skills' demand and supply.

After the 2008 crisis, flexibility has been on the top of the reform agendas put forth in Southern Europe to restart GDP and employment growth.[1] In the meantime, technological competitiveness and innovation came to the fore as key strategies to promote growth in firms and industries. In the sake of the crisis, companies that manage to safeguard (and in some cases increase) their market share are mostly those introducing new products or improving quality and technological content of the existing ones.

The push towards a greater external flexibility faces theoretical controversies and contrasting empirical findings. A large body of literature has analysed the relationship between flexibility and employment dynamics. Reviewing these contributions, Kleinknecht et al. (2009) emphasize that a significant part of the available evidence militates for no effects or negative effects of flexibility on employment. Another stream of literature focuses on the linkage between flexibility and productivity. Even in this case, the evidence is mixed. However, a non negligible group of studies reports a negative relation between flexibility and productivity. A more scant literature provides evidence on the relationship between flexibility and product innovation.

Two opposite hypotheses are identifiable concerning the linkage between flexibility and innovation. First, a greater external flexibility may be associated with horizontal (and less hierarchical) organizations where knowledge (and workers) move rapidly within as well as inside/outside the organization itself. In this case, external flexibility may spur knowledge flows favouring the entry of new ideas having a potentially positive impact on product innovation. According to the second hypothesis, in turn, labour flexibility can reduce the propensity towards product innovation by weakening the process of tacit or firm-specific knowledge accumulation. Pivotal for the development of innovations, the accumulation of tacit and firm-specific knowledge heavily rely on long lasting labour relations as well as on organizational environments favouring cooperation between workers and employers. In this respect, the uncertainty about labour relationships' duration - typical of temporary and other flexible labour contracts - can discourage the accumulation of organization-specific knowledge. Similarly, the uncertain duration may negatively affect the propensity towards loyalty and cooperation between employers and employees as well as among employees.

These contrasting hypotheses point to different organizational profiles and/or firms' competitive strategies. A first distinction regards, on one side, firms relying on innovation and product quality to achieve market success; on the other, companies that compete by reducing costs (particularly labour cost). However, a significant heterogeneity may emerge even among firms relying on innovation and technological competitiveness strategies. The key element regards the role played by tacit and firm-specific knowledge - and, hence, by stable and cooperative labour relationships - in different technological regimes (Kleinknecht et al., 2014). In the garage-business model - i.e. the model proxing the Schumpeter Mark I technological regime -, competition is characterized by continuous firms entry and exit and the type of knowledge involved in the development of innovations is general and generally available. Conversely, in the routinized-innovation model - i.e. proxing the Schumpeter Mark II technological regime characterized by high entry barriers - innovations are developed relying on historically accumulated, firm-specific and idiosyncratic knowledge. As a result, the relationship between labour flexibility and innovation may vary substantially according to different competitive strategies (technology vs costs); and technological regimes (Schumpeter Mark I vs II). In addition, magnitude and direction of the flexibility-innovation nexus can change according to country-level structural and institutional specificities.

[1] The spreading of labour market reforms after the crisis has been assessed, for OECD economies, by Adascalitei et al. (2015) and by Cirillo and Guarascio (2015) for the Italian economy. Indeed, specificities in forms of liberalization across countries have to be highlighted (Picot and Tassinari (2017).

In Europe, labour flexibility has been mostly pursued by reducing workers protections against layoffs and favouring the use of temporary contracts (Cirillo et al., 2017). Despite a large policy consensus, such push towards flexible labour markets has not given rise to significant employment and productivity improvements (Kleinknecht et al., 2009; Fana et al., 2016). This is particularly true for Southern EU economies where, over the last decades, a sluggish productivity performance prevented the expected convergence towards the "core" - Germany and the other Central-Northern EU economies (Landesmann, 2015). In this respect, a set of recent empirical and theoretical contributions analysed the impact of labour flexibility when heterogeneity - in terms of production structures, technological regimes, policy-mix and macroeconomic conditions - is explicitly accounted for (Cirillo and Guarascio, 2015), (Dosi et al., 2016). These contributions show that, in presence of structural weaknesses - identified, for example, with the prevalence of low-tech sectors and low-skilled employment - and feeble aggregate demand, lowering workers protection can negatively affect productivity dynamics.

Despite a long-lasting policy debate, the empirical literature does not provide a clear assessment of the relationship between usage of temporary contracts, productivity and innovation dynamics. Indeed, results are controversial and often discordant. From a policy perspective, the International Monetary Fund has recently claimed that labour market regulation is not found to have "...statistically significant effects on total factor productivity" (Fonds, 2015). Analogously, no consensus is registered concerning the linkage between labour flexibility and innovation. In turn, most of the recent reforms (for a review, see Cirillo and Guarascio, 2015) put forth in the EU have reduced previous restrictions about the usage of fixed term contracts to increase flexibility. As a consequence, the share of temporary contracts surged – but with a remarkable degree of heterogeneity - all across European economies. In this context, scholars as Boeri and Garibaldi (2007) highlighted the emergence of dual labour markets envisaging an increasing risk of slow mobility, worsening wage distribution and persistent traps of temporary jobs for new entrants (Scherer, 2004).

Given the emergence of temporary employment as a peculiar trait of the European labour markets, it is worth exploring if and how the diffusion of this type of contracts affects EU economies' industrial structure and its propensity towards innovation. So far, few empirical works have investigated the linkage between temporary contracts and innovation dynamics. Even more so, no contribution have explored econometrically the relationship between temporary contracts and product innovation. This paper aims at filling this literature gap relying on a rich longitudinal database providing information - at the industry level for five major EU economies - on economic and innovative performance as well as on temporary employment. Community Innovation Surveys (CIS) data on product innovation are selected as indicator of sectoral innovative performances, consistently with a large literature based on innovation surveys (Mairesse and Mohnen, 2010). This work addresses the following research questions. First, we test whether a relatively more intense use of temporary contracts affects the development of new products in European industries. Second, in line with the hypothesis spelled out above, we test whether the investigated relationship is sensitive to technological regimes - Schumpeter Mark I vs Mark II - and industries' characteristics - low vs high tech sectors clustered using the Peneder classification. Finally, we distinguish between workers' age cohorts, to test whether the impact of temporary employment on innovation changes according to the age cohort most affected by this type of contracts.

The state of play is organized as follow. Section 2 discusses the theoretical and empirical literature analysing the relation between labour market institutions and innovation. Section 3 describes the data and provides some preliminary evidence, while 4 reports the econometric strategy and discusses the main results. Finally, 5 presents some conclusions.

2 Background Literature

A large number of contributions has explored the economic impact of labour market flexibilization both at the macro and at the micro level. These studies flourished along the process of flexibilization that, since the late

1980s, characterized almost all the advanced economies. Empirical papers studying the association between flexibility and employment dynamics try to figure out to what extent removing rigidities within the labour market affects wage determination mechanisms, job search-and-matching processes or productivity dynamics. A significant set of comparative analysis that attempted to verify if reforms with a similar design - all measures aiming at flexibilizing labour markets by introducing short-term contracts or easing workers entry and exit - produced differentiated impacts in different socio-economic environments. A more recent group of contributions, finally, shed light on the linkage between labour flexibility and innovation dynamics at the firm level. Overall, two main groups of contributions can be identified in the literature which has openly addressed the relationship between flexibility and economic performances, and more specifically innovation dynamics. On the one hand, the ones that pursue international comparisons looking at the interaction of indexes - such as the OECD Indicator of Employment Protection Legisltion - the EPL[2] - and innovation variables (patents, R&D expenditure, product and process innovation). On the other hand, the ones analysing - at both firm and sectoral levels - the effect of different types of flexible employment on innovation and productivity dynamics. The empirical evidence provides mixed and not conclusive results. Indeed, behind such heterogeneous empirical outcomes, different theoretical approaches stand out. According to a neoclassical viewpoint, rigidities - intended as the combination of fixed term contracts and firing restrictions - may hamper labour market adjustment to shocks hindering the achievement of an optimal equilibrium. Therefore, "stringent layoff regulations increase the cost of firing workers, reducing the productivity threshold at which firms are willing to lay off workers" (Bassanini et al., : p.9, 2009 p.9). Murphy et al. (2017) further develop the econometric strategy proposed by Bassanini et al. (2009) and focus on the role played by adjustment costs. They claim that firms with higher job reallocation propensity record lower "innovation intensity" in presence of stringent labour rules (in particular temporary regulation). In presence of strong restrictions on firings and employment subsidies, firms become reluctant to abandon relatively unproductive opportunities, leading to a fall in the average productivity and aggregate Total Factor Productivity (TFP), as explained by Lagos, : p.27. In this respect, distinct patterns of specialization may depend on labour market rigidity, with low EPL countries specializing in *primary innovation*[3], and high EPL countries focusing on imitative *secondary innovations*[4], such that they are able to reduce the risk of paying firing costs (Saint-Paul, 1997, 2002). Authors as Cuñat and Melitz (2012) provide an empirical test of the neoclassical hypothesis on the relationship between labour market institutions and economic performances. They find that countries with relatively more flexible labour markets have a comparative advantage in industries with high consumers demand volatility, because of different allocative reaction in case of micro level shocks. In this respect, Bartelsman et al. (2008) identify the relatively higher firing costs faced by EU firms as one of the causes of their weaker innovation performance as compared to the US companies - i.e. high firing costs are supposed to rise the burden associated to investment failures reducing the incentive to experiment. On similar lines, Alesina and Zeira (2006) state that the presence of stricter labour regulations in Europe impede to reach a 'competitive' level of (skill biased) wage inequality and thus direct inefficiently investments on low skill sectors through labour savings technologies, instead that on high skill industries. The introduction of imperfect information within the neoclassical setting slightly changes the interpretation of the flexibility-innovation relationship. Sticky wages (and eventually rigid firing rules) may improve rather than weaken productivity dynamics due to their potentially positive correlation with workers' effort (Akerlof and Yellen, 1990; Shapiro and Stiglitz, 1984). In this framework, lower job turnover can rise the value of the job for the worker, favouring loyalty, cooperation and reducing the risk of moral hazard. Belot et al. (2007) consider the welfare effect of an endogenous level of employment protection and acknowledge the existence of a trade off between flexibility and worker commitment or effort. According to approaches including market imperfections,

