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Abstract

The interplay between organization practices and innovation is highly relevant in modern business. This paper analyses whether a specific organizational dimension, namely workforce agility, affects innovative performance. We rationalize this effect within an organizational economics perspective that stresses the role of behavioural motives and human attitudes in the innovation process. In particular, we distinguish the contribution of two components: time agility and task agility. For both of them, we hypothesize that a higher level of agility is associated with stronger employees' commitment, which in turn stimulate creativity and innovation. Using a sample of nearly 18,000 private-sector workplaces in 28 countries, we report conditional correlations between workforce agility and innovation that are consistent with our framework. Establishments with higher workforce agility are more likely to innovate. This relationship is particularly strong in the case of task agility, especially for process innovation. Moreover, the contribution of agility-related practices tends to be weaker (although not absent) in industries where specialized and technical expertise is more relevant for innovation. The analysis of managers' perceptions about internal working climate and employees' commitment suggest that its positive effect on innovation is likely to be driven by the fact that workforce agility improves work motivation at the workplace, favouring innovation-oriented behaviours. Managerial and policy implications are discussed.

Keywords: workforce agility, task agility, time agility, innovation

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1 Introduction

In the modern business world, management and organization practices are increasingly recognized as key drivers of firm innovation. In the very complex, turbulent and challenging environment in which both small and big firms have to compete, the importance of being ready to react to manifold changes is crucial to raise the rate of innovation. To survive competition, firms' choices about organizational structure are as important as the ability to design the right incentives and to absorb knowledge spillovers (Haneda and Ito, 2018). In particular, much attention has been given to activities that relate to different types of work organization, including flexible labour utilization strategies (Wachsen and Blind, 2016; Hoxha and Kleinknecht, 2020), work management systems (Appelbaum et al., 2000) and new human resources management (HRM) approaches (Laursen and Foss, 2003). In this paper we expand this line of research by focusing on a novel component of work organization that is being attributed growing relevance by the management and strategy literature, namely workforce agility.

From a general point of view, firm agility has recently emerged as one of the key organizational paradigms that managers should follow to build sustained competitive advantages and as a key critical business success factor (Doz et al., 2008; Cegarra-Navarro et al., 2016; Teece et al., 2016). Even though a clear-cut definition is not available, it generally refers to the firm's ability to continuously adjust and adapt strategic direction in a core business (Holbeche, 2018) and has been developed along several dimensions, including strategic agility (Kosonen and Doz, 2010; Doz, 2020), organizational agility (Teece et al., 2016) and business agility (Lars and Pries-Heje, 2006).

On this basis, research has widely investigated the drivers of firm agility as well as the competences needed to sustain it (Holbeche, 2018). Early contributions emphasized the importance of technological infrastructure to achieve agility, but more recent perspectives give prominence to the role of human resources (Alavi et al., 2014; Carmeli and Dothan, 2017). Other studies, closer to our approach, have focused on the importance of achieving a greater amount of workforce agility to impact positively on certain firm dimensions (Doz, 2020; Vecchiato, 2015). However, this literature has been mostly focused on the relevance of agility for economic performance, while few studies provide insights on its effect on innovation by running a rigorous empirical test of this relationship. Moreover, relatively little is still known about the mechanisms through which this effect should actually take place. With this paper we attempt to make the first steps to fill these gaps.

We frame the impact of firm agility on innovation within a theoretical perspective based on human capital and HRM practices. Teece (1982) provides one of the earliest contributions recognizing internal firm organization as a factor that complements technology in determining innovation. This view has later been extended by the human capital literature, which highlights the importance of skills and organizational knowledge em-

bodied in employees as key drivers of innovation (Protogerou et al., 2017; Teixeira and Tavares-Lehmann, 2014). In this framework, the effect of organizational practices such as agility goes through human attitudes that foster innovation-oriented behaviour at the workplace. Such attitudes include a variety of traits such as the ability to find new ideas, the willingness to exert effort and the propensity toward risks. Moreover, job satisfaction can represent one further attitude that is favourable to innovation (e.g., Lenihan et al., 2019). A similar approach is found also in the literature studying the contribution of HRM practices, and in particular their impact on different types of innovation (for a survey see Seeck and Diehl, 2017). In these works the importance of studying the link between HRM and innovation lies in the role played by the inner motivations and capabilities of the employees. The more a firm is able to stimulate such motivation, especially fostering creativity and inventive thinking, the better its innovative performance.

Building on this literature, we argue that workforce agility can contribute to innovation by promoting human attitudes that favour innovation. Following Teece et al. (2016) we define workforce agility as the set of practices that an organization uses to effectively redeploy its workforce to value creating activities. In this respect, we identify agility as a characteristic of the workforce that is rooted in specific traits and behaviours, which make workers act in a proactive manner as well as adapt and react to changes of the context (Griffin and Hesketh, 2003; Dyer and Shafer, 2003). In particular, we focus on two dimensions of workforce agility: *time agility*, namely the extent to which firms allow employees to adapt their working time to personal and organizational needs; and *task agility*, namely whether employees are endowed with the skills to switch tasks among co-workers in response to the firm's needs. For both such dimensions, we hypothesize that a higher level of agility is associated with stronger employees' commitment and motivation, which in turn stimulate creativity and exchange of ideas at the workplace. This should ultimately improve the firm's innovative performance, especially in contexts where innovation is less dependent on technical and specialized expertise.

We test the validity of these theoretical predictions using unique establishment-level data from the third wave of the European Company Survey (2013), covering nearly 18,000 private-sector workplaces located in 28 European countries and providing harmonized information on workforce arrangements, firm hierarchies, and innovation. Specifically, this survey contains specific questions about flexible time arrangements (*time agility*) and task rotation (*task agility*). This allows us to obtain a composite measure of workforce agility along these two dimensions. Moreover, the survey provides information about product and process innovation, alongside a large set of other establishment-level characteristics. The availability of such a wealth of information allows us to control for several factors that may affect the relationship between workforce agility and innovation.

Overall, the empirical analysis produces results that are highly consistent with our hypotheses. In terms of product and process innovation, a firm's innovative performance,

is positively associated with workforce agility. In particular, the role of task agility is more relevant than time agility especially for process innovation. Moreover, the contribution of agility-related practices is weaker (although not absent) in industries where specialized and technical expertise is likely to play a relevant role as a driver of innovation. We account for the potential endogeneity of workforce agility by exploiting the contractual use of extra pays as an exogenous factor that shifts the probability of organizing workforce in agile ways. Our instrumental variable (IV) estimates reinforce our main findings. Finally, we explore underlying mechanisms that can drive the main results. We document a positive correlation between workforce agility and different measures of employees' commitment, including proxies for the quality of work climate and the relationships among colleagues. Taken together, these pieces of evidence suggest that the positive effect of workforce agility on innovation is likely to be associated with improvements in workers' motivation due to the presence of agile management practices.

The paper contributes to the empirical works that study organizational and non-R&D drivers of innovation (Santamaría et al., 2009). A growing number of contributions emphasize that alongside standard in-house investments in R&D, different aspects of firm organization have positive effects on innovative performance. The latter are usually distinguished between: i) external factors, such as research partnerships (Hagedoorn, 2002), knowledge linkages (D'Este and Iammarino, 2010; D'Este and Patel, 2007; Bozdogan et al., 1998; Rangus and Slavec, 2017), technology acquisition (Conte and Vivarelli, 2014; Parisi et al., 2006), user-producer interactions (Von Hippel, 1986) and open-innovation modes (Chesbrough, 2003; Laursen and Salter, 2006); and ii) internal factors, including management practices (Laursen and Foss, 2003; Haneda and Ito, 2018; Bos-Nehles et al., 2017; Shipton et al., 2006; Beugelsdijk, 2008) and governance structures (Addison et al., 2017; Kraft et al., 2011; Belloc, 2019). Our paper integrates this literature in two ways. First, we consider a specific component of firm organization that has so far received relatively little attention as a driver of innovation, namely workforce agility. In particular, a novel aspect of our approach is that we exploit detailed information on firm-level time and task organization to derive a composite measure of workforce agility. Second, we investigate how such organizational component affects different types of innovation. In this respect, it is important to notice that, while the R&D literature has extensively investigated the difference between product and process innovation (e.g. Rouvinen, 2002; Gómez et al., 2016), less evidence exists on the importance of non-R&D drivers for these two types of innovation. Our paper provides some initial evidence on this specific issue.

The remaining of the paper is organized as follows. In Section 2, we introduce our theoretical framework. In Section 3, we describe the data and the key variables used in the empirical analysis, whose results are presented in Section 4. Section 5 concludes.

2 Theoretical framework

2.1 Overview

At the theoretical level, two preliminary remarks help to characterize the contribution that management practices, and more specifically workforce agility, can offer to the innovation process. First, innovation is a complex endeavour that depends on a variety of skills and behaviours. An extended literature documents the importance of education and technical knowledge (Bresnahan et al., 2002; Greenan, 2003; Leiponen, 2005; Piva and Vivarelli, 2009), especially when applied to activities such as problem recognition, generation of ideas, promotion, and realization of those ideas. In addition, behavioural traits such as creativity and risk taking play an important role as well (Siyal et al., 2021), as they affect the way firms approach and find solutions to new challenges (Beugelsdijk, 2008). Second, neither skills nor behaviours can be taken as given; rather they depend on organization. While technical knowledge develops via firm-specific patterns of learning, behavioural traits such as creativity are influenced by employees' commitment and motivation. In particular, the more intrinsically motivated the workers, the larger the scope for inventive and creative thinking, and the more successful innovation (Amabile, 1983). Such intrinsic characteristics of the workforce hinge on attitudes such as being at ease with new ideas, willingness to learn new abilities and being confident about the capability of managing further responsibilities, that can all be stimulated by some form of psychological empowerment (Muduli and Pandya, 2018).

On this ground, one of the main tasks of today's organizations is to design formal and informal mechanisms enabling learning patterns and behavioural attitudes that are conducive to innovation. In the literature, such mechanisms have been broadly associated with the concepts of routines (Nelson and Winter, 1982), capabilities (Richardson, 1972) and dynamic capabilities (Teece et al., 1997). Despite some conceptual differences, all these approaches share a common emphasis on the relevance of experiential, localized, socially constructed and embedded knowledge and cognition as key drivers of innovative performance (Foss, 2003). In particular, firms need to develop routines and capabilities that promote innovation by balancing out command (an inescapable feature of organization) and commitment, fostering processes of social and organizational identification among co-workers[1].

[1]Recent works stress the balance between command and commitment by contrasting two approaches to the study of organizations: the exchange view and the political view of the firm. The former frames organizations mainly as governance structures that enable transactions among "free" agents. The latter contends that a salient (although not unique) feature of organizations is their hierarchical structure articulated in relations of authority and power (Cohen et al., 1996; Dosi, 1995; Dosi and Marengo, 2015; Dosi et al., 2020). Although both approaches have wide recognition, the political view is better suited to fully grasp what goes on within the "black box" of organizations, especially with reference to motivations and behaviour. On this point, experimental evidence indeed suggests that authority relations exert strong influence on work motivation (Falk and Kosfeld, 2006; Burdin et al., 2018).