[2]The EPL measures the level of strictness of labor legislation across countries, concerning in particular the cost of dismissing single workers or groups of workers with various type of contracts. For further details, http://www.oecd.org/els/emp/oecdindicatorsofemploymentprotection.htm

[3]New goods with higher volatility.

[4]Improvement of mature goods with lower level of volatility and more stable demand.

stronger labour laws can help overcoming bounded rationality and coordination problems (Williamson et al., 1975). Storm and Naastepad (2007) point out the importance of regulatory complementaries and observe that when labour flexibility increases, the amount of controlling technologies and supervision bureaucracies rises. A contrasting interpretation, however, emerges from the results in Riphahn (2004). Using German data, the author finds that absenteeism - taken as a proxy for workers' effort - is higher in public rather than in private sector explaining such difference with the stronger protections (against dismissals) characterizing public sector's employees. Ichino and Riphahn (2005) extend this reasoning analysing a set of white collars workers hired by a large Italian bank. They find that the incidence of absenteeism is more than doubled after workers were granted of protection in case of dismissal. The relation between job tenure and turnover, on one side, and innovation, on the other, is important also within the endogenous growth theoretical framework (Acemoglu). According to this setting, human capital and technological change are the key growth drivers. However, both are strictly connected to the degree of labour turnover. As Wasmer (2006) explains, (in equilibrium) a stricter EPL - pointing to a greater stability of employment relationships - may spur the accumulation of workers' skills having also a positive feedback on innovation dynamics. Accordingly, a too intense job turnover may weaken firm-specific human capital accumulation impacting negatively on firm productivity and innovation (Acharya et al., 2010). As unintended corroboration, many researchers agree that employees with temporary contracts are less involved in firm-specific training than permanent employees (Arulampalam and Booth, 1998), since longer work relationships encourage employers to provide training (Booth et al., 2002). Even in this case, weaker firm-specific human capital accumulation might impact negatively on firm productivity and innovation

A different perspective is offered by theoretical and empirical analysis building on the evolutionary approach (Nelson and Sidney, 1982). According to this framework, workers are key actors for the development of firms' knowledge base and capabilities. By accumulating process-specific experience and refining (over time) their ability in performing tasks and solving problems, workers contribute to the build-up of their company's capabilities. This is the 'learning process' described by authors as (Freeman, 1989; Nelson, 1993; Lundvall, 1992) which is identified as one of the crucial elements driving economic and technological change. Testing how labour market flexibility affects within-firm learning processes on a panel of Italian firms, Lucidi and Kleinknecht (2009) find that the accumulation of firm-specific knowledge and the adoption of innovation-based competitive strategies are hampered by the presence of highly flexible labour markets. The authors' explanation point to the fact that a strong labour flexibility pushes firms towards strategies based on cost reduction while are less favourable for innovative firms that can better fit with rigid labour markets. This is particularly relevant for firms characterized by a Schumpeter-Mark II routinised regime (Kleinknecht and Naastepad, 2005; Kleinknecht et al., 2009), where the accumulation of tacit knowledge is essential to obtain product and process innovation. Moving along this line, Kleinknecht and Naastepad (2005) find that rising level of turnover - eased by temporary contracts and weak firing restrictions - negatively affects cohesion and trust while spreading moral hazard and opportunistic behaviour. Focusing on institutional heterogeneities, (Estevez-Abe et al., 2001), Kleinknecht and Naastepad (2005) highlight that Anglo Saxon system - traditionally characterized by a more flexible labour market - outperforms the Rhineland model - characterized by more 'rigid' labour markets - in terms of job creation, but is weaker in terms of productivity growth.[5] A strong labour flexibility - associated with a relatively higher probability of being fired - is likely to reduce workers propensity to share their know-how among their colleagues weakening the development of firms-specific knowledge base (Kleinknecht and Naastepad, 2005). At the same time, a strong risk of losing their job may encourage workers to disclose firm specific knowledge to external competitors fuelling a vicious circle with employers scarcely prone to include workers in decisions involving strategic information, on the one hand; and workers not incline to provide strong efforts and to contribute to firm-specific knowledge accumulation, on the other. Furthermore, labour market flexibility may also affect capital-labour relations. The introduction of a strong flexibility might reduce labour relative bargaining power due to the

[5]This kind of comparison is proposed also in the studies based on the 'Varieties of capitalisms' approach (Hall and Soskice, 2001).

employment risk implied by the reduction of protections against layoffs or due to the diffusion of temporary contracts. If such a bargaining power reduction occurs, this may discourage personnel from criticizing managers, eventually favouring wrong management practices ending up damaging the collective process of learning. Dosi et al. (1988) underlines the importance of collective learning in technologies where firms dynamic capabilities depend also on the ability to react actively to the environment. In these productive contexts, the cooperation between employers and employees and the active contribution of the latter to knowledge accumulation is crucial for firms adaptation and resilience to external shocks. In this sense, the dynamic interplay between workers and organizational practices within firms is addressed also in the description of the "innovative enterprise" made by Lazonick (2005).[6] A more recent strand of literature has introduced the concept of employee driven innovation. It consists in innovation promoted by "multi skilling employees", performing job rotation schemes defined as High Performance Work Systems - HPWS - (Leoni, 2012). In this setting, workers do not just represent a production factor as in the human capital framework, but a source of creativity (Amabile, 1988). In support of this hypothesis, empirical works show that practices related to functional flexibility of employees (autonomy, team working, quality circles, suggestion schemes, etc.) are positively related to organizational innovativeness (Michie and Sheehan, 2003; Kleinknecht et al., 2009) whereas they result not to be complementary with numerical flexibility, given the conflict potentially arising between different types of workers (Arvanitis, 2005). As unintended corroboration, many researchers agree that employees with temporary contracts are less involved in firm-specific training than permanent employees (Arulampalam and Booth, 1998), since longer work relationships encourage employers to provide training (Booth et al., 2002). Interestingly, this result is acknowledged also by authors which detect a negative effect of EPL, such as Scarpetta et al. (2002). Finally, another group of contributions close to our approach studies empirically the relationship between numerical flexibility and innovation using, as a proxy for labour flexibility, the use of temporary contracts. Overall, the effects of temporary contracts on innovation and productivity can depend on the reason behind their use, as stressed by Arvanitis (2005). Some scholars admit the presence on non-monotonic consequences of short term contracts according to their relative contractual weight on the total workforce employed in the unit under scrutiny (Altuzarra and Serrano, 2010; Hirsch and Mueller, 2012). Other contributions tend to highlight the persistence of a deterrent impact of temporary employment on innovation dynamics. In a recent paper on Italian firms, Franceschi and Mariani (2015) show that innovation - measured both by the probability of submitting a patent application every year and by the number of applications per year - falls when the share of temporary worker rises. Such result is explained hypothesizing a short term maximization behaviour of firms. A similar result is found by Lucidi and Kleinknecht (2009), where innovation is taken as a hidden determinant of productivity. Overall, the stream of literature investigating the relationship between innovation and labour flexibility is still at an early stage but one stylized fact can be convincingly spelled out: magnitude and direction of the flexibility-innovation nexus depends strongly upon technological characteristics and regimes of firms and industries. Kleinknecht and Naastepad (2005) pioneered these analyses focusing mostly on firms and adopting a 'Schumpeterian' approach. In his studies, Kleinknecht and Naastepad (2005); Kleinknecht et al. (2009, 2014) find that labour market flexibility impacts differently when the prevalent technological regime is a Schumpeter Mark I or Mark II (see the description above). In the first case, innovation occurs at the margin of already existing technologies and the contribution of workers endowed with firm-specific (tacit) knowledge is almost irrelevant for the development of innovation. In the Schumpeter Mark II case, contrarily, this type of knowledge is crucial. Focusing on the introduction of product innovations (the type of innovations that are mostly associated with Schumpeter Mark II regimes), the development of workers creativity building on their on-the-job specific experience turns out to be a key component of the whole process of technological change. In such environments, Kleinknecht

[6] With respect to this, the concept of functional flexibility must be distinguished from numerical and wage flexibility. The former is based on the possibility for workers to assume different roles and responsibilities within the same firm (for a seminal distinction see Beatson, 1995). This internal mobility can facilitate cooperation, increase workers' motivation and enforce trust. Indeed, in a context of incomplete contracts and bounded rationality, employees' participation can facilitate the solution of problems and enhance a trial error learning process (Lorenz, 1999).

et al. (2009) argues, long lasting labour relationships, trust and cooperation between employers and employees are fundamental ingredients to rise firms' innovative performances. These arguments are significantly in line with the hypotheses put forth in the efficiency wage literature (Akerlof and Yellen, 1990). Looking at workers' productivity, the efficiency wage theory hypothesizes that workers' effort is positively correlated with wage levels. Therefore, providing above-market-clearing wages would benefit both parties (i.e. firms and workers) through a productivity-enhancing effect. Overall, work environments protecting workers from uncertainty on job duration and wage levels as well as favouring trust and cooperation in the workplace are expected to push product innovation, particularly in those organizations relying on firm-specific knowledge. Few contributions have explored this linkage at the industry level. Aiming at filling this gap, we explore the flexibility- product innovation nexus looking at manufacturing and services industries in the five major EU economies (France, Germany, Italy, Spain and the Netherlands) adding to this stream of literature in various ways: i) we test whether sectors characterized by a relatively more intense degree of flexibility display an innovation dynamics different from the one observed in the other industries; ii) we verify to what extent the relationships emerging at the aggregate level change when industries are split by technological intensity (medium-high vs low tech industries classified according to the Peneder taxonomy) and regimes (Schumpeter Mark I vs Mark II industries classified according to Kleinknecht et al. (2014)'s taxonomy; iii) we finally investigate how country-level heterogeneities interact with sectors' technological characteristics in shaping the relations under investigation.

3 Data, main variables, and descriptive evidence

3.1 Sources and sample

The empirical analysis carried out to study the flexibility-innovation nexus takes advantage of information drawn from different data sources. We merge information on economic performance - stemming from the WIOD database -, innovative dynamics - drawn from the CIS surveys - and temporary employment - LFS database - on 21 manufacturing and 17 service industries for five European economies (France, Germany, Italy, the Netherlands and Spain) observed over the period 2000-2012. The analysis is carried out at the 2-digit sectoral level according to NACE Rev.1 classification. [7]

Innovation variables stem from four European Community Innovation Surveys (CIS) while economic variables are taken from the World Input Output Database (WIOD) (Timmer et al., 2012). Data on employment and on workers' educational attainment stem from the Eurostat Labour Force Survey (LFS). The country coverage of the database includes five major European countries – Germany, France, Italy, Netherlands and Spain - representing a large part of the European economy. 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 released by national statistical institutes (Bogliacino and Pianta, 2012).

This study is directly related to structural analyses that use industry-level data (Lucchese and Pianta (2012); Bogliacino and Pianta (2012); Guarascio et al. (2015, 2016)). The methodological choice of sectoral data is premised on two principal arguments: i) demand is not a constraint at the firm level, for which business stealing allows firms to grow at the expense of their competitors, but it is downward sloping at the industry level; ii) technological trajectories are only partly captured at the microlevel using proxies of technical change, while industry-level variables internalize, to some extent, the knowledge base and spillovers (Dosi et al. (1988), Malerba (2005)). This kind of industry level-dataset accounts for the complexity of innovation at the sectoral level, as well as for consideration of both supply and demand determinants of economic and innovative performance. Finally, there are different reasons to believe that the impact of temporary employment might not be homogeneous across sectors. Using a panel of industry-level data allows to exploit the cross-country variation as well as

[7] To establish the requisite conditions for comparability, innovation and employment variables taken respectively from CIS6 and LFS have been converted into Nace Rev.1 using the conversion matrix found in Perani and Cirillo (2015).

changes on the impact of policies in different industries - Lisi and Malo (2017).

The database has a panel structure with the following periodization. Innovation variables are drawn from CIS 3 (1998-2000), CIS 4 (2002-2004), CIS 6 (2006-2008) and CIS 8 (2010-2012). Economic variables are computed for the periods 2000-2002, 2004-2006 and 2008-2010. Data on labour contracts (share of temporary employees) and share of workers with university degree refer to the periods 2002, 2006 and 2010. All economic variables are deflated using the sectoral Value Added deflator from WIOD (base year 2000), corrected for PPP (using the index provided in Stapel et al. (2004)).

Following Guarascio et al. (2015) and Cirillo (2016), we compute compound annual growth rates - approximating the difference in log - for all economics variables. For innovation, we use shares (share of firms introducing new products and share of firms introducing both product and process innovations), while the lagged value of expenditure per employee (R&D expenditure) is introduced to proxy technological input. The use of long differences softens variables autoregressive character. Finally, temporary employment is computed as the share of total and young employees (15-34) having a temporary contract in the sector.[8]

3.2 Technological heterogeneity of sectors: the Herfindahl-Hirschmann index and the Peneder taxonomy

The effect of the introduction of temporary employment on technologies might not be homogeneous across sectors. Indeed, sectors display strong differences not only with respect to their production process and technological properties, but also for what concerns the skill level of the workforce employed (Lisi and Malo, 2017). In this article, we build on Kleinknecht and Naastepad (2005) introducing an explicit distinction between two different models of knowledge and accumulation of innovation emphasizing sectoral technological patterns. In detail, we distinguish an 'entrepreneurial' (or garage business) model and a 'routinised' model of innovation. The latter are sometimes called Schumpeter mark I and Schumpeter mark II regimes and the difference between them relates to the properties of the knowledge base required for innovation (Kleinknecht and Naastepad (2005), p.2). While the Schumpeter mark I model - called "garage business innovation" - describes starters in high-tech, niche players in contexts of turbulent competition, creative destruction and frequent market; the "routinised innovation" model proxying a Schumpeter mark II regime features mature firms with professional R&D laboratories often working in context of monopolistic competition, oligopolies where stable hierarchy of dominant innovators persist. The two regimes are also characterised by different properties of the knowledge base accumulation: while in the first regime - Schumpeter mark I - general and generally available knowledge is detected; in Schumpeter mark II model, knowledge is historically accumulated, that is firm specific and idiosyncratic knowledge from experience leading to high entry barriers for competitors. These two different regimes theorised by Schumpeter (1912, 1943) can rely on different types of labour market institutions: on the one hand, Schumpeter mark I industries are more likely to hire through external labour markets, on the other hand Schumpeter mark II models often rely on internal labour markets where insiders are well-protected. In this article, we use as a proxy to distinguish the two different regimes of knowledge accumulation, the degree of concentration of intangible assets. While Kleinknecht et al. (2014) use the amount of R&D expenditure stemming from the Dutch firm-level Community Innovation Survey, we rely on firm-level information from AMADEUS database. AMADEUS contains data on intangible fixed assets on around 21 million companies across Europe. The comparability of enterprises in AMADEUS is permitted thanks to national industry codes. Furthermore, the measure of intangible fixed assets is a valuable proxy for knowledge base characteristics, in fact intangible assets include operational assets that lack physical substance, such as patents, copyrights, trademarks, fran-

[8]It is worth noting that the Eurostat definition of temporary contracts concerns employees with temporary contracts "that declare themselves as having a fixed term employment contract or a job which will terminate if certain objective criteria are met, such as completion of an assignment or return of the employee who was temporarily replaced". As underlined by Lisi and Malo (2017), the Eurostat definition of temporary employment does not allow to distinguish between fixed-term contracts and temporary agency workers.

chises and goodwill. Therefore a measure of concentration of intangible assets can be a valuable proxy for the extent to which an industry is Schumpeter mark I or Schumpeter mark II. As well as in Kleinknecht et al. (2014), we apply as a measure of concentration the Herfindahl–Hirschman index according to formula 1. We have computed at the 2-digit NACE sectoral level the share of intangible assets owned by firm i and therefore the Herfindahl for each sector j according to the standard formula:

$$HHI_j = \sum_{i=1}^{n} s_i^2 \tag{1}$$

where s is the share of fixed intangible assets owned by firm i with respect to all the other firms i operating in the same sector j. In other words, every industry receives a value on a continuous scale between 0 (perfect dispersion of intangible assets) and 1 (perfect concentration of intangible assets). Values closer to zero indicate a Schumpeter I garage business model; values closer to 1 indicate a Schumpeter II model in which dominant innovators have erected strong entry barriers thanks to their historical accumulation of (tacit) knowledge. In order to check the consistency of the measure adopted, we show in table 1 the ranking of sectors according to the highest score of concentration in intangible assets. Sectors registering the highest scores of concentration across countries do not vary which is quite reasonable considering the economic structure of countries in the analysis.