Inspired by these approaches, economists and business scholars have devoted growing attention to specific managerial interventions that help firms to improve their innovative performance. This is the case, for instance, for the so-called new HRM practices, which encompass "a host of contemporary changes in the organization of the employment relation, referring to team-based organization, continuous (often team-based) learning, decentralization of decision rights and incentives, emphasis on internal knowledge dissemination, etc." (Laursen and Foss, 2003, p. 248). Such practices can be conducive to innovation activity for a number of reasons: they improve the discovery and utilization of localized knowledge (Hayek, 1945; Jensen and Meckling, 1995), they favour the recombination of different human resource inputs (Karim and Kaul, 2015), and they generally stimulate knowledge diffusion within firms (Ortega, 2001). Moreover, as suggested by Seeck and Diehl (2017), the contribution of HRM practices can also go through the inner motivations and capabilities of the employees, whose importance as drivers of firm performance has risen. Overall, a growing number of empirical works indeed provides evidence showing a positive effect of new HRM practices on innovation (e.g., Laursen and Foss, 2003; Shipton et al., 2006; Foss et al., 2011; Santangelo and Pini, 2011).

Building on this literature, a recent stream of research stresses the role of organizational agility as a driver of firm competitiveness and innovation. Agile firms are generally described as firms that can quickly adapt their organization to sustain competitive advantages in turbulent and fast changing market environments (Teece et al., 2016). In the agility paradigm, speed and flexibility of responses are considered key requirements that enable firms to stay ahead of competitors (Holbeche, 2018). On this ground, several contributions investigate the factors that allow firms to effectively meet these requirements. Carmeli and Dothan (2017), for instance, focus on the role of generative work spaces and show that the latter indeed improve organizational agility, i.e. how quickly an organization transforms a conception into a product that is ready for the market. Doz (2020) links the ability to respond successfully to external changes (i.e., strategic agility) to the coherence among skills and behaviours of senior executives, which favours the smooth and prompt adaptation of management practices. Vecchiato (2015) stresses instead the importance of corporate foresight, which is considered one of the main levers of agility-induced value creation. Finally, several works emphasize the role of organizational practices as drivers of firm agility (Sherehiy and Karwowski, 2014; Sumukadas and Sawhney, 2004), especially through the mediation of motivational factors such as psychological empowerment (Muduli, 2016).

Although rich and variegated (for a detailed review on the workforce/organizational dimension see Muduli, 2013), the agility literature still lacks a critical scrutiny of the actual mechanisms through which agility should indeed contribute to firm performance. In most of the contributions the virtue of agility is taken as given and the latter is itself treated as a direct synonym of good performances. This is true especially when we take

into account the innovative side of economic performance, which is largely acknowledged as a key driver of today's business value. In sum, there is clearly a rising theoretical and empirical understanding of the relevance of organizational agility for firm competitiveness, but that understanding needs to be integrated with more focused theoretical and empirical investigations about the mechanisms through which agility promotes innovation. This is precisely the aim of the next section.

2.2 How workforce agility can promote innovation

As already mentioned, we define workforce agility as the capacity of an organization to effectively and efficiently redeploy/redirect its workforce to value creating activities, especially innovation[2]. On this basis, we identify two main channels through which workforce agility can contribute to innovation: the first channel concerns the organization of working time and can be labelled as time agility; the second channel refers to the organization of tasks that employees carry out inside firms and can be labelled as task agility. For both dimensions we hypothesize a positive effect on innovative performance that is linked to the role of intrinsic motivations and creativity. Insights from management research indeed suggest that creativity represents an important antecedent of firm innovation (Amabile, 1988), especially during early stages of the knowledge evolution cycle (Zollo and Winter, 2002). Moreover, such literature points to the characteristics of the work environment as important drivers of creative behaviour (Beugelsdijk, 2008). Besides creativity, other factors that can provide a motivation-relevant foundation of human capital for innovation include the commitment of employees and managers to the organization as well as job satisfaction, which are found to be key determinants of behaviours related to innovation, such as taking risks and being interested in improving the degree and novelty of own skills (Lenihan et al., 2019). All these factors are influenced by the way firms are organized and can translate into a higher probability of introducing innovations. We contribute to this theorizing by linking such complex set of human attitudes to the features of the work environment associated with workforce agility, placing particular emphasis on the effect that the latter exerts on work motivations.

Let us start by considering the working time dimension. We interpret time agility as the opportunity offered to employees to adapt the time of their daily work to personal needs or wishes. This opportunity is usually associated with the presence of flexible time arrangements, such as flexi-time and working-time accounts. Recent studies document a positive association between flexible time arrangements and productivity (Bloom et al.,

[2]This definition shares some similarities with the concept of workplace flexibility as defined by Hill et al. (2008), i.e. 'the ability of workers to make choices influencing when, where, and for how long they engage in work-related tasks'. Both definitions consider changes and adaptations of workers' activities as an inherent feature of workplaces. However, while Hill et al. (2008) take a worker perspective on the issue of flexibility, we adopt an organizational perspective that stresses the ability of the organization as a whole to adapt rapidly to changing demand and supply.

2015; Beckmann, 2016). Theoretically, this effect can be driven either by an increase in individual or organizational productivity, or by the fact that flexible time arrangements improve employee well-being and job-life balance, favouring long-term engagement with the company and leading to higher investments in firm-specific skills and human capital (Golden, 2011). When applied to the case of innovation, the positive contribution of time agility can be rationalized drawing on self-determination theory (Deci and Ryan, 1985). In presence of hierarchical authority relations, practices that give employees more autonomy in managing their working time can affect innovation because they foster employees' intrinsic motivations. According to Gagné and Deci (2005), intrinsic motivations involve people doing an activity because they find spontaneous satisfaction from the activity itself and they tend to be stronger in presence of higher autonomy in decision-making, including in the management of working time[3]. As argued above, intrinsic motivations are in turn considered key enablers of creative thinking, ultimately leading to improved innovative performance.

A similar line of reasoning can be used to characterize the link between innovation and task agility. We interpret the latter as the ability of employees to switch tasks among co-workers in response to organizational needs. Researchers in the field of human resource management and personnel economics have long recognized the importance of exposition to job variety as a driver of creativity and innovation (Nonaka and Takeuchi, 1995; Kang et al., 2007). Employees that carry out different tasks in their daily activities, either alone or within teams, display lower opposition to changes and new ideas and higher willingness to at least consider their potential benefits (Shipton et al., 2006). Moreover, numerous empirical studies show that workers involved in jobs of broader scope and higher task variety exhibit stronger commitment and intrinsic motivation for their work (for a review see Joo and Lim, 2009). In particular, organizational practices such as job rotation and teamwork are found to strengthen employees' motivation by reducing boredom and keeping them interested in their job (Coşgel and Miceli, 1999). All these motivational factors foster creativity, risk taking and learning at the workplace, thus favouring innovation (**?**Beugelsdijk, 2008). As a result, we expect firms adopting practices that stimulate task agility, be it through task rotation and/or teamwork, to have better innovative performance than firms that do not.

To sum up, our main theoretical hypothesis is that higher workforce agility, considered along both its working time and task dimensions, is associated with stronger employee' engagement and motivation and lower resistance to change and new ideas. Altogether, these factors should positively affect innovation.[4]

[3]Several experiments conducted by psychologists in highly differentiated contexts have shown that environments supporting autonomy significantly increase intrinsic motivations (for a review, see Gagné, 2003).

[4]Here we consider time and task agility as additive drivers of a firm's innovation. Indeed, the effect of both such dimensions is framed as going through work motivation and behaviour. We leave to future

Before going into the detail of the empirical analysis two clarifications are needed. First, we must highlight that, although important, workforce agility and its related impact on employees' motivation is only one of the many drivers of innovation. Knowledge and expertise are important factors too, which may sometime constraint the implementation of practices fostering agility. For instance, a division of labour based on highly specialized skills may reduce the extent to which tasks can be switched among co-workers, thus limiting task agility. At the same time, especially for highly technical products and services, these skills can become key parts of the innovation process and their contribution may sometime be more significant than the one of workforce agility, which is based on purely motivational factors. Therefore, we expect the effect of workforce agility on innovation to change depending on the type of production as well as the type of innovation, being weaker in those cases in which technical and specialized expertise is more relevant. In this respect, there is already some evidence showing that different types of innovation (e.g. product vs. process) are not driven by the same set of determinants (Rouvinen, 2002; Gómez et al., 2016; Reichstein and Salter, 2006), although much less is known on this issue about the differentiated impact of non-R&D factors such as workforce agility.

Second, it is important to relate our main research hypothesis to some recent findings linking innovative performance and labour flexibility. In particular, Hoxha and Kleinknecht (2020) and Reljic et al. (2021) show that rigid labour relations may foster innovation. Their interpretation is that the use of numerical flexibility via non-standard labour contracts reduces work commitment and limits incentives to invest in innovative activities. At a theoretical level, we share with these contributions a common understanding of the importance of work motivation in the innovation process. Specifically, the role that we attribute to workforce agility is similar to the one that this literature associates with the concept of functional flexibility. However, while these contributions focus primarily on the features of contractual relationships, our analysis stresses the importance of work management practices, especially in relation to the organization of working time and tasks.

3 Data and variables

3.1 The European Company Survey: an overview

To test the effect of workforce agility on firm innovation we use establishment-level data from the third wave of the European Company Survey (ECS 2013). ECS data cover a representative sample of nearly 18,000 non-agricultural establishments employing at least 10 employees and located in 28 countries (27 EU Member States and Croatia). A crucial

research the task of exploring the existence of additional complementary factors that may eventually reinforce the impact of workforce agility on innovation.

advantage of this survey is that it provides harmonized cross-country information on management practices and organizational design at the workplace level. Moreover, it contains information on whether the establishment has introduced any new product/service and/or process. The survey is conducted in two steps. The first step involves a telephone interview with a manager, who is asked about establishment characteristics, organizational practices (e.g. compensation policies, working-time arrangements, etc), and industrial relations. The second stage comprises an interview with an employee representative in those establishments in which an employee representation structure is present. As information obtained in the second stage is conditional on having an employee representation structure, our analysis is exclusively based on the information gathered in the management questionnaire. Our data, even though rich with respect to the multidimensional concepts that are captured, suffers from some limitations that we need to keep in mind. First and foremost, we cannot rely on panel data structure, as variables are available for just one year, and for this reason our results are mainly referred to findings showing correlations rather than causation. Secondly, as evidenced above, the data are gathered mainly from the managers' perspective, thus without considering the workers' point of view. In the empirical analysis we carry out several robustness checks to take into account at least some of these limitations.

3.2 Main variables

3.2.1 Dependent variables

We use two different dependent variables accounting for the type of innovation the establishment carries out:
1. Product innovation: dummy variable that is equal 1 if the manager of the establishment replied "yes" to the question: "Since the beginning of 2010 has this establishment introduced any new or changed products or services (either internally or externally)?"
2. Process innovation: dummy variable that is equal 1 if the manager of the establishment replied "yes" to the question: " Since the beginning of 2010 has this establishment introduced any new or significantly changed processes, either for producing goods or supplying services?"

3.2.2 Independent variables: workforce agility

Our main independent variable is the one measuring workforce agility which is built summing up the values of two variables:
1. Time agility: categorical variable ranging from 1 to 7, as the answer to the question "Approximately what percentage of employees have the possibility to adapt - within certain limits - the time when they begin or finish their daily work according to their personal

needs or wishes?". The possible answers are: "none at all", "less than 20%", "20% to 39%", "40% to 59%", "60% to 79%", "80% to 99%", "all".
2. Task agility: sum of two categorical variables ranging from 1 to 3. The first variable measures the degree of task rotation. The manager of the establishment has to answer to the question "Do any of the employees at this establishment rotate tasks with other employees?".[5] Possible answers include: "no, none do" or "no, the high level of required skills or expertise prevents employees from rotating tasks"[6], "yes, some do", "yes, most do". The second variable measures the extent to which employees work in teams made up of many people working together, answering this question: "Do you have any teams in your establishment?". Possible answers are: "no", "yes, most of them work in a single team", "yes, most of them work in more than one team".