Table 1: High-concentrated sectors by country

Country	Macro sector	NACE 2 digit sector	Herfindal Index
Germany	Manufacturing	Basic metals	0.87
		Rubber and plastic products	0.85
		Other non-metallic mineral products	0.80
	Services	Air transport	1.00
		Post and telecommunications	0.87
		Activities related to financial intermediation	0.68
Spain	Manufacturing	Other non-metallic mineral products	0.75
		Coke, refined petroleum products and nuclear fuel	0.56
		Food products and beveradges	0.32
	Services	Air transport	0.48
		Supporting and auxiliary transport activities	0.37
		Other business activities	0.32
France	Manufacturing	Rubber and plastic products	0.52
		Manufacturing NEC	0.52
		Coke, refined petroleum products and nuclear fuel	0.32
	Services	Post and telecommunications	0.94
		Air transport	0.66
		Land transport and transport via pipelines	0.49
Italy	Manufacturing	Other non-metallic mineral products	0.39
		Basic metals	0.37
		Other transport equipment	0.33
	Services	Post and telecommunications	0.86
		Air transport	0.59
		Water transport	0.34
Netherlands	Manufacturing	Other transport equipment	0.99
		Electrical machinery and apparatus n.e.c	0.90
		Fabricated metal products	0.86
	Services	Air transport	0.93
		Post and telecommunications	0.90
		Computer and related activities	0.59

The Herfindahl index built on intangible fixed assets is strongly correlated - at 5% of significance level - with the share of firms introducing innovations (0.21*) and product innovations (0.22*), while it correlates by only 0.07 (not significant) with the amount of R&D expenditure per employee. Indeed, the degree of concentration of intangible assets is higher in larger firms - we detect a positive correlation by 0.11 significant at the 5% -, such correlation is even stronger in manufacturing firms (0.13*).

As alternatively measure applied in this study to distinguish technological intensity of sectors is the Peneder classification as presented in Peneder (2010) where sectors are characterised by a variety of firms' features such as the Schumpeter's distinction between 'creative' and 'adaptive response', technological opportunities, appropri-

ability conditions and cumulativeness of knowledge. Sectors are classified according to the prevailing behaviour of firms in terms of creative versus adaptive knowledge generation, intramural versus external acquisition of R&D, appropriability conditions such as patents and other formal and strategic methods and, indeed, cumulativeness of knowledge - in so-called creative firms internal sources of innovation are more or equally important than external sources, while in adaptive firms, external sources prevail. In this analysis, we focus on high and med-high technological sectors collapsing the five-original Peneder classification in two broader groups: the high and med-high technological sectors and the others. The ranking of sectors in terms of innovation expenditures and Peneder categories - see 1 - is confirmed even collapsing the five clusterisation in two groups. [9] The detailed list of sectors according to Peneder classification is shown in table 7 in the Appendix.

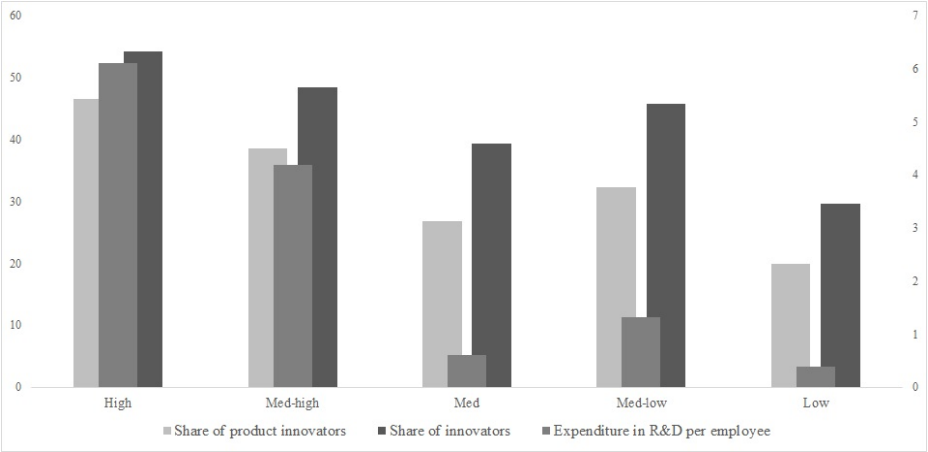

Figure 1: Share of product innovators, innovators and expenditure in R&D by Peneder group

It is worth noting that in this work we cluster sectors according to technological features provided by Schumpeter and Peneder characterizations. From this point of view, our approach differs from Lisi and Malo (2017) that classify sectors on the basis of employees' characteristics - such as the share of workers with a tertiary education or the share of workers performing science and technology tasks. Without disregarding such election, we classify sectors according to their technological characteristics expressed by firms' features more than workers' educational or skill profiles.

3.3 Main variables and descriptive evidence

This section contains the description of the main variables used in the analysis - see table 2. The innovative output is proxied by the share of firms introducing products new to the firm and to the market.[10] The latter is studied focusing on its relationship with innovation input – captured by R&D expenditure per employee; market structure – average firm size; economic dynamics – change of sectoral value added; technological intensity of sectors - proxied by Peneder classification or alternatively by the Herfindahl index built on firms' intangible assets; and labour market institutions – share of temporary contracts (both total and of 15-34 years old workers).[11] Innovation variables stem from the Community Innovation Survey - Eurostat -, while labour market variables are drawn from the European Labour Survey - EU LFS - and economic variables from the OECD-STAN database. As detailed above, the Herfindahl index is built on AMADEUS firm level data.

[9] The two groups of sectors - namely high and med-high tech versus med-low and low-tech sectors in the Peneder classification show statistically significant differences in the mean values of innovations, product innovations and expenditure in R&D per employee. In detail, the share of innovating firms in high and med-high tech sectors accounts for 51% while it registers 35% in the low-tech group. Focusing on product innovators, the share of firms declaring to introduce product innovations is about 42% in high-tech sectors and 24% in low-tech ones. Finally, we register a sharp difference in mean for the amount of expenditure in R&D per employee accounting for only 0.6 thousands of euro in low-tech sectors while it is about 5.1 in high and med-high tech sectors.

[10] In the Appendix, we perform the same test using as innovative output the share of firms introducing both product and process innovations.

[11] In the Appendix we show descriptive statistics for the main variables - see 6.