The sum of time agility and task agility gives us a composite measure of workforce agility, which is a categorical variable ranging from 3 to 13.[7] In Figure 1 we show that the two measures of time and task agility are positively correlated, which is consistent with the idea that they capture related practices of work organization.

3.2.3 Independent variables: control variables

We add to our empirical exercise some establishment level controls to account for potential correlates of innovative performance. In particular, we consider four groups of control variables. First, we include the demographic characteristics of the establishment such as age and size. Even though both variables tend to exhibit some positive association with innovation, their impact can differ. In the case of age, for instance, two different mechanisms may be at work: on the one side, younger firms may be more prone to take risk but also more financially constrained, while bigger firms may be more innovation oriented as a result of higher financial possibilities even though more risk averse (Pellegrino and

[5]Unfortunately, the survey does not include questions concerning the variety of tasks that are rotated among employees. Thus in principle our measure may involve rotation within a narrow set of tasks following standard shift schedules. However, a closer inspection of training data reveals that the latter is unlikely to be the case. In particular, we observe that in establishments where most of the employees rotate tasks with co-workers, intensive on-the-job training (at least 60% of the workforce) is 1.4 times more frequent than in establishments where task rotation is absent (38% vs. 27%). Moreover, in the latter type of production site only 44% of on-the-job training is aimed at providing employees with the skills needed to take on a different job position, whereas such value rises to 63% in establishments with high task rotation. Although indirect, this evidence is consistent with the fact that task rotation is indeed associated with relatively complex and potentially more variegated jobs, which may ultimately foster work motivation.

[6]They both belong to category 1. In this way we take into account limits to task rotation that can be due to either skill specificity or managerial choice. From our perspective both such factors may reduce the ability of employees to experience a variegated task environment with potentially negative effects on work motivation.

[7]To control for common method biases, we performed Harman's single factor test. In particular, we loaded all the variables into an exploratory factor analysis and checked that the first factor did not account for the majority of the covariance among the variables. Specifically, we obtain that the factor analysis produced three factors, the first of which accounted for only 38.5% of the variance.

Piva, 2020). In our analysis, we control for age using two dummy variables selecting middle-aged (10-49 years) and old (> 49 years) establishments. Size is controlled for using the log of the number of employees.

The second group of control variables accounts for the variation of innovation activities at the establishment level. The latter include a dummy equal 1 if R&D activities (e.g. design or development of new products or services) are carried out within the establishment. Even though not comparable to the inclusion of R&D expenditure, this variable can nevertheless account for such knowledge inputs that are crucial in the innovation process. We also add a variable capturing the establishment's ability to monitor possible external knowledge sources (external search), which takes the form of a dummy equal 1 if the manager replied "yes, using staff assigned specifically to this task" to the question "Does this establishment monitor external ideas or technological developments for new or changed products, processes or services?". As suggested by the open innovation literature (Chesbrough, 2003; Laursen and Salter, 2006), to control for this variable is important as sources of external knowledge can be relevant to foster any type of innovation activity. Finally, we control for past innovation using a variable (past technological change) capturing the changes in the use of technology that have taken place within the establishment during the last three years (dummy equal 1 if the manager replied "yes" to the question listing "changes in technology use" among the changes occurring at the workplace since the beginning of 2010).

Another group of controls that we consider consists of establishment-specific characteristics. Among the latter, we include a dummy (information system) equal 1 if the manager replied "yes" to a question related to the use of specific types of information-related systems of production ("Does this establishment use information systems to minimize supplies or work-in- process? These are sometimes known as just-in-time or lean production systems or as working according to zero-buffer principle"). These variables should stand for the capability to react fast to possible new market needs from a "hardware" perspective. We also control for the financial health of the establishment (worse finance), using a dummy equal 1 if the manager replied "worsened" to the question "Since the beginning of 2010, has the financial situation of this establishment...". Finally, we add two variables that account for the existence of outsourcing-related practices (outsourcing) and for multi-site firms (multi-establishments). The former, is a dummy equal 1 if the manager replied "Production of goods and services" to the question "Is this establishment partly or entirely outsourcing each of the following activities (this activity) to a third party that is not owned by your establishment or the company you belong to?". The latter, is a dummy equal 1 if the manager replied that the establishment object of the survey is "one of a number of establishments at different locations belonging to the same company".

The last group of regressors that we include in our analysis relates to characteristics

of the workforce: the percentage of employees who are older than 50 years (old workforce), the percentage of female (women); the percentage of workers having a university degree (high education), and the percentage of employees with an open-ended labour contract (permanent contract). All these items are computed as categorical variables ranging from 0 to 3 ("less than 20%" or "none at all", "20% to 39%", "40% to 59%", "more than 59%").

3.3 Descriptive statistics

Before turning to analyse the results of our empirical exercise, we provide some descriptive statistics of our sample, mainly to characterize the behaviour of our main variables of interest. Mean, standard deviation and range of variation for all the variables included in our analysis are reported in Table 1.

Figure 2 shows the country-level workforce agility scores from all the observations in our data. Nordic countries, such as Finland and Sweden, are those that show the highest values, followed by Luxembourg, Austria, Slovenia and Denmark. At the bottom of the hierarchy are countries in southern Europe such as Cyprus and Greece, along with Balkan and eastern European countries like Croatia, Hungary, Poland and Bulgaria. In one sense this cross-country ranking is not surprising, since it approximates the cross-country productivity ranking. Although we are far from establishing any causal relationship, it is certainly plausible that, within our theoretical framework, workforce agility positively affects national productivity. A regression of real GDP per capita on workforce agility across the sample of 28 countries yields a strong positive correlation with an R-squared of 0.34. Thus, the contribution of workforce agility to country-level economic performance appears to be potentially important from a qualitative point of view.

Interestingly, workforce agility exhibits high heterogeneity within and between countries. Figures 3 and 4 report the firm-level histogram of workforce agility by country. For ease of comparison we also report in each graph the probability density function of the standard Normal distribution. In most countries workforce agility has a distribution that is skewed towards low values, with few exceptions such as Finland and Sweden where skewness points in the opposite direction. In some contexts, such as Italy, Luxembourg and Spain, within-country heterogeneity is particularly high, with histograms that approximate a bimodal distribution. Overall, the existence of heterogeneity in workforce agility is consistent with previous country-level evidence on other types of management practices as documented by Bloom and Van Reenen (2010, 2007).

To have a first look at the relationship between innovation and workforce agility we plot in Figure 5 the country-level share of establishments reporting the introduction of either product or process innovation against the value of workforce agility. Visual inspection suggests that the two variables move together, although the correlation does not seem to be particularly strong. A cross-country regression reveals a correlation coefficient

equal to 0.028, which is only weakly significant (p-value = 0.191). This positive but weak correlation could also be due to high heterogeneity within countries as evidenced before. However, the association between the two variables improves when we remove countries with few (<500) observations. In this case the correlation coefficient rises to 0.044 and it becomes statistically significant (p-value = 0.041). Overall, this result suggests that the positive relationship between innovation and workforce agility is plausible, although a rigorous test of its validity requires a more elaborated multivariate analysis. This is what we now turn to.

4 Results

4.1 Baseline model

Our empirical analysis is carried out estimating a probit model as the dependent variable is always a dummy. In all regressions, besides our main independent variable, that is workforce agility, we introduced further control variables previously described, which account both for organizational features of the establishment as well as socio-demographic characteristics of the employees. Moreover, we include dummies to account for the industry to which the establishment belongs and the country. Table 2 reports correlation coefficients among our main covariates.

In Table 3 our benchmark regressions are shown. In the first column, where the dependent variable represents the ability to carry out any type of innovation activity, we see that control variables have the expected signs and significance. Larger establishments and those that carry out R&D activities, as well as those endowed with a monitoring capability of the external knowledge and employing young and highly skilled employees are those that have higher probability of innovation. This is also the case for the establishments that have introduced changes in the use of technology as well as for those that rely on just-in-time or lean production systems and outsourced part of the production to a third party. The signs and significance level of the control variables are quite robust even when other dependent variables, describing whether the establishment has introduced product (column 2) or process innovation (column 3), are used.

With respect to our main independent variable we see that it is positive and highly significant in all models, pointing out that coherently with our hypotheses, a higher level of workforce agility is positively associated with better innovative performance. Confirmatory results are found also for product and process innovation. In particular, we find that one-standard-deviation increase from the mean value of workforce agility is associated with an increase in the probability to introduce product and process innovation of about 2.1% and 2.6%, respectively. This effect corresponds to nearly one-tenth of the effect associated with the same type of variation in the logarithm of size.

From column 4 to 6 we run the same regression as in columns 1-3 but considering the two dimensions of task agility and time agility as separate. We find that both variables positively contribute to the innovative performance of the establishment, independently of the type of innovation that is introduced. However, when calculating the size of the effects we notice that a greater role is played by task agility. In particular, one-standard-deviation increase from the mean value of task agility is associated with an increase in the probability of introducing product innovation equal to 1.8%. For time agility the same variation corresponds to a 1.4%-increase (the difference between the two coefficients is significantly different from zero, p-value = 0.002). For process innovation the difference between the two effects is even stronger, i.e. 2.9% vs. 1.2% (p-value = 0.000). This stands for the fact that having experienced higher task rotation can generate more behavioural flexibility that can easily translate into enhanced innovation activities. Overall, these results provide strong support for our theoretical hypotheses.[8]

4.2 Additional results

As argued above, one factor that may limit the effect of workforce agility on innovation is the relevance of technical and specialized skills. Whenever such skills are key inputs in production, firms may face constraints in the implementation of agility-related practices, especially in terms of task rotation. Moreover, the marginal contribution of purely motivational factors to innovation can become small, being technical expertise the main source of innovative performance.

To test whether this is actually the case, we carry out an empirical exercise where we split the sample depending on the technological characteristics of the industry. Data limitations prevent us from obtaining an overarching classification and we thus limit the analysis to the comparison among three categories: knowledge-intensive services (KIS), less-knowledge intensive services (LKIS) and manufacturing.[9] In line with our expectations KIS, which are likely to make more intensive use of specialized and technical skills especially compared to LKIS, is the only group in which the mean value of task agility is smaller than the one of time agility (see Figure 6). To check whether this difference translates also into a comparatively small marginal effect of workforce agility on innovation we run our baseline model within each industrial category. The results of this exercise

[8] As a further robustness check we run a model in which the dependent variable accounts for the fact that the establishment can carry out both product and process innovation. The results (available from the authors upon request) are in line with the ones of the benchmark estimates.

[9] This classification is made following Eurostat's indicators on high-tech industry and knowledge – intensive services (available at: https://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an3.pdf, last accessed 25 June 2021). In particular, KIS include the following NACE Rev.2 sectors: Information and communication (section J); Financial and insurance activities (section K); Professional, scientific and technical activities (section M); Arts, entertainment and recreation (section R). Instead, LKIS include: Wholesale and retail trade; Repair of motor vehicles and motorcycles (section G); Accommodation and food service activities (section I); Real estate activities (section L).

are reported in Table 4. For LKIS and manufacturing we confirm the previous findings: workforce agility is positively associated with both product and process innovation. In KIS, on the contrary, workforce agility turns out to positively correlate with process innovation but not with product innovation. These results are consistent with the idea that where technical and specialized skill are particularly important (i.e. KIS as opposed to LKIS) the contribution of workforce agility to innovation may weaken.

As a further check on this, we carry out the same exercise described in Table 4 but distinguishing between time and task agility. Results are reported in Table 5. Once again, the outcome is broadly consistent with previous findings for both manufacturing industries and LKIS. In the case of KIS, only task agility is positive and significant as a determinant of process innovation, while the chances of introducing product innovation are actually smaller for firms with higher time agility. This may be due to the fact that in this type of sectors product innovation is more grounded on R&D effort and the higher time flexibility given to the employees may act as an obstacle to complete the type of tasks needed to achieve product innovation.

Overall, these results confirm that the effect of agility-related practices on innovation is not homogeneous across sectors and types of innovation. In particular, it tends to be smaller, although not absent, in more knowledge-intensive industries and for product innovation compared to process innovation. With reference to sectors, our interpretation is that in knowledge-intensive industries specialized and technical expertise tends to play a relatively important role as a driver of innovation, which consequently limits the contribution that a firm can get from other non-technical factors such as workforce agility. It follows that in these sectors the innovative potential of agility-related practices should be evaluated jointly with the technical features of productions firms are involved in. Instead, one possible explanation of the difference between types of innovation is that changes of the production process tend to be more likely to emerge when employees are often asked to rotate tasks (task agility), because this exposes them to learn by doing different tasks and learn by using different machinery. Such learning-effect may in turn combine with the motivational effect of workforce agility and explain its comparatively larger effect observed for process innovation compared to product innovation.

4.3 Robustness

4.3.1 Bivariate probit

One potential issue when estimating models with product and process innovation as dependent variables is that the error term of the different innovation outcomes can be correlated. Such correlation can be due to several factors. For instance, process innovation may eventually lead to the introduction of a new product. Alternatively, it is product innovation that may involve complementary modifications of the production process. Moreover,

such correlation can be due to common factors affecting the probability of introducing both types of innovation that are not adequately controlled for in the model.[10] Failure to deal with these issues leads to biased and inconsistent estimates (Gómez et al., 2016).

We therefore estimate a bivariate probit model, which allows for correlation among disturbances, thus solving the problems evidenced before. In all models we cluster errors at the establishment level to control for the fact that observations are correlated within establishments. Results are shown in Table 6. In columns 1-4 we consider all the establishments, whereas in columns 5-8 we restrict the analysis to the establishments that report having carried out R&D activities. In all models, the estimated ρ is positive and significant, suggesting that product and process innovation are indeed likely to be undertaken jointly. In this sense, estimating a bivariate probit is the right way to proceed.

Regarding the influence of workforce agility on process innovation, column 1 reveals the positive and significant effect, as expected. The same holds for product innovation (column 2), although the size of the coefficient is slightly smaller. In columns 3 and 4 we separate once again the components of workforce agility and confirm previous results. Time and task agility correlate positively with product and process innovation. For both types of innovation, the coefficient associated with task agility is significantly larger than the one of time agility. The analysis on the sub-sample of establishments that carry out R&D activities confirms a relatively stronger effect of workforce agility on process innovation (columns 5 and 6) as well as the larger contribution of task agility compared to time agility for all innovation types (columns 7 and 8). For the other control variables, results are in line with our baseline estimates. Overall, the results of the bivariate probit model confirm that agility-related practices are important drivers of innovation, especially when considered in their task dimension and in relation to process innovation.

4.3.2 Instrumental variable

An additional issue that may affect our baseline estimates stems from the endogeneity of our focus variable. For example, there may an unobservable factor that is correlated with both innovation and workforce agility. To deal with this we consider an instrumental variable (IV) strategy for workforce agility, grounding the identification of a plausible instrument on the institutional determination of payment schemes. Even though identification is only imperfect and we cannot interpret the outcomes as plainly causal relationships, we are more confident about the validity of our results when they are robust to an IV specification. We believe we cannot do much more to improve the identification of a causal effect given the institutional setting and the available data.

As documented by Breu et al. (2002) and Van Oyen et al. (2001), workforce agility is often associated with organizational practices characterized by highly decentralized

[10] In our sample 5,801 establishments out of 17,651 (33%) report having introduced both product and process innovation.

decision-making and weak (if any) monitoring. The reason is that in these contexts activities related to hierarchical coordination and metering of effort can be very expensive. On the other hand, the lack of managerial monitoring exposes firms to the risk that employees shirk on their effort and it thus requires firms to adopt alternative solutions to avoid it (Holmstrom and Milgrom, 1987). One factor that can serve this purpose is the introduction of a well-designed system of incentives: labour contracts that foresee some kind of (individual and/or team) incentive pay on the top of standard fixed wages can indeed favour the alignment of employees' interest with the ones of the company, limiting issues related to shirking even in the absence of close monitoring (Lazear, 1995). It follows that in presence of incentive-based employment contracts the adoption of human resources management practices fostering workforce agility tends to be easier.

At the same time, it is possible to argue that the adoption of incentive-based labour contracts has strong institutional roots. Barth et al. (2008), for instance, document that performance pay, while being motivated by agency problems, tends to be more common in less unionized firms and in contexts in which wage-setting institutions allow for decentralized bargaining. Along the same lines, the literature studying the variety of institutional settings across countries shows that the presence of flexible-reward systems is complementary to other types of institutions such as the ones regulating dismissal protections in the labour market (Hall and Soskice, 2001). Moreover, Arrowsmith and Marginson (2010) report suggestive evidence that the evolution of the competitive environment is more relevant than the focus on pay itself to explain changes in the adoption of variable payment systems. Overall, these contributions suggest that the introduction of incentive-based payments is highly influenced by the institutional context in which firms operate. We are thus inclined to consider the presence of such incentives as a relatively exogenous (i.e. contextually determined) factor that shifts the chances of relying on workforce agility.

Specifically, we build a variable that is the sum of four dummy variables: they all refer to questions pertaining to whether some variable payment options, on top of basic pay, are in place in the establishment of the respondent. In particular, dummies are equal 1 if the following payment schemes are in use: "Payment by results, for example piece rates, provisions, brokerages or commissions" , "Variable extra pay linked to the individual performance following management appraisal", "Variable extra pay linked to the performance of the team, working group or department", "Variable extra pay in form of share ownership scheme offered by the company". We use their sum to instrument for workforce agility.

The results are collected in Table 7. Consistent with our priors, the first-stage results show that incentive pay schemes correlate positively with workforce agility confirming it is a good instrument. The Wald test of exogeneity is always significant at 1% level, which suggests the need to account for the endogeneity of our variable of interest. When entered in the innovation regressions, the coefficients of the instrumented workforce agility have

sign and significance coherent with our baseline regressions. In particular, we confirm that workforce agility positively correlates with all types of innovation.[11]

4.4 Mechanisms

In order to dig deeper into the mechanisms through which workforce agility can impact on innovation activities we run some additional regressions where we consider as dependent variables other establishment level characteristics that can account for different channels through which the observed effect can occur. In our theoretical framework, we argued that workforce agility can strengthen innovation by favouring intrinsic motivation and creativity. While we do not have direct information about creativity at the workplace, the survey contains a large variety of questions on the characteristics of the work environment. In particular we know whether the general working climate is considered good or very good, whether decisions on working tasks are taken primarily by workers, whether activities relying on employees' commitment such as the use of suggestion schemes (i.e. the collection of ideas and suggestions from the employees, voluntary and at anytime, traditionally by means of a "suggestion box") and sharing of good practices among co-workers are present, and whether the manager perceives low motivation to be a main issue at the establishment. All these variables can be considered indirect proxies of the strength of employees' motivation. They are thus introduced into the empirical model as dummy variables and regressed against workforce agility together with the other variables used in the benchmark specification to account for a firm's characteristics and workforce composition, as well as industry and country fixed effects.

The results of this empirical exercise are reported in Table 8. Each column refers to a different dependent variable among the ones described above. In all models shown in columns 1-4, the coefficient of workforce agility is positive and significant. This suggests that, in line with our priors, establishments with higher workforce agility are more likely to be characterized by socially engaging work environments. In such establishments, employment relations are of relatively high quality, workers enjoy autonomy in decision-making and they are frequently engaged in activities that favour the exchange of knowledge among employees. Altogether, these factors may crowd in intrinsic motivation to work, as confirmed by the fact that the lack of motivation is less likely to appear as an important issue in establishments with higher workforce agility (column 5). These results, together with the fact that intrinsic motives are often found to be conducive to creativity

[11] The magnitude of the effect is larger than in the baseline estimates. This could be due to measurement error in our indicator of workforce agility. Moreover, baseline estimates could also be downward biased if an omitted determinant of innovative performance is negatively correlated with workforce agility. For example, new technologies may be associated with an increase in skill polarization (Michaels et al., 2014), which in turn may make the adoption of agile workforce management practices associated with task rotation more difficult to implement. In other words, the co-existence of highly and low-educated workers may make it more difficult to organize workforce within the agility framework.

and innovation, are consistent with out theoretical framework.

5 Conclusions

In this study we investigated the role of workforce agility in driving innovative performance. We studied its impact using an organizational economics perspective that stresses the relevance of behavioural motives in the innovation process. In particular, we emphasized that alongside standard "hard" drivers of innovation such as firm size, market structure and technology investments, an important role is played by the organization of human resources. The latter affects the way in which employees are trained and motivated, which in turn impacts on individual orientation towards creative and innovative thinking. The novelty of our approach lies in the consideration of workforce agility as a crucial factor in triggering these behavioural motives, with positive consequences for both product and process innovation. Using a cross-country establishment-level dataset for the year 2013, we provide robust evidence in support of a positive relationship between workforce agility, measured as the combination of task and time agility, and innovation.

More in detail, although our results showed that firms characterized by a higher degree of workforce agility exhibit higher probabilities of introducing any type of innovation, the magnitude of the impact is different depending on the type of innovation, being the highest for process innovation. We further showed that disentangling the two components of workforce agility both the dimensions of time and task agility significantly impact on innovation activities, even though to a different extent. In particular, the role of task agility seems to be the most important to drive the final effect on innovation. Moreover, we found that the contribution of workforce agility to innovative performance differs across sectors and tends to be weaker in industries where technical skills and specialized knowledge are key drivers of innovation. We thus acknowledge that our measure of workforce agility can account for only some dimensions of the innovation process, that are those more connected with the "soft" dimension rather than the "hard" one. Finally, as hypothesized in our theoretical framework, we documented that the positive association between innovation and workforce agility is likely to be driven by differences in the quality of employment relationships and work engagement that characterize agile and non-agile firms.

It is worth acknowledging some limitations of our study. First, due to the cross-sectional nature of the data we cannot infer a causal interpretation of the results. This is a common limitation in most of the literature studying the economic effect of management and organizational practices, including firm agility. Moreover, we lack data measuring innovation and R&D intensities, which prevents us from taking adequately into account the heterogeneity of innovation activities across establishments. While being conscious of these limitations, we are reassured of the validity of our results because a consistent

picture emerges when using different estimation strategies. Moreover, compared to previous studies on organizational agility, we rely on a much larger and rich dataset, which strengthens the external validity of our results. However, further research will have to put the positive association between innovation and workforce agility under stricter causal scrutiny, especially using longitudinal data that can account for path dependency in both process and product innovation.

A second limitation of our study stems from the lack of establishment-level information about additional factors that are usually associated with the agility paradigm, such as the ability to change and adjust the competitive strategy in a core business. This constraint forces us to focus on the innovative contribution of a specific component of agility that relates to the organization of the workforce. Future research will have to verify whether our results hold also when employing a more encompassing view of organizational agility. Moreover, a broader characterization of agility practices will also allow a deeper investigation of potential complementarities among the different agility dimensions, with interesting links to recent advances in organizational analysis (e.g., see Brynjolfsson and Milgrom, 2013).

Finally, an additional limitation of our study is that the available data refers only to 2013. Although our theoretical framework is general enough to account for different time periods, it is true that in recent years the business environment has been hit by repeated and severe shocks. Thus, further research will have to check whether our main results continue to be valid even in more recent years.