Table 2: Main variables

Variable	Description	Unit	Source	Period covered
New products	Share of firms introducing a product new to them and to the market	Share	CIS	1998-2012
New products and processes	Share of firms introducing products and processes new to them and to the market	Share	CIS	1998-2012
R&D	Sectoral R&D expenditure per employee	Thousands euro per employee	CIS	1998-2012
Firm size	Average number of employees in firms	Absolute value	CIS	1998-2012
Value added	Sectoral value added	Compound rate of change	WIOD	2000-2012
Share of temporary employees	Share of temporary employees over total employees	Share	LFS	2002-2010
Share of temporary employees (15-34 years)	Share of temporary employees (15-34) over total employees	Share	LFS	2002-2010
Herfindahl index	Herfindahl index on firm value intangible assets	Index	AMADEUS	2002-2010
Peneder classification	Peneder classification for Med-high teh sectors	Dummy variable	Peneder (2010)	time invariant

3.4 Descriptive evidence

In what follows we provide a preliminary descriptive picture of the main variables used in the analysis focusing on the relationship between the share of temporary employees in the sector and the technological intensity proxied both by the Peneder classification and the Herfindahl index. Figure 2 highlights heterogeneity in the distribution of temporary contracts across countries and sectors combining two possible dimensions of heterogeneity. The first one concerns the institutional setting of each country. For instance, Spain registers the highest shares of temporary employment - almost the double compared to Germany, France, Italy and Netherlands. This is verified across all Spanish sectors. A further measure of heterogeneity is related to the technological intensity of sectors classified according to Peneder in high, med-high, med-low and low tech sectors. In almost all countries, a sort of polarization effect emerges with high shares of temporary employment both in high tech and low tech sectors remarking the existence of two kind of "precariousness"; the one related to high-tech sectors concerning tertiary educated workers with university degree and managerial positions, the other concentrated in low-tech sectors and often concerning low-skilled jobs. As underlined in Broughton et al. (2016), on a sectoral basis it is important to note that the share of different types of contract varies by the economic activity of the employer. Full-time, permanent contracts are lowest in agriculture, fishery and forestry and other services and highest in manufacturing and non- manufacturing industries. This type of contracting is also high in public administration and education. Such pattern of polarization of temporary jobs in high and low tech sectors is quite evident in Germany, Spain and Italy. However, the share of temporary jobs in high-tech sectors prevails on temporary jobs in low-tech sectors in Germany, while the opposite pattern is detected in Spain and Italy, where the share of employees covered by short-term contracts prevails in low-tech industries. In France and Netherlands, the majority of temporary jobs are detected in med-low and low-tech industries. The coexistence of two typologies of temporary employment emerging from figure 2 opens the debate on the differentiated effects that "precariousness" can have on innovation output in different industries. Indeed, different reasons can be found to this outcome, some attaining to the specificities of each country, others to the different types of temporary contracts observable in these advanced sectors, where a certain degree of labour mobility can be also related to workers professional decisions, instead of representing a "strategic" decisions of firms to reduce labour costs.

Figure 3 focuses on the relationship between the share of temporary employees in the sector and the share of firms declaring to introduce product innovations. In detail, the scatter plot allows to distinguish between countries and macro-sectors according to the Peneder classification as well as the degree of concentration of intangible assets expressed by the Herfindahl index - which is proxied by the dimension of bubbles. First, a general negative relationship can be detected between the two dimensions; high and med high tech sectors show on average a higher share of product innovating firms and lower shares of temporary jobs. However, this holds particularly for Germany and the Netherlands. Conversely, in Spain, even high and med-high tech sectors register on average a percentage of temporary employees higher than 20%.

The industries located in Central-Northern Europe - Germany, France and the Netherlands - display a significantly larger share of product innovators, while Southern European industries - in Spain and Italy - outpace Central Northern ones in terms of diffusion of temporary contracts. The average share of temporary contracts over the total is, respectively, of the 16.25% and of the 11.12%.

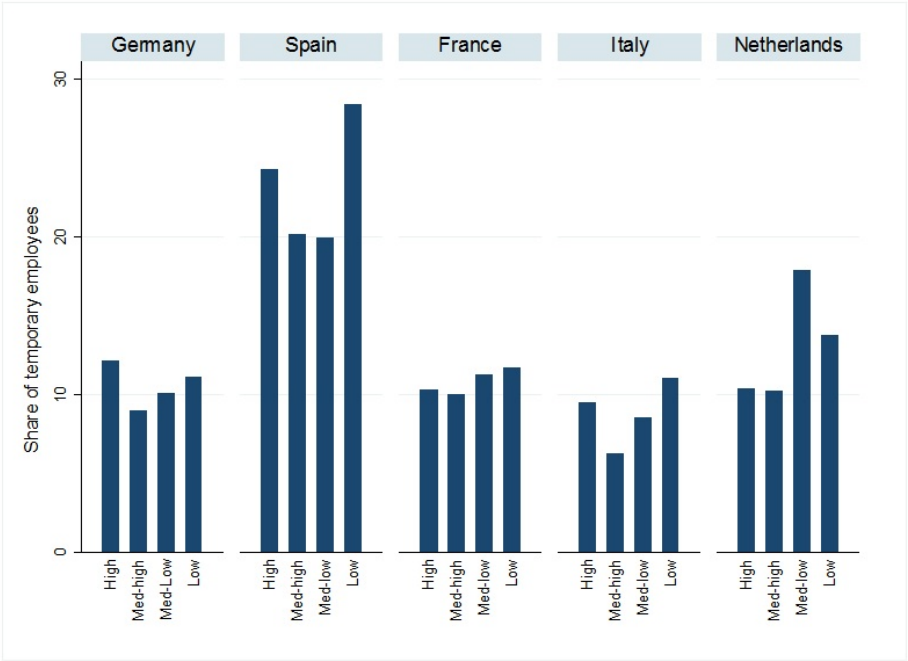

Figure 2: Share of temporary employment by technological sector and country

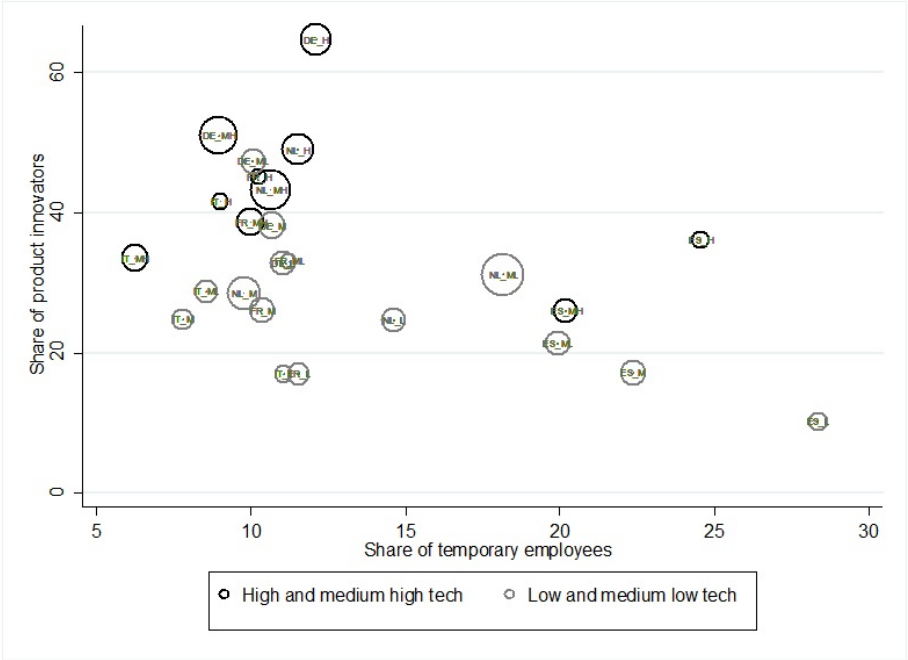

Figure 3: Temporary employment and product innovators by technological group

The evidence reported in this section offers a number of insights. Two major levels of heterogeneity in the distribution of temporary jobs should be detected. At the country level, a high degree of heterogeneity across countries should be recognized - Spain among Southern countries is by far the country with the highest percentages of temporary jobs. However, the distribution of temporary contracts also differs across sectors. In some countries - Germany, Spain and Italy - a pattern of polarization in temporary jobs emerges. In detail, both high and low tech sectors register higher percentage of temporary employment compared to med-high and med-low technological sectors. Furthermore, it seems that more concentrated sectors - see the Herfindahl index on intangible assets - register on average higher percentage of innovators and lower percentages of temporary jobs. Overall, a general negative relationship emerges between the share of temporary work in the sector and the share of product innovators. This relationship holds both across sectors and countries. However - as said - a major degree of heterogeneity should be registered at the country level and by technological group. Central-Northern European industries outperform Southern ones in terms of both input (R&D expenditure) and output of innovation (new products). This element confirms previous findings in Guarascio et al. (2015). The relative weight of temporary contracts - a proxy of the degree of flexibility of the labour market - is by far larger in the South than in the Central-North Europe. The joint consideration of these evidences sheds lights on the structural divergence of the two areas concerning both innovativeness and labour market configurations. The econometric analysis that follows aims to test whether differences in labour contracts distribution help explain such divergent dynamics in terms of innovation.

4 Econometric strategy and results

4.1 Empirical strategy

The aim of this work is to empirically investigate the relationship between the share of temporary jobs and the dynamics of innovations taking into account sectoral technological patterns and institutional settings expressed by national labour market policies. The relationship we estimate is expressed by the following equation:

$$ShareofProdInnov_{ijt} = b_0 + b_1\,\mathrm{ShareTemp}_{ijt} + b_2\,\mathrm{Tech}_{ijt} + b_3\,\mathrm{ShareTemp}_{ijt} * \mathrm{Tech}_{ijt} + b_4\,\mathrm{X}_{ijt} + b_5\,\mathrm{Z}_{ijt} + b_6\,\mathrm{EPL}_{jt} + \epsilon_{ijt} \quad (2)$$

where the share of firms introducing product innovations $ShareofProdinnov_{ijt}$ of sector i in time t and country j is regressed against the share of employees with temporary contracts $ShareTemp_{ijt}$ and a set of employee-level characteristics $\boldsymbol{X}_{ijt}$ (share of employees with University degree), a set of sector variables $\mathrm{Z}_i jt$ (value added growth, lagged expenditure per employee in R&D) and the EPL - *Employment Protection Index* which only varies by country over time. In order to explicitly consider the heterogeneity of sectoral patterns, we introduce a proxy of technological intensity $Tech_{jit}$ - taking alternatively the value of a dummy according to the Peneder grouping (where 1 corresponds to High and Med-tech sectors and 0 to Low-tech sectors) or a continuous value such as the Herfindahl index built on firms' intangible asset values. The introduction of the interaction term in the econometric specification allows to explicitly consider the interacted effect of temporary jobs and technological intensity on product innovations.

The design of the time structure is a crucial element of our empirical strategy. As argued, we rely on long lags to account for variables persistency as well as to get rid of the time invariant part. To address endogeneity issues, we use all regressors at their first lag – in the case of variables expressed in shares, we use the first year of the period. In this way, risks of simultaneity related to endogeneity are considerably reduced and estimation consistency significantly strengthened.

4.2 Results

In table 3 we test different specifications of model 2. In all the regressions, the variable indicating the share of temporary workers always shows a negative and statistically significant coefficient suggesting that, on average and holding other factors constant, a higher share of temporary employment is more correlated with less innovative sectors (where the share of firms introducing product innovation is lower). More specifically, in regression (2) of 3 we introduce the institutional variable EPL that indicates the level of rigidity in the labour market. This variable changes across countries and for each country is sector invariant. It always displays a positive and significant coefficient, suggesting that more labour protection can be correlated with a higher number of innovative firms. In regressions (3) and (4) of 3 we add a technological specification, respectively using the Peneder classification and the Herfindahl index. In the first case, we observe that the estimated coefficient for the dummy of "high and intermediate to high innovative" sectors is significant and positive. This implies that on average, the number of firms introducing product innovation will be higher in more technologically advanced sectors. A similar outcome is obtained in regression (4), where we use the Herfindahl index. Also in this case, we find a positive and significant coefficient. It suggests that as the concentration increases, also the share of firms innovating over the total in each sector is expected to rise. These results are quite in line with our previous reasoning on the role of knowledge and technological regimes. Still an interesting issue would be to investigate the presence of a differentiated impact of employment according to the innovation intensity in the sector under study. This is done introducing a new variable where we interact the share of temporary workers with the technological dummy. However, in this case we find two different results. In the case of regression (5) where we use the Peneder dummy, the interaction term presents a negative and statically significant coefficient. This confirms our hypothesis according to which precarious jobs can have more deterrent impact on highly innovative sectors where knowledge is accumulated tacitly and embodied in organisational routines and workers' abilities. On the other hand, when we consider the interaction with the Herfindahl index in regression (6), we get a negative coefficient but not statistically significant different from zero. Focusing on control variables, we observe that R&D expenditure's coefficient is always positive and significant. This is consistent with standard theories according to which R&D is an important input for innovation. Furthermore, regarding the role of human capital, we can see that the coefficient for the share of high educated workers is always significant and positive (apart for regression (1)). The sign of the coefficient confirms the positive role that education has on innovation.

The same econometric procedure is followed in table 4 where we focus only on young temporary employment (15-34 years old). This share is computed over the total level of young employment at sectoral level and provides a measure of the degree of precariousness among the young workers, whereas we avoid considering the share of young temporary workers over the total level of employment. We are convinced that taking the former indicator will make it possible to disentangle two different forces at stage and to focus on the one we are interested in. Indeed, we would like to consider the role played by temporary young workers on innovation and to control for the indirect effects played by specific employment dynamics at sectoral level, possibly reflected in the age composition of the workforce and in the relative weight of young new workers on the total labor force. Nevertheless, we consider fundamental to account for the cohort 15-34, given that it has been mostly affected by labour market changes in terms of entrance and exit conditions. In this case, we find similar but not exactly equal results. First, the coefficient of the share of temporary employment is always negative and overall significantly different from zero (apart from regressions (5) and (7)). The EPL variable shows also in this case a positive and significantly different from zero coefficient. The technological dummy represented with the Peneder classification is always positive and different from zero, confirming the results observed in table 3. The Herfindahl index is always positive but loses significance in regression (6), where we introduce the interaction term. Furthermore, the two interaction terms in regressions (5) and (6) are both not significant. At last, in table 5 we change the dependent variable and we consider the share of firms declaring to have introduced both

product and process innovation (consistently with CIS database). We perform this further set of regressions to check if our results were sensibly related to the type of dependent variable chosen. Our fundamental findings are reinforced. Indeed, the estimated coefficient for temporary workers is always negative and significantly different from zero; the two variables representing the technological and innovation intensity always exhibit positive and significantly different from zero coefficients. In the Appendix, we present additionally another table where, instead of using directly the EPL, we control for the institutional setting of different countries weighting the level of employment by the EPL index. Our objective is to consider the specific case of countries, like Spain, where the overall index is already low. In this case, the share of temporary workers is not able to fully capture the concentration of precarious jobs. The weighted procedure allows to correct partially this problem. Also in this case, we get similar and even stronger results for all the main variables investigated.

Table 3: Share of temporary employees and innovation (I)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Share of firms introducing product innovations							
Average firm size (lagged)	-2.154	-1.640	-2.934	-3.354	-3.382	-3.738	-3.676*	-3.748
	(-1.20)	(-0.87)	(-1.75)	(-1.61)	(-1.89)	(-1.73)	(-1.98)	(-1.72)
Expenditure in R&D per employee (lagged)	2.203***	2.087***	1.386***	2.044***	1.352***	2.029***	1.247***	2.025***
	(8.69)	(8.84)	(5.78)	(8.86)	(5.67)	(8.82)	(4.87)	(8.45)
Rate of change of Value Added	0.0702	-0.0832	0.0483	-0.0943	0.0503	-0.0815	0.0698	-0.0806
	(0.46)	(-0.57)	(0.35)	(-0.57)	(0.37)	(-0.50)	(0.52)	(-0.49)
Share of workers with tertiary education	0.119	0.189**	0.140**	0.177**	0.160**	0.185**	0.130*	0.183**
	(1.82)	(2.92)	(2.62)	(2.65)	(3.01)	(2.80)	(2.49)	(2.81)
Share of workers with temporary contracts	-0.909***	-0.763***	-0.597***	-0.779***	-0.488**	-0.615**	-0.438**	-0.613**
	(-6.02)	(-5.43)	(-4.64)	(-5.40)	(-3.29)	(-2.98)	(-2.92)	(-2.97)
Employment Protection Index		16.77***	16.43***	13.23***	16.40***	13.69***	14.28***	13.57***
		(5.34)	(5.97)	(3.85)	(5.93)	(3.99)	(5.01)	(3.83)
High innovation intensity			12.67***		18.54***		19.12***	
			(6.18)		(4.45)		(4.64)	
Herfindahl index				11.23**		18.34*		18.31*
				(2.67)		(2.19)		(2.18)
High innovation intensity*Share of temporary employees					-0.522*		-0.513*	
					(-2.07)		(-2.08)	
Herfindahl index*Share of temporary employees						-0.668		-0.667
						(-1.08)		(-1.08)
Southern Europe							-3.140	-0.182
							(-1.51)	(-0.08)
2006	7.756**	4.540	4.482	4.741	4.459	4.410	4.744*	4.426
	(2.75)	(1.68)	(1.84)	(1.75)	(1.85)	(1.63)	(2.04)	(1.66)
2010	-0.607	-4.298	-3.672	-4.419	-3.689	-4.691	-3.457	-4.679
	(-0.21)	(-1.56)	(-1.44)	(-1.53)	(-1.45)	(-1.62)	(-1.42)	(-1.64)
Constant	33.36***	23.29***	19.48***	23.35***	17.79***	21.51***	20.16***	21.66***
	(10.58)	(6.78)	(6.08)	(6.84)	(5.26)	(5.72)	(5.33)	(4.92)
N	377	377	377	358	377	358	377	358
	t statistics in parentheses							
	* p<0.05, ** p<0.01, *** p<0.001							