Our results have important implications for both managers and policy makers. As for the former, they provide further evidence that also non-R&D factors, such as organization practices and in particular workforce agility, are important drivers of innovation. Although this result tends to be true in general, the magnitude of the effect may depend on the type of innovation (i.e. it is stronger for process innovation than for product innovation) and the organizational dimension taken in into account (i.e. it is stronger for task agility than for time agility). These results can provide useful insights for managers wishing to improve the innovative performance of their company through organization. In particular, they can be highly relevant for those managing small and young firms, which usually rely on a different "knowledge production function" compared to large companies (Pellegrino and Piva, 2020). Lacking financial resources to invest in R&D, such function tends to attribute great relevance to management as driver of innovation (Rammer et al., 2009) and workforce agility can become an additional organizational practice that may contribute to it.

Moreover, the results of our analysis provide insights to policy discussions about work organization. In fact, while some aspects of workforce agility are clearly a discretionary choice of the managers (e.g., the decision to rely on job designs that involve task agility) others, such as the possibility to implement flexible time arrangements, require

an adequate legal and contractual framework. Policy makers should thus engage with employer and employee associations (e.g. business representatives and trade unions) to design a system of industrial relations that takes qualitative aspects of the employment relationships such as agile and autonomous time arrangements into greater account. Our work can also represent the basis for further papers on the topic of workforce agility, for example using other sources of data. One of the most relevant could be the Glassdor data, that is a database covering both private and public firms through which it is possible to measure several aspects of corporate culture. It provides several items of information such as especially those relative to employee reviews of their employers, which could represent a different point of view from that of managers', which we adopted in this paper.

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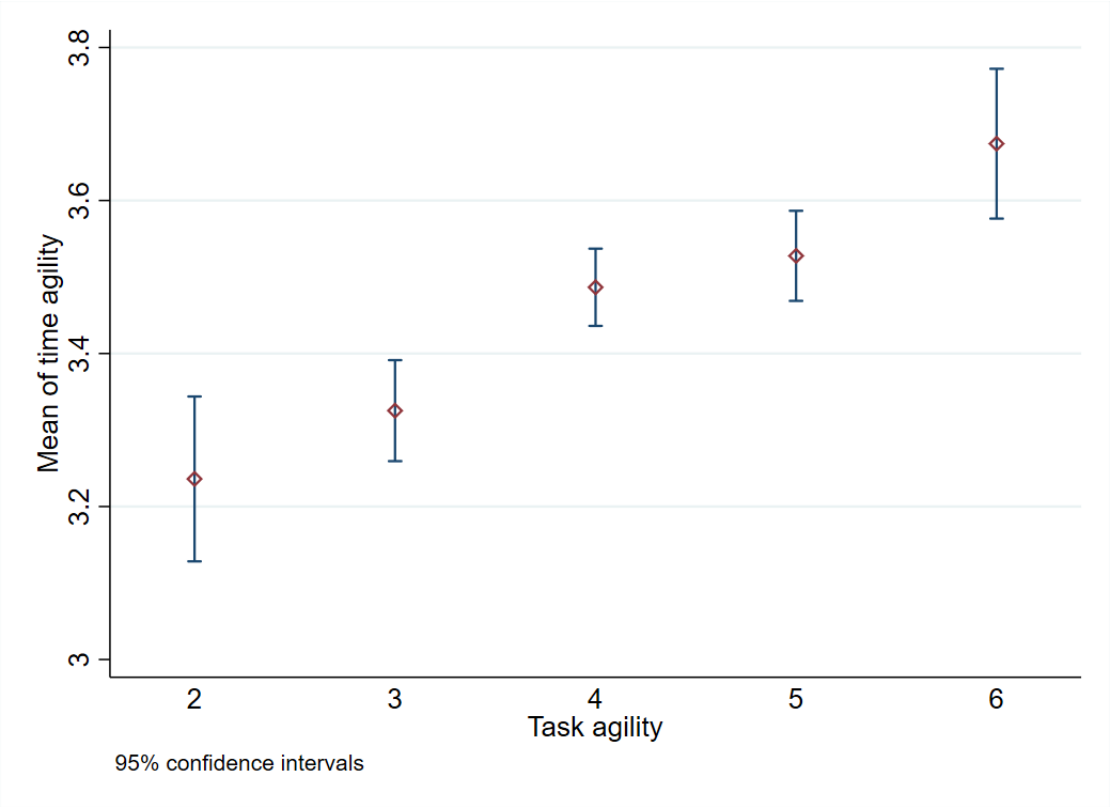
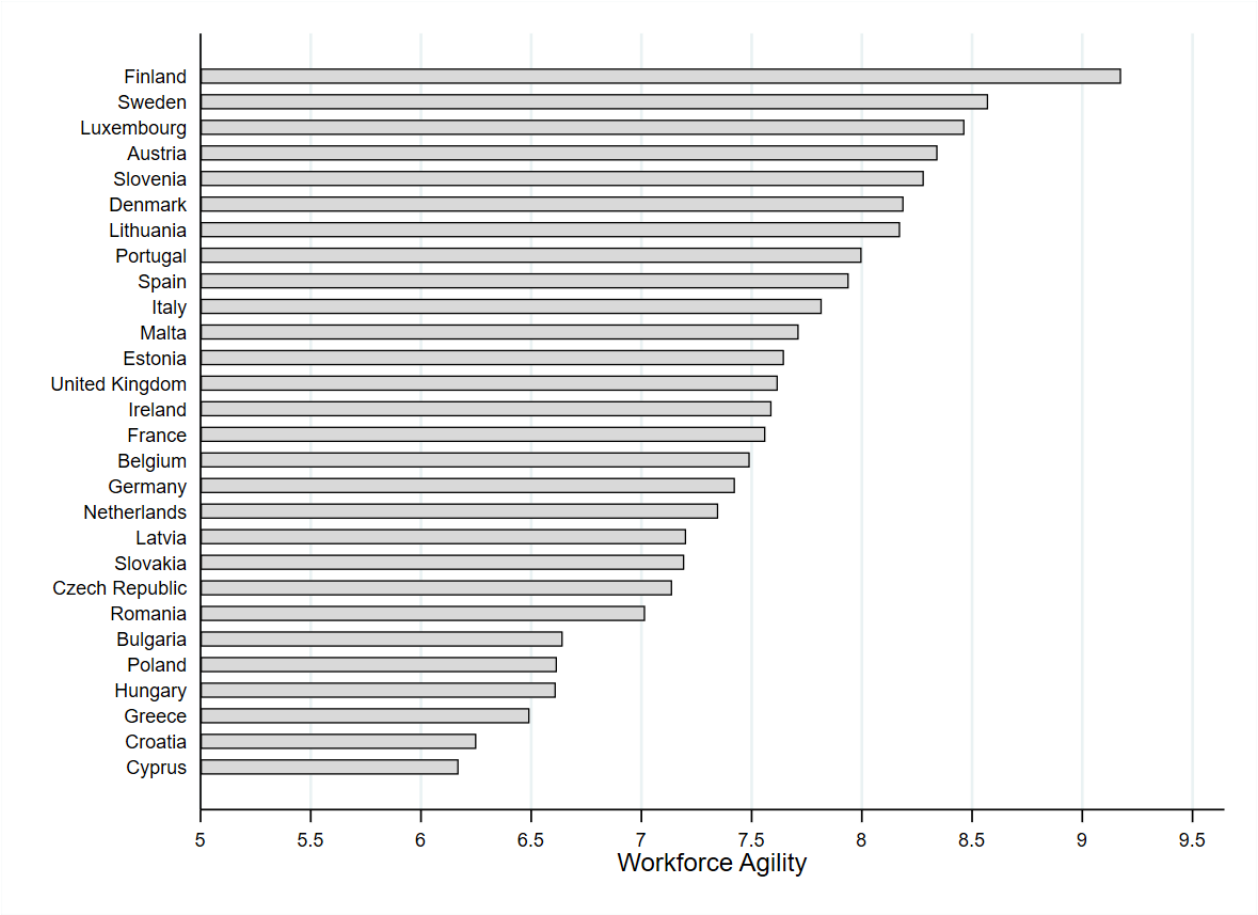
Figures and Tables

Figure 1: Correlation between time agility and task agility.



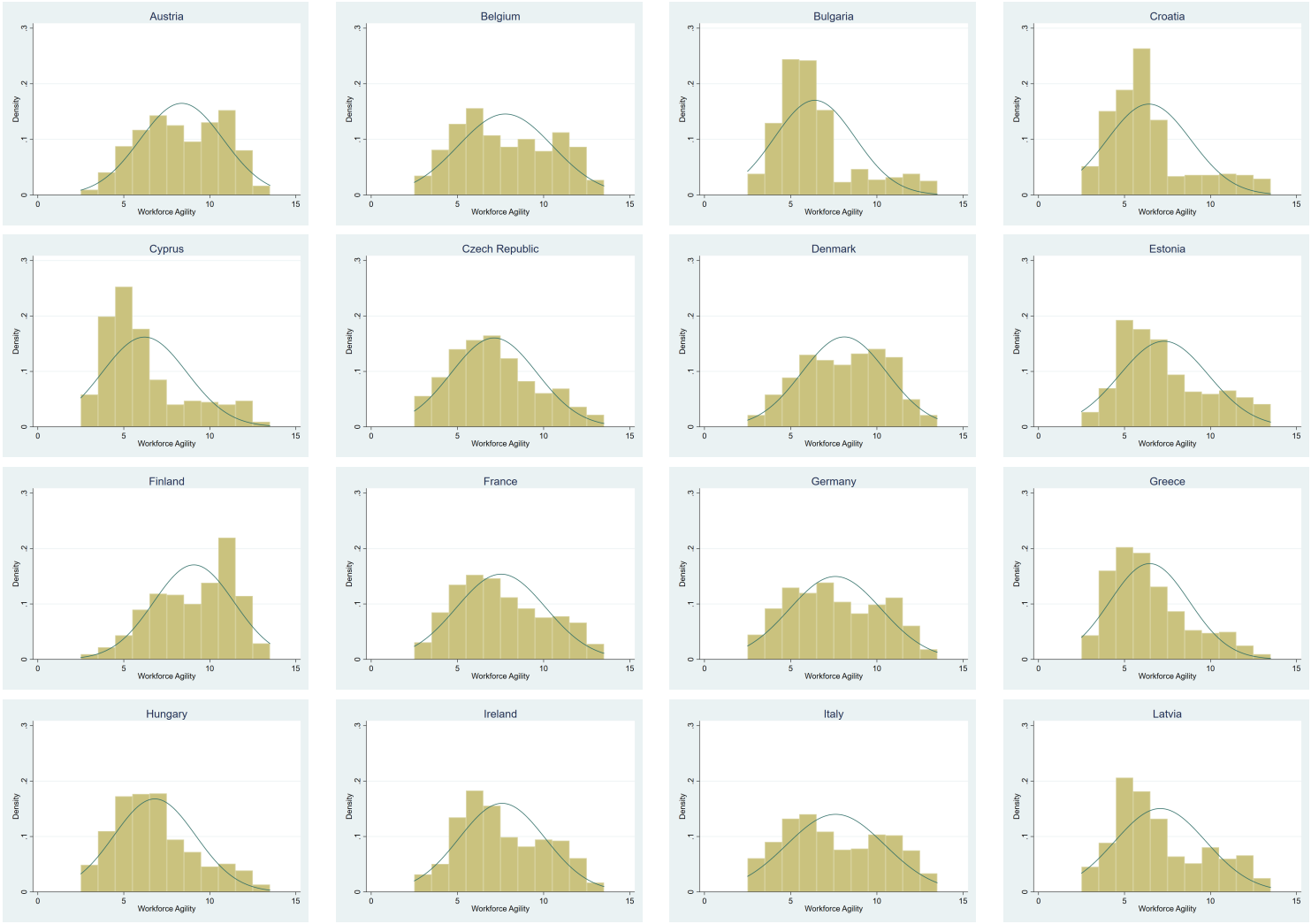
Notes: Pooled data from the European Company Survey 2013. Mean value of time agility by categories of task agility.