Table 4: Share of temporary employees and innovation (II)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Share of firms introducing product innovations							
Average firm size (lagged)	-1.245	-0.909	-2.477	-2.583	-2.578	-3.047	-3.115	-3.187
	(-0.74)	(-0.50)	(-1.53)	(-1.27)	(-1.60)	(-1.43)	(-1.77)	(-1.46)
Expenditure in R&D per employee (lagged)	2.460***	2.264***	1.468***	2.226***	1.478***	2.211***	1.307***	2.159***
	(9.17)	(9.34)	(5.97)	(9.34)	(6.03)	(9.29)	(5.00)	(8.64)
Rate of change of Value Added	0.0998	-0.0995	0.0458	-0.116	0.0404	-0.106	0.0670	-0.0966
	(0.64)	(-0.65)	(0.33)	(-0.68)	(0.29)	(-0.62)	(0.49)	(-0.57)
Share of workers with tertiary education	0.0588	0.169*	0.121*	0.157*	0.127*	0.160*	0.0877	0.144*
	(0.88)	(2.58)	(2.29)	(2.31)	(2.43)	(2.37)	(1.71)	(2.17)
Share of temporary employees (15-34)	-0.266*	-0.348***	-0.271**	-0.369***	-0.199	-0.271*	-0.201	-0.282*
	(-2.29)	(-3.45)	(-2.95)	(-3.57)	(-1.71)	(-1.97)	(-1.79)	(-2.07)
Employment Protection Index		20.20***	19.05***	16.86***	19.10***	17.12***	15.60***	15.60***
		(6.12)	(6.78)	(4.70)	(6.75)	(4.75)	(5.33)	(4.22)
High innovation intensity			13.64***		18.31***		19.08***	
			(6.50)		(3.83)		(4.13)	
High innovation intensity *Share of temporary employees (15-34)					-0.202		-0.199	
					(-1.17)		(-1.22)	
Herfindahl index				11.07**		23.20		22.01
				(2.60)		(1.71)		(1.62)
Herfindahl index*Share of temporary employees (15-34)						-0.499		-0.455
						(-0.97)		(-0.89)
Southern Europe							-4.775*	-2.121
							(-2.33)	(-0.94)
2006	7.110*	4.045	4.119	4.326	4.087	4.288	4.737	4.566
	(2.34)	(1.39)	(1.58)	(1.46)	(1.57)	(1.45)	(1.94)	(1.60)
2010	0.500	-3.632	-3.097	-3.696	-3.126	-3.728	-2.725	-3.551
	(0.16)	(-1.22)	(-1.13)	(-1.18)	(-1.15)	(-1.19)	(-1.07)	(-1.17)
Constant	28.83***	20.05***	16.79***	20.27***	14.94***	17.96***	19.52***	20.29***
	(8.24)	(5.81)	(5.42)	(5.95)	(4.18)	(4.52)	(4.89)	(4.34)
N	379	379	379	360	379	360	379	360

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 5: Share of temporary employees and innovation (III)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Share of firms introducing innovations							
Average firm size (lagged)	-1.314	-0.412	-1.488	-1.631	-1.615	-2.062	-1.926	-2.113
	(-0.84)	(-0.29)	(-1.17)	(-1.00)	(-1.24)	(-1.21)	(-1.38)	(-1.22)
Expenditure in R&D per employee (lagged)	2.060***	1.853***	1.244***	1.856***	1.235***	1.838***	1.126***	1.819***
	(7.59)	(9.28)	(6.82)	(9.11)	(6.69)	(9.02)	(5.57)	(8.45)
Rate of change of Value Added	-0.0241	-0.273	-0.176	-0.275	-0.176	-0.262	-0.159	-0.258
	(-0.15)	(-1.88)	(-1.20)	(-1.75)	(-1.19)	(-1.65)	(-1.08)	(-1.63)
Share of workers with tertiary education	0.0491	0.175**	0.139*	0.158*	0.145*	0.166*	0.113	0.158*
	(0.68)	(2.71)	(2.42)	(2.38)	(2.43)	(2.54)	(1.81)	(2.40)
Share of temporary employees	-1.033***	-0.771***	-0.636***	-0.774***	-0.604***	-0.590**	-0.554**	-0.580**
	(-6.48)	(-5.39)	(-4.62)	(-5.30)	(-3.73)	(-2.85)	(-3.29)	(-2.79)
Employment Protection Index		30.41***	30.28***	27.41***	30.27***	27.92***	27.99***	27.32***
		(8.34)	(9.05)	(6.68)	(9.01)	(6.74)	(8.11)	(6.51)
High innovation intensity			10.89***		12.56***		13.14***	
			(5.73)		(3.32)		(3.47)	
Herfindahl index				7.965*		15.96*		15.80*
				(1.98)		(2.08)		(2.04)
High innovation intensity*Share of temporary employees					-0.150		-0.142	
					(-0.59)		(-0.56)	
Herfindahl index*Share of temporary employees						-0.751		-0.744
						(-1.29)		(-1.29)
Southern Europe							-3.302	-0.894
							(-1.66)	(-0.43)
2006	6.697*	0.791	0.852	1.105	0.845	0.728	1.118	0.798
	(2.18)	(0.30)	(0.36)	(0.42)	(0.35)	(0.27)	(0.48)	(0.30)
2010	1.586	-4.838	-4.328	-4.702	-4.341	-5.005	-4.098	-4.943
	(0.52)	(-1.71)	(-1.63)	(-1.59)	(-1.63)	(-1.70)	(-1.60)	(-1.71)
Constant	49.42***	31.11***	27.70***	31.18***	27.22***	29.13***	29.80***	29.90***
	(16.11)	(9.02)	(8.40)	(8.98)	(7.51)	(7.57)	(7.37)	(6.65)
N	385	385	385	364	385	364	385	364
	t statistics in parentheses							
	* p<0.05, ** p<0.01, *** p<0.001							

5 Conclusions

During the last decade, European labour markets have registered a sharp increase of precarious jobs, mainly in terms of temporary contracts, which has come along with a general weakening of technological intensity of sectors at least in some countries. The necessity of providing to firms a more flexible labour force, a less rigid regulation and lower dismissals economic costs, has massively dominated both political debates and economic researches at national and international level, such that it is possible to recognize a pressure towards *one size fits for all* policy for almost all countries showing high unemployment rates and low innovation growth. Heterogeneous results obtained from a theoretical and empirical perspective, make compelling to proceed in a different way, which is accounting for a wide range of factors, regarding distinct institutional settings, relative technological advantages acquired through time, infrastructures development, human capital and industrial structure. The existing intense debate on the relationship between labour market rigidities and innovation outcomes has not reached a uniform consensus, at least focusing on empirical results. Indeed, different models relying on a variety of theoretical approaches offer different conclusions validating dissimilar empirical strategies. The majority of studies produced on this debate has disregarded the sectoral dimension neglecting the technological patterns of sectors and their interrelations with workers' skills and competencies. The aim of this paper was to investigate the impact of the significant growth in temporary employment recorded in the last two decades on innovative capabilities of European industries explicitly taking into account the technological features of sectors shaping different modalities of technology generation and depicting different models of business competition – proxied in this literature by Schumpeter mark I and Schumpeter mark II models. For this reason, we have proceeded through a sectoral analysis of five European countries (Germany, The Netherlands, France, Italy and Spain) over the period 2000-2012, in order to test how the share of temporary employment affected the share of firms introducing product innovation in each industry. Indeed, an analysis at sectoral level allowed us to distinguish technological patterns and knowledge accumulation regimes, especially through the use of Peneder classification and Herfindahl index. We reach three main conclusions. First, a general negative relation between flexible workforce within industries and innovation outcomes emerges. Industries with higher concentration of precarious workers show on average lower performance in terms of product and process innovations adopted. Second, sectoral technological patterns matter. The negative relation between temporary employment and innovation performances is even stronger in high-tech industries (proxied by the Peneder classification). Third, the adoption of tout court flexibilization policies appears to have increased divergence instead of promoting convergence across sectors of European countries. As a matter of fact, one aspect which is usually neglected in mainstream approaches dealing with labour market regulation, is the understanding of how firms' incentives and organizational capabilities react to "structural reforms" and whether adverse changes may influence future outlooks and long-term performances, leading to outcomes opposite to the ones originally pursued.