Figure 2: Workforce agility across countries.



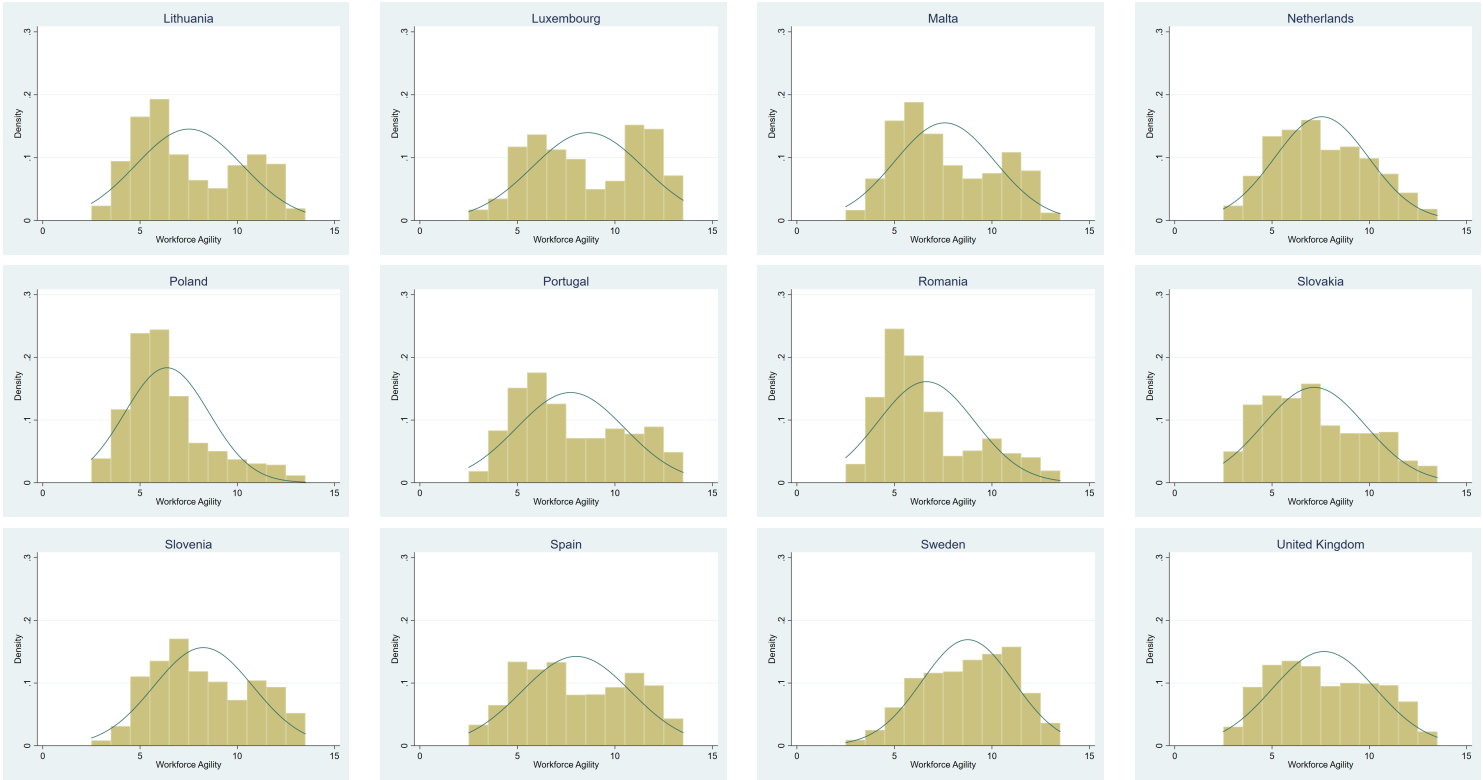
Notes: Pooled data from the European Company Survey 2013. Averages are taken across all firms within each country using sample weights.

Figure 3: Heterogeneity of workforce agility across countries (first group).



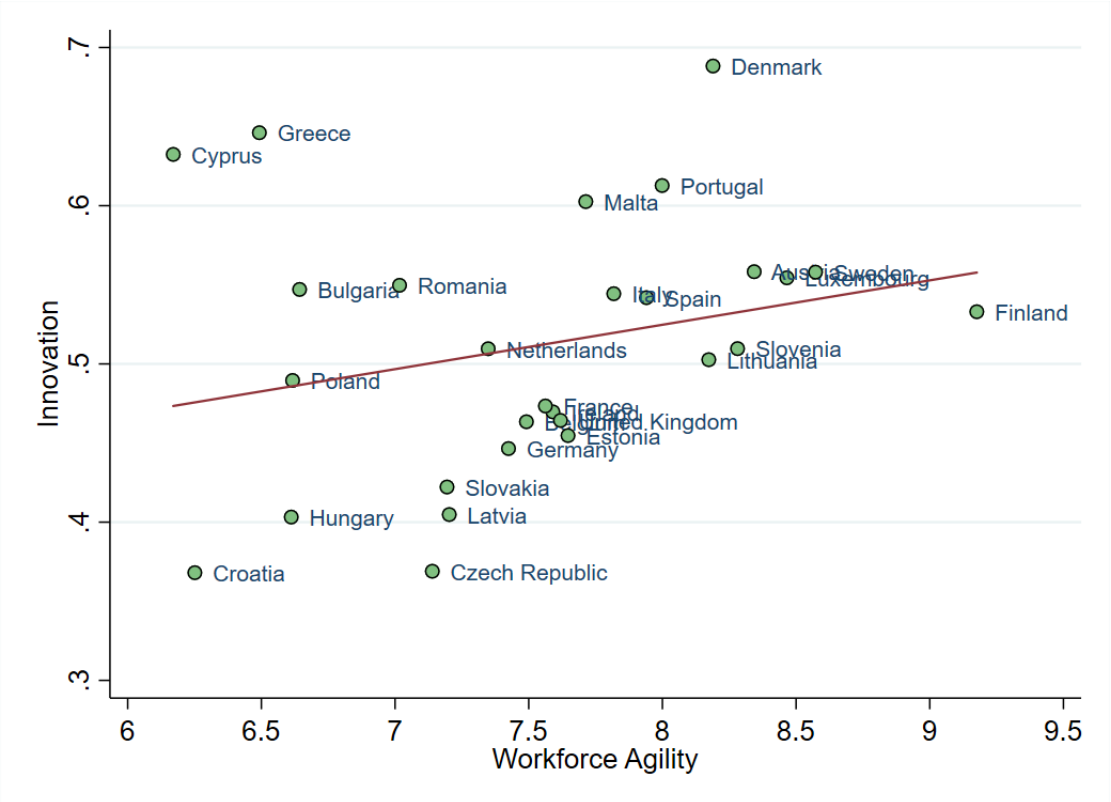
Notes: Pooled data from the European Company Survey 2013. Sample weights are used for a sample of countries. Bars are the histogram of the actual density. The line is the normal density for comparison.

Figure 4: Heterogeneity of workforce agility across countries (second group).



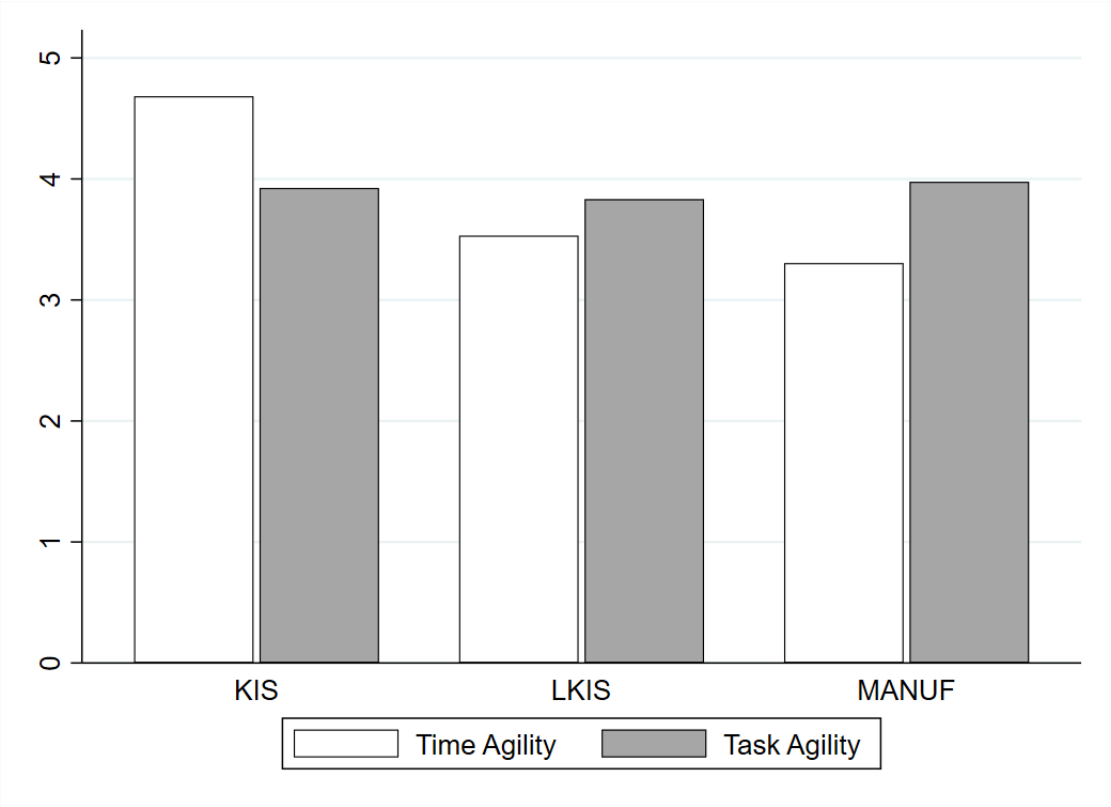
Notes: Pooled data from the European Company Survey 2013. Sample weights are used for a sample of countries. Bars are the histogram of the actual density. The line is the normal density for comparison.

Figure 5: Workforce agility and innovation across countries.



Notes: Pooled data from the European Company Survey 2013. Sample weights are used. The figure displays the correlation between country-level mean values of workforce agility and the share of establishments that introduced product or process innovation.

Figure 6: Time and task agility across sectors



Notes: Pooled data from the European Company Survey 2013. Sample weights are used. The figure displays the mean values of time and agility for different types of sectors: knowledge-intensive services (KIS), less-knowledge intensive services (LKIS), and manufacturing (MANUF).

Table 1: Descriptive statistics.

Variable	Description	Obs	Mean	Std. Dev.	Min	Max
Innovation	The establishment has introduced any new products/services or processes in the last 3 years (yes/no)	24,081	0.558	0.497	0	1
Product	The establishment has introduced any new products/services in the last 3 years (yes/no)	23,750	0.459	0.498	0	1
Process	The establishment has introduced any new processes in the last 3 years (yes/no)	23,673	0.431	0.495	0	1
Time Agility	% employees that can adapt working time according to personal needs (0%, <20%, 20-39%, 40-59%, 60-79%, 80-99%, 100%)	23,941	3.457	2.365	1	7
Task Agility	Employees rotating tasks (none, some, most) & working in teams (none, most in 1 team, most in >1 team)	23,687	4.077	1.092	2	6
Workforce Agility	Sum of time agility and task agility	23,562	7.539	2.651	3	13
Size	Number of employees working at the establishment	24,081	159.673	652.042	10	59,800
Age <10	Years since the establishment has been carrying out its activity < 10 (yes/no)	23,971	0.144	0.351	0	1
Age 10-49	Years since the establishment has been carrying out its activity between 10 and 40 (yes/no)	23,971	0.641	0.479	0	1
Age >49	Years since the establishment has been carrying out its activity > 49 (yes/no)	23,971	0.215	0.411	0	1
R&D	The establishment carries out activities related to the design and development of new products or services (yes/no)	23,919	0.535	0.499	0	1
External Search	The establishment monitors external ideas and technological developments using staff assigned to this task (yes/no)	23,585	0.765	0.423	0	1
Past Technological Change	The establishment has experienced changes in technology use in the last three years (yes/no)	23,773	0.481	0.500	0	1
Information System	The establishments uses information systems to minimize supplies or work-in-process (yes/no)	22,979	0.527	0.499	0	1
Worse Finance	The financial situation of the establishment has worsened in the last three years (yes/no)	24,081	0.288	0.453	0	1
Outsourcing	The establishment is partly or entirely outsourcing production of goods and services (yes/no)	23,173	0.316	0.465	0	1
Multi-establishments	The establishment is one of a number of establishments belonging to the same company (yes/no)	24,075	0.328	0.470	0	1
Old Workforce	% employees older than 50 years (0-19%; 20-39%; 40-59%; >59%)	23,109	0.711	0.867	0	3
Women	% female employees (0-19%; 20-39%; 40-59%; >59%)	23,836	1.363	1.149	0	3
High Education	% employees having a university degree (0-19%; 20-39%; 40-59%; >59%)	22,508	0.767	1.083	0	3
Permanent Contract	% employees with a permanent labour contract (0-19%; 20-39%; 40-59%; >59%)	23,877	2.718	0.792	0	3

Notes: Pooled data from the European Company Survey 2013

Table 2: Correlation matrix.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(1) Time Agility	1.00																	
(2) Task Agility	0.05*	1.00																
(3) Workforce Agility	0.91*	0.46*	1.00															
(4) log(Size)	-0.04*	0.12*	0.01	1.00														
(5) Age <10	0.03*	0.01	0.03*	-0.12*	1.00													
(6) Age 10-49	-0.03*	-0.01	-0.03*	-0.11*	-0.57*	1.00												
(7) Age > 49	0.01	0.01	0.01	0.24*	-0.21*	-0.68*	1.00											
(8) R&D	0.10*	0.15*	0.15*	0.22*	-0.04*	-0.04*	0.09*	1.00										
(9) External Search	0.07*	0.14*	0.12*	0.15*	-0.02*	-0.03*	0.06*	0.28*	1.00									
(10) Past Technological Change	0.07*	0.14*	0.12*	0.12*	0.00	-0.02*	0.02*	0.19*	0.18*	1.00								
(11) Information System	0.01*	0.14*	0.07*	0.22*	-0.04*	-0.03*	0.07*	0.17*	0.17*	0.14*	1.00							
(12) Worse Finance	-0.04*	-0.01	-0.04*	-0.08*	-0.04*	0.05*	-0.02*	-0.04*	-0.03*	-0.02*	-0.03*	1.00						
(13) Outsourcing	0.04*	0.09*	0.07*	0.06*	-0.00	-0.02*	0.03*	0.13*	0.10*	0.11*	0.10*	-0.00	1.00					
(14) Multi-establishments	0.07*	0.03*	0.08*	0.19*	-0.00	-0.07*	0.09*	0.05*	0.07*	0.08*	0.10*	-0.01*	0.03*	1.00				
(15) Old Workforce	-0.04*	-0.03*	-0.04*	0.12*	-0.13*	-0.06*	0.18*	0.00	0.00	-0.03*	0.01	0.04*	0.01	0.02*	1.00			
(16) Women	0.07*	0.01	0.06*	0.05*	0.03*	-0.02*	-0.01	0.04*	0.00	0.03*	-0.02*	-0.00	-0.04*	0.09*	-0.00	1.00		
(17) High Education	0.24*	0.05*	0.23*	0.02*	0.07*	-0.02*	-0.05*	0.13*	0.13*	0.06*	0.00	-0.04*	0.04*	0.10*	-0.06*	0.16*	1.00	
(18) Permanent Contract	0.03*	0.01	0.03*	0.01*	-0.04*	-0.01	0.04*	0.03*	0.05*	-0.01	0.03*	-0.01*	0.02*	0.03*	0.04*	-0.01	0.07*	1.00

Notes: Pooled data from the European Company Survey 2013; * p<0.1.

Table 3: Baseline regressions: Workforce agility and innovation.

	(1) Innovation	(2) Product	(3) Process	(4) Innovation	(5) Product	(6) Process
Workforce Agility	0.029***	0.024***	0.030***			
	(0.004)	(0.004)	(0.004)			
Time Agility				0.018***	0.017***	0.016***
				(0.005)	(0.005)	(0.005)
Task Agility				0.071***	0.051***	0.087***
				(0.010)	(0.010)	(0.010)
log(Size)	0.083***	0.055***	0.100***	0.079***	0.053***	0.095***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Age 10-49	-0.039	-0.012	-0.077**	-0.038	-0.011	-0.075**
	(0.030)	(0.030)	(0.031)	(0.030)	(0.030)	(0.031)
Age > 49	-0.040	-0.010	-0.037	-0.039	-0.009	-0.037
	(0.039)	(0.038)	(0.039)	(0.039)	(0.038)	(0.039)
R&D	0.475***	0.527***	0.367***	0.470***	0.524***	0.361***
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)
External Search	0.253***	0.211***	0.279***	0.247***	0.207***	0.272***
	(0.026)	(0.026)	(0.027)	(0.026)	(0.026)	(0.027)
Past Technological Change	0.694***	0.529***	0.762***	0.689***	0.525***	0.755***
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Information System	0.197***	0.148***	0.260***	0.190***	0.143***	0.251***
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
Worse Finance	-0.020	-0.027	-0.035	-0.020	-0.027	-0.035
	(0.024)	(0.023)	(0.024)	(0.024)	(0.023)	(0.024)
Outsourcing	0.162***	0.104***	0.145***	0.157***	0.101***	0.138***
	(0.023)	(0.022)	(0.023)	(0.023)	(0.022)	(0.023)
Multi-establishments	0.186***	0.160***	0.206***	0.185***	0.160***	0.205***
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
Old Workers	-0.064***	-0.066***	-0.056***	-0.064***	-0.066***	-0.057***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Women	0.043***	0.056***	0.034***	0.043***	0.056***	0.034***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
High Education	0.036***	0.058***	0.018	0.040***	0.061***	0.023*
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Permanent Contract	-0.009	-0.004	-0.004	-0.009	-0.004	-0.003
	(0.013)	(0.013)	(0.014)	(0.013)	(0.013)	(0.014)
Observations	17,647	17,647	17,647	17,647	17,647	17,647
Country + industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Model	Probit	Probit	Probit	Probit	Probit	Probit

Notes: Estimates obtained from probit models with robust standard errors in parentheses. In columns 1 and 4, the dependent variable is a dummy variable indicating whether the establishment has introduced any innovation, either in products (i.e. any new or significantly changed product or service) or processes (i.e any new or significantly changed processes). In columns 2 and 5, the dependent variable is a dummy variable indicating whether the establishment introduced any product innovation. In columns 3 and 6, the dependent variable is a dummy variable indicating whether the establishment introduced any process innovation. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Workforce agility and innovation: comparison across industrial categories

	(1)	(2)	(3)	(4)	(5)	(6)
	KIS		LKIS		MANUF	
	Product	Process	Product	Process	Product	Process
Workforce Agility	-0.012	0.028***	0.018**	0.030***	0.031***	0.038***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)	(0.008)
log(Size)	0.084***	0.095***	0.045***	0.087***	0.073***	0.139***
	(0.024)	(0.024)	(0.020)	(0.020)	(0.015)	(0.016)
Age 10-49	-0.140**	-0.138*	-0.065	-0.113*	0.045	0.004
	(0.071)	(0.073)	(0.058)	(0.059)	(0.062)	(0.063)
Age > 49	-0.233**	-0.132	-0.106	-0.060	0.076	0.002
	(0.097)	(0.098)	(0.079)	(0.080)	(0.072)	(0.073)
R&D	0.505***	0.424***	0.380***	0.404***	0.596***	0.310***
	(0.061)	(0.063)	(0.045)	(0.046)	(0.041)	(0.042)
External Search	0.319***	0.337***	0.201***	0.308***	0.175***	0.253***
	(0.077)	(0.079)	(0.051)	(0.054)	(0.048)	(0.049)
Past Technological Change	0.424***	0.700***	0.521***	0.630***	0.541***	0.854***
	(0.054)	(0.055)	(0.042)	(0.042)	(0.036)	(0.037)
Information System	0.207***	0.286***	0.142***	0.265***	0.104**	0.233***
	(0.055)	(0.056)	(0.042)	(0.043)	(0.040)	(0.041)
Worse Finance	-0.029	0.067	-0.038	-0.054	0.001	-0.076*
	(0.061)	(0.062)	(0.046)	(0.047)	(0.041)	(0.042)
Outsourcing	0.149***	0.104*	0.124***	0.154***	0.091**	0.137***
	(0.058)	(0.059)	(0.046)	(0.046)	(0.038)	(0.039)
Multi-establishments	0.116**	0.256***	0.200***	0.282***	0.131***	0.144***
	(0.059)	(0.060)	(0.045)	(0.046)	(0.043)	(0.044)
Old Workers	-0.090***	-0.027	-0.067**	-0.069**	-0.055***	-0.050**
	(0.035)	(0.036)	(0.027)	(0.029)	(0.021)	(0.022)
Women	0.027	0.049*	0.043**	0.016	0.038**	0.000
	(0.027)	(0.028)	(0.019)	(0.019)	(0.016)	(0.017)
High Education	0.053**	-0.014	0.083***	0.032	0.080***	0.029
	(0.025)	(0.025)	(0.022)	(0.022)	(0.024)	(0.025)
Permanent Contract	-0.056	-0.026	-0.061**	0.022	-0.009	-0.016
	(0.036)	(0.038)	(0.026)	(0.028)	(0.024)	(0.024)
Observations	2,640	2,640	4,395	4,395	5,742	5,742
Country + industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Model	Probit	Probit	Probit	Probit	Probit	Probit

Notes: Estimates obtained from probit models with robust standard errors in parentheses. In columns 1 and 2 establishments belong to knowledge-intensive services (KIS). In columns 3 and 4 establishments belong to less knowledge-intensive services (LKIS). In columns 5 and 6 establishments belong to manufacturing industries (MANUF). For all the industrial categories, the dependent variable is a dummy variable indicating whether the establishment introduced any product or process innovation. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Time agility, task agility and innovation: comparison across industrial categories