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A Appendix

Table 6: Descriptive statistics by main variables

	mean	sd	min	max
Share of temporary workers	13.27	8.70	1.79	70.02
Share of temporary workers (15-34 years old)	24.87	11.37	4.42	71.87
New products	32.92	18.63	0.07	93.40
New products and processes	44.02	18.64	0.25	94.56
Average firm size	0.28	0.82	0.00	12.93
Share of workers with tertiary education	23.60	17.17	0.80	86.25
Rate of change of Value Added	0.89	7.91	-42.94	46.91
R&D per employee	2.76	4.83	0.00	33.17
Herfindahl index	0.27	0.26	0.00	1.00
N		760		

Table 7: Sectors by Peneder classification

Sectors	**Peneder classification**
Food products, beverages	Med-low
Tobacco products	Med-low
Textiles	Med-high
Wearing apparel	Low
Leather, -products, footwear	Low
Wood, -products, cork	Med
Pulp/paper, -products	Med
Publishing, reproduction	Med-low
Ref. petroleum, nucl. fuel	Med-high
Chemicals	Med-high
Rubber and plastics	Med-high
Mineral products	Med-high
Basic metals	Med-high
Fabricated metal products	Med
Machinery, nec.	High
Computers, office machinery	High
Electrical equipment, nec.	High
Communication technology	High
Precision instruments	High
Motor vehicles	Med-high
Other transport equipment	Med-high
Manufacturing nec.	Med
Recycling	Low
Electricity and gas	Med-low
Water supply	Med-low
Wholesale trade	Low
Land transport, pipelines	Low
Water transport	Low
Air transport	Med
Auxiliary transport services	Low
Post, telecommunications	Med-high
Financial intermediation	Med
Insurance, pension funding	Med-low
Auxiliary financial services	Low
Computer services	High
Research and development	High
Other business services	Med

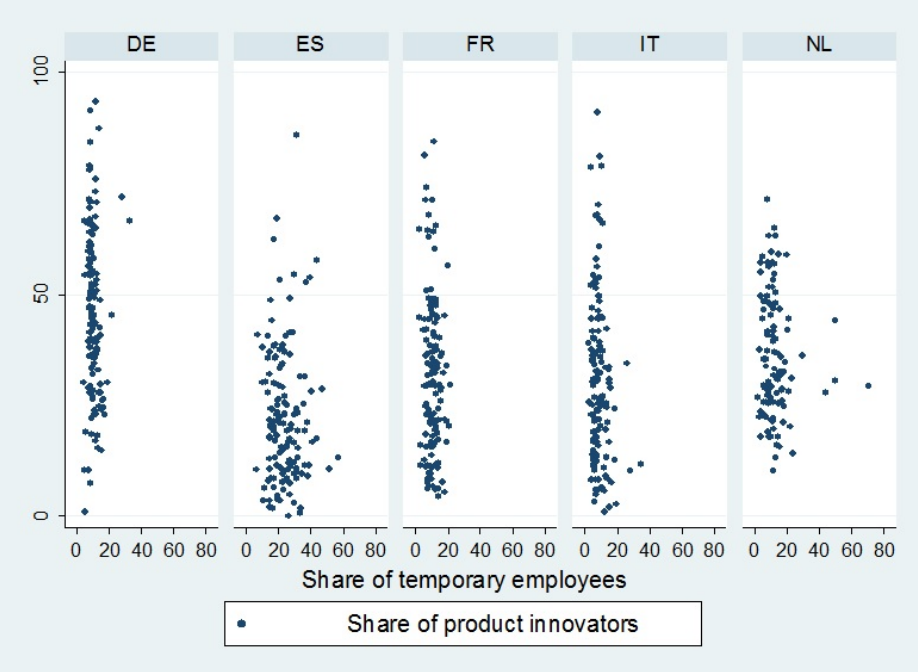

Figure 4: Product innovators and temporary employment by time

Table 8: Share of temporary employment (weighted) and innovation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Share of firms introducing product innovations						
Average firm size (lagged)	-1.721	-3.080	-3.408	-3.480	-3.308	-3.860*	-3.332
	(-0.98)	(-1.92)	(-1.75)	(-1.96)	(-1.71)	(-2.06)	(-1.70)
Expenditure in R&D per employee (lagged)	2.118***	1.433***	2.077***	1.378***	2.036***	1.215***	2.016***
	(9.18)	(6.05)	(9.23)	(5.95)	(9.14)	(4.93)	(8.71)
Rate of change of Value Added	-0.0632	0.0719	-0.0917	0.0727	-0.0607	0.0862	-0.0609
	(-0.43)	(0.52)	(-0.57)	(0.53)	(-0.38)	(0.66)	(-0.38)
Share of workers with tertiary education	0.219***	0.168**	0.211**	0.187***	0.212**	0.147**	0.204**
	(3.40)	(3.17)	(3.18)	(3.50)	(3.23)	(2.81)	(3.15)
Share of temporary employees (weighted)	-0.337***	-0.300***	-0.311***	-0.255***	-0.236***	-0.221***	-0.232***
	(-9.39)	(-9.49)	(-8.45)	(-7.29)	(-4.51)	(-6.25)	(-4.55)
High innovation intensity		12.18***		16.92***		17.79***	
		(6.02)		(5.35)		(5.73)	
Herfindahl index			11.86**		18.62***		18.12**
			(3.17)		(3.48)		(3.24)
High innovation intensity*Share temporary employees				-0.172**		-0.169**	
				(-2.80)		(-2.80)	
Herfindahl index*Share temporary employees					-0.339*		-0.327*
					(-2.30)		(-2.12)
Southern countries						-4.448*	-0.915
						(-2.29)	(-0.44)
2006	6.097*	6.300**	5.585*	6.003*	5.247*	6.018**	5.266*
	(2.34)	(2.67)	(2.18)	(2.56)	(2.05)	(2.62)	(2.06)
2010	-2.950	-2.159	-3.731	-2.446	-3.947	-2.536	-3.956
	(-1.12)	(-0.88)	(-1.39)	(-1.00)	(-1.47)	(-1.08)	(-1.48)
Constant	31.57***	28.56***	28.95***	27.10***	27.43***	28.87***	27.95***
	(11.95)	(11.14)	(9.78)	(10.24)	(8.70)	(10.64)	(7.77)
N	377	377	358	377	358	377	358

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 9: Share of temporary employees (15-34) (weighted) and innovation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Share of firms introducing product innovations						
Average firm size (lagged)	-1.021	-2.557	-2.819	-2.659	-2.290	-3.284	-2.443
	(-0.57)	(-1.59)	(-1.42)	(-1.58)	(-1.17)	(-1.78)	(-1.20)
Expenditure in R&D per employee (lagged)	2.316***	1.556***	2.259***	1.542***	2.204***	1.289***	2.134***
	(9.83)	(6.49)	(9.83)	(6.48)	(9.63)	(5.15)	(8.92)
Rate of change of Value Added	-0.0979	0.0464	-0.128	0.0504	-0.0953	0.0640	-0.0991
	(-0.64)	(0.32)	(-0.76)	(0.36)	(-0.58)	(0.48)	(-0.61)
Share of workers with tertiary education	0.209**	0.160**	0.200**	0.162**	0.191**	0.116*	0.173**
	(3.28)	(3.08)	(3.02)	(3.14)	(2.88)	(2.29)	(2.67)
Share of temporary employees (15-34)	-0.205***	-0.185***	-0.187***	-0.158***	-0.135***	-0.135***	-0.135***
	(-8.36)	(-8.83)	(-7.42)	(-6.08)	(-4.04)	(-5.34)	(-4.02)
High innovation intensity		13.02***		16.77***		18.17***	
		(6.28)		(4.82)		(5.41)	
Herfindahl index			12.35**		22.22***		19.98**
			(3.30)		(3.44)		(2.92)
High innovation intensity*Share of temporary employees (15-34)				-0.0697		-0.0744	
				(-1.73)		(-1.92)	
Herfindahl index*Share of temporary employees (15-34)					-0.232*		-0.200
					(-2.24)		(-1.86)
Southern Europe						-6.236**	-2.750
						(-3.22)	(-1.27)
2006	6.078*	6.304*	5.579*	6.139*	5.348*	6.151**	5.409*
	(2.20)	(2.56)	(2.06)	(2.49)	(1.97)	(2.59)	(2.02)
2010	-1.943	-1.229	-2.840	-1.343	-2.907	-1.712	-3.030
	(-0.70)	(-0.49)	(-1.02)	(-0.53)	(-1.04)	(-0.72)	(-1.09)
Constant	32.01***	28.93***	29.18***	27.52***	27.01***	30.15***	28.83***
	(11.16)	(10.61)	(9.16)	(9.45)	(7.92)	(10.49)	(7.35)
N	379	379	360	379	360	379	360

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001