	(1)	(2)	(3)	(4)	(5)	(6)
	KIS		LKIS		MANUF	
	Product	Process	Product	Process	Product	Process
Time Agility	-0.023**	0.016	0.004	0.020**	0.023***	0.016*
	(0.012)	(0.013)	(0.009)	(0.009)	(0.009)	(0.009)
Task Agility	0.033	0.076***	0.081***	0.077***	0.059***	0.113***
	(0.025)	(0.026)	(0.020)	(0.020)	(0.017)	(0.017)
log(Size)	0.082***	0.093***	0.040**	0.083***	0.069***	0.130***
	(0.024)	(0.024)	(0.020)	(0.020)	(0.016)	(0.016)
Age 10-49	-0.140**	-0.137*	-0.061	-0.111*	0.048	0.010
	(0.071)	(0.073)	(0.058)	(0.059)	(0.062)	(0.063)
Age > 49	-0.235**	-0.134	-0.098	-0.056	0.079	0.008
	(0.097)	(0.098)	(0.079)	(0.080)	(0.072)	(0.073)
R&D	0.500***	0.418***	0.369***	0.396***	0.593***	0.303***
	(0.061)	(0.063)	(0.045)	(0.046)	(0.041)	(0.042)
External Search	0.312***	0.331***	0.191***	0.300***	0.171***	0.243***
	(0.077)	(0.079)	(0.051)	(0.054)	(0.048)	(0.050)
Past Technological Change	0.415***	0.691***	0.516***	0.627***	0.537***	0.846***
	(0.054)	(0.055)	(0.042)	(0.042)	(0.036)	(0.037)
Information System	0.201***	0.281***	0.133***	0.259***	0.098***	0.216***
	(0.055)	(0.056)	(0.042)	(0.043)	(0.040)	(0.041)
Worse Finance	-0.028	0.067	-0.035	-0.052	0.001	-0.081*
	(0.061)	(0.062)	(0.046)	(0.047)	(0.041)	(0.042)
Outsourcing	0.142**	0.096	0.116**	0.149***	0.090**	0.134***
	(0.058)	(0.059)	(0.046)	(0.046)	(0.038)	(0.039)
Multi-establishments	0.112*	0.252***	0.197***	0.280***	0.131***	0.145***
	(0.059)	(0.060)	(0.045)	(0.046)	(0.043)	(0.044)
Old Workers	-0.092***	-0.029	-0.068**	-0.070**	-0.055***	-0.052**
	(0.035)	(0.036)	(0.027)	(0.029)	(0.021)	(0.022)
Women	0.030	0.052*	0.040**	0.014	0.038**	0.000
	(0.027)	(0.028)	(0.019)	(0.019)	(0.016)	(0.017)
High Education	0.053**	-0.013	0.091***	0.037*	0.084***	0.040
	(0.025)	(0.025)	(0.022)	(0.022)	(0.024)	(0.025)
Permanent Contract	-0.056	-0.026	-0.063**	0.022	-0.010	-0.017
	(0.037)	(0.038)	(0.026)	(0.028)	(0.024)	(0.024)
Observations	2,640	2,640	4,395	4,395	5,742	5,742
Country + industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Model	Probit	Probit	Probit	Probit	Probit	Probit

Notes: Estimates obtained from probit models with robust standard errors in parentheses. In columns 1 and 2 establishments belong to knowledge-intensive services (KIS). In columns 3 and 4 establishments belong to less knowledge-intensive services (LKIS). In columns 5 and 6 establishments belong to manufacturing industries (MANUF). For all the industrial categories, the dependent variable is a dummy variable indicating whether the establishment introduced any product or process innovation. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Workforce agility and innovation: bivariate probit.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All establishments				Establishments with R&D = 1			
	Process	Product	Process	Product	Process	Product	Process	Product
Workforce Agility	0.031***	0.024***			0.030***	0.008		
	(0.004)	(0.004)			(0.006)	(0.006)		
Time Agility			0.017***	0.017***			0.011*	0.001
			(0.005)	(0.005)			(0.007)	(0.007)
Task Agility			0.087***	0.050***			0.101***	0.036***
			(0.010)	(0.010)			(0.013)	(0.013)
log(Size)	0.101***	0.056***	0.096***	0.053***	0.093***	0.052***	0.089***	0.050***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.012)	(0.012)	(0.012)	(0.012)
Age 10-49	-0.078***	-0.013	-0.077***	-0.012	-0.056	-0.054	-0.056	-0.054
	(0.031)	(0.030)	(0.031)	(0.030)	(0.043)	(0.042)	(0.043)	(0.042)
Age > 49	-0.041	-0.009	-0.041	-0.008	-0.009	-0.039	-0.011	-0.039
	(0.039)	(0.038)	(0.039)	(0.038)	(0.052)	(0.051)	(0.053)	(0.051)
R&D	0.365***	0.526***	0.358***	0.523***				
	(0.023)	(0.023)	(0.023)	(0.023)				
External Search	0.281***	0.213***	0.273***	0.209***	0.369***	0.220***	0.360***	0.216***
	(0.027)	(0.026)	(0.027)	(0.026)	(0.043)	(0.042)	(0.043)	(0.042)
Past Technological Change	0.764***	0.528***	0.757***	0.524***	0.767***	0.555***	0.759***	0.552***
	(0.021)	(0.021)	(0.021)	(0.021)	(0.028)	(0.028)	(0.028)	(0.028)
Information System	0.260***	0.149***	0.251***	0.144***	0.247***	0.128***	0.234***	0.123***
	(0.022)	(0.022)	(0.022)	(0.022)	(0.030)	(0.029)	(0.030)	(0.029)
Worse Finance	-0.037	-0.029	-0.038	-0.029	-0.072**	-0.027	-0.072**	-0.026
	(0.024)	(0.023)	(0.024)	(0.023)	(0.032)	(0.031)	(0.032)	(0.032)
Outsourcing	0.149***	0.104***	0.143***	0.101***	0.144***	0.111***	0.137***	0.108***
	(0.023)	(0.022)	(0.023)	(0.022)	(0.029)	(0.029)	(0.029)	(0.029)
Multi-establishments	0.202***	0.159***	0.202***	0.158***	0.183***	0.111***	0.183***	0.111***
	(0.024)	(0.023)	(0.024)	(0.023)	(0.032)	(0.031)	(0.032)	(0.031)
Old Workers	-0.056***	-0.065***	-0.056***	-0.065***	-0.064***	-0.072***	-0.066***	-0.073***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.018)	(0.017)	(0.018)	(0.017)
Women	0.033***	0.055***	0.033***	0.055***	0.029**	0.058***	0.030**	0.058***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.014)	(0.013)	(0.014)	(0.013)
High Education	0.019	0.059***	0.023*	0.061***	0.035**	0.079***	0.041***	0.082***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.015)	(0.015)	(0.015)	(0.015)
Permanent Contract	-0.004	-0.004	-0.004	-0.004	-0.010	-0.018	-0.009	-0.018
	(0.013)	(0.013)	(0.013)	(0.013)	(0.018)	(0.018)	(0.018)	(0.018)
Wald	2491.17		2484.09		1392.42		1387.47	
Rho	0.783***		0.782***		0.772***		0.771***	
Observations	17,647	17,647	17,647	17,647	9,487	9,487	9,487	9,487
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Model	Bivariate Probit	Bivariate Probit	Bivariate Probit	Bivariate Probit	Bivariate Probit	Bivariate Probit	Bivariate Probit	Bivariate Probit

Notes: Estimates obtained from bivariate probit models with clustered standard errors in parentheses. Columns 1-4 and 5-8 are the results of a simultaneous estimation allowing for correlation among the error terms of the innovation outcomes. The latter include a dummy variable indicating whether the establishment has introduced any product innovation and a dummy variable indicating whether the establishment has introduced any processes innovation. *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Workforce agility and innovation: IV results.

	(1) Product [Second Stage]	(2) Workforce Agility [First Stage]	(3) Process [Second Stage]	(4) Workforce Agility [First Stage]
Workforce Agility	0.330***		0.332***	
	(0.017)		(0.018)	
log(Size)	0.067***	-0.135***	0.098***	-0.135***
	(0.008)	(0.017)	(0.009)	(0.017)
Age 10-49	0.045*	-0.167***	0.003	-0.167***
	(0.026)	(0.054)	(0.027)	(0.054)
Age > 49	0.079**	-0.267***	0.058*	-0.267***
	(0.034)	(0.070)	(0.034)	(0.070)
R&D	0.214***	0.373***	0.118***	0.373***
	(0.040)	(0.042)	(0.034)	(0.042)
External Search	0.014	0.365***	0.060*	0.365***
	(0.029)	(0.048)	(0.032)	(0.048)
Past Technological Change	0.231***	0.312***	0.389***	0.312***
	(0.039)	(0.039)	(0.051)	(0.039)
Information System	0.028	0.184***	0.102***	0.184***
	(0.022)	(0.040)	(0.026)	(0.040)
Worse Finance	0.001	-0.051	-0.004	-0.051
	(0.020)	(0.042)	(0.021)	(0.042)
Outsourcing	0.033	0.088**	0.060***	0.088**
	(0.021)	(0.041)	(0.022)	(0.041)
Multi-establishments	0.086***	0.013	0.118***	0.013
	(0.023)	(0.043)	(0.024)	(0.043)
Old Workers	-0.019	-0.067***	-0.013	-0.067***
	(0.012)	(0.023)	(0.012)	(0.023)
Women	0.014	0.075***	-0.000	0.075***
	(0.010)	(0.018)	(0.009)	(0.018)
High Education	-0.085***	0.360***	-0.110***	0.360***
	(0.014)	(0.021)	(0.013)	(0.021)
Permanent Contract	-0.015	0.035	-0.014	0.035
	(0.011)	(0.024)	(0.012)	(0.024)
Extra Pay		0.188***		0.188***
		(0.018)		(0.018)
Wald	87.88***		82.39***	
Observations	17,402	17,402	17,402	17,402
Country + industry dummies	Yes	Yes	Yes	Yes
Model	IV Probit	IV Probit	IV Probit	IV Probit

Notes: Estimates obtained from probit models with robust standard errors in parentheses. In column 1, the dependent variable is a dummy variable indicating whether the establishment has introduced any product innovation . In column 3, the dependent variable is a dummy variable indicating whether the establishment has introduced any processes innovation. Columns 2 and 4 report the IV first-stage results for columns 1 and 3, respectively. The instrumental variable (Extra Pay) counts the types of extra-pay instruments used in the establishment. *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Mechanisms: work climate, autonomy, engagement and motivation.

	(1) Working Climate	(2) Autonomy	(3) Sugg. Scheme	(4) Share Good Pract.	(5) Low Motives
Workforce Agility	0.038***	0.039***	0.036***	0.072***	-0.028***
	(0.005)	(0.004)	(0.004)	(0.004)	(0.005)
Observations	17,071	17,071	17,071	17,071	17,071
Country + industry dummies	Yes	Yes	Yes	Yes	Yes
Firm's characteristics	Yes	Yes	Yes	Yes	Yes
Workforce composition	Yes	Yes	Yes	Yes	Yes
Model	Probit	Probit	Probit	Probit	Probit

Notes: Estimates obtained from probit models with robust standard errors in parentheses. In column 1, the dependent variable is a dummy variable coded 1 if the current general working climate is rated good or very good, and 0 otherwise. In column 2, the dependent variable is a dummy coded 1 if decisions on the planning and execution of daily work tasks are taken mainly by the employees undertaking the tasks, and 0 otherwise. In column 3, the dependent variable is a dummy coded 1 if suggestion schemes (i.e. the collection of ideas and suggestions from the employees, voluntary and at any time, traditionally by means of a 'suggestion box') are used at the establishment, and 0 otherwise. In column 4, the dependent variable is a dummy coded 1 if employees document and keep records of their good work practices or lessons learned with the purpose to share these with other employees, and 0 otherwise. In column 5, the dependent variable is a dummy coded 1 if the manager reports that low motivation of employees is one of the problem that he/she encounters at the establishment, and 0 otherwise. Firm's characteristics: log of the number of employees and age dummies (10-49, >49). Workforce composition: % employees aged 50+, % women, % employees with university degree, % employees with permanent contract. *** p<0.01, ** p<0.05, * p<0.1.