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MSc International Management

Employee Autonomy: More Freedom More Innovation?[1]

An empirical study on the effects of employee autonomy on start-up innovation performance in Europe.

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Abstract

Since 2022, 5 million new start-ups have been created, making a 42% increase from pre-pandemic levels. Innovation is the lifeblood of start-ups, and understanding the mechanisms that drive it has become crucial in today's competitive business landscape. Start-ups, characterized by their risk-taking nature and limited resources, rely on their employees as unique sources of knowledge to gain a competitive edge. This research investigates the effect of employee autonomy on start-up innovation performance in three different types of innovation: product, process and marketing innovation. Using data from the European Company Survey of 2019, this study employs an Ordinary Least Squares (OLS) regression to examine the relationships between employee autonomy and start-up innovation in product, process and marketing. The results of this study show that employee autonomy increases start-up process innovation. No significant effects are found regarding the effects of employee autonomy on product and marketing innovation. Moreover, only when employees responsible for innovation have access to a personal computer they will innovate. The theorised positive effect of other factors such as employee ideas or employee motivation remains unclear. The findings of this study offer important contributions to enhancing managerial practices and developing human resources strategies in start-ups in Europe.

Keywords: Start-up Innovation, Employee Autonomy, Entrepreneurship, Organizational Performance, Product Innovation, Process Innovation, Marketing Innovation.

JEL: L26, O31, M54, L25.

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1. Introduction

Over the past few decades, strategies emphasizing the importance of firm innovation have topped executive agendas (Cassiman and Valentini, 2016). It is widely recognized that innovation is essential for remaining competitive in today's business environment, therefore, many firms have focused on promoting innovative working environments to sustain their competitive advantages (Li et al., 2021). Consequently, many firms are focusing on fostering innovative working environments to remain competitive (Li et al., 2021). Innovative behaviour can be defined as "the initiative taken by employees to introduce new products, processes or markets into the organization" (Amo & Kolvereid, 2005; Dhar, R., 2016). Therefore, firms must acknowledge their dependence on employees as unique sources of ideas to overrun competitors, and managers must empower employees to adopt innovative behaviours (Afsar et al., 2014; Li et al., 2021).

Hackman and Oldham (1980) defined job autonomy as "the degree to which the job provides substantial freedom, independence and discretion to the individual in scheduling the work and in determining the procedures to be used in carrying it out". Job autonomy plays an important role in determining the level of innovation of firms, and recent literature has found a positive effect between employee autonomy and firm innovation (Paradkar et al., 2015; Masood, M., & Afsar, B., 2017; De Spiegelaere et al., 2016). However, most articles that study this relationship focus on large established companies, with limited research on the effects of employee autonomy on start-up innovation (Masood, M., & Afsar, B., 2017; Burcharth et al., 2017; Dhar, R., 2016).

Start-ups have become increasingly important in the current business landscape, especially since the COVID-19 pandemic outbreak, characterized by a boom. These firms have emerged as the torchbearers of change, creating new business rules and driving innovation (HustleHub, 2023). Analysts predicted that the post-pandemic growth rate of entrepreneurship would continue to be high, bringing positive prospects for the world economies (Altun, 2022). Moreover, start-ups play a crucial role in driving both social change and economic recovery. They help achieve sustainable development, catalyzing economic growth on both global and local scales. Start-ups are known for being highly innovative (Statista, 2023; Fiorentino, et al., 2021), and often operate in fundamentally different environments compared to large established firms (HustleHub, 2023; Kerrigan, 2018; Esade, 2024), characterised by limited resources, higher uncertainty and a

greater need for rapid adaption and innovation (Esade, 2024; Daviau, 2024). These environments, coupled with unique organizational structures such as flatter organizational structures, a risky culture and a flexible approach to creativity and management (Salina, 2024; Anicich, Lee & Sánchez, 2024), can lead to different outcomes when employee autonomy is fostered (Reisinger & Fetterer, 2021). Employees in start-ups feel more in control over their own destinies, which makes them feel more valued and connected to the organization. Moreover, while start-up teams are willing to delegate tasks earlier than large companies, larger established firms insist that it can create confusion on who should do what (Das, 2021). After the recent increase in knowledge-based start-ups and the creation of new industries, it has become crucial to examine the effects of employee autonomy in the context of start-ups, given that it can yield significantly different results than in established firms (Theurer, Tumasjan & Welpe, 2018). Despite the increasing importance of start-ups in driving economic growth and fostering innovation, there is a lack of evidence on how employee autonomy specifically affects start-up innovation (Andries, P., & Czarnitzki, D., 2014). Existing research on the effects of employee autonomy in start-ups remains limited, and some results are controversial (Dhar, R., 2016; Klaas et al., 2010; Demircioğlu, 2020; Andries & Czarnitzki, 2014).

This study focuses on how employee autonomy affects start-up innovation performance. Using data from the European Company Survey (2019), the study explores what is the effect of employee autonomy on start-up innovation performance. Therefore, the central question of this study is:

What are the effects of employee autonomy on start-up innovation performance?

The results indicate that employee autonomy increases start-up innovation performance in the context of process innovation only. The effects of employee autonomy on product and marketing innovation are negligible. It is also found that the use of a personal computer has a mediating effect between employee autonomy and start-up innovation performance. This paper significantly contributes to the literature. First, it revisits research on employee autonomy and start-up innovation performance, providing additional insights into managerial practices within start-up teams. The results of this study highlight the importance of providing employee autonomy for highly innovative start-ups. Second, this study offers supportive evidence for developing human resources strategies that foster motivation and autonomy in the workplace.

The remainder of this study is structured as follows. First, the literature review and theoretical framework present the main assumptions based on existing literature and revised theories,

leading to the development of hypotheses. Second, the empirical methodology section details the data and methods used to answer the research question and delves into the analysis and its outcomes. Third, the results section presents the study's findings. Fourth, the discussion section explores the reasons behind the results and critically examines the relationships between the variables. Fifth, the limitations and implications section outline the constraints of the study, its theoretical and practical implications, and suggests directions for future research. Finally, the conclusion briefly summarizes the study results.

2. Literature Review & Theoretical Framework

2.1.Employee Autonomy

Employee autonomy is described as “the freedom given to employees to better perform their tasks while developing and improving the overall business” (Li et al., 2021). It does not mean working in isolation or independently from others, it is the freedom given to employees to better shape their workplace environment. Accordingly, employees who are satisfied when given autonomy tend to perform well, have higher productivity, and are more committed to their work (Demircioğlu, 2020). Autonomy is a thriving motivation for employees (Lammers et al., 2016), and it is rooted in trust respect, integrity, and interdependence of employees (Mohammad et al., 2019). It has been found that employee autonomy can increase employee motivation (Lammers et al., 2016), and some studies found a positive link between workplace autonomy and workplace innovation (Li et al., 2021; Dhar, R., 2016; De Spiegelaere et al., 2016).

2.2.Employees as a source of innovation

The current competitive business environment is forcing companies to increasingly rely on employees as a source of innovation (Li et al., 2021). It is widely known that the ability of an organization to innovate is closely linked to its human capital (Andries & Czarnitzki, 2014) and employees should display their creative capabilities so that firms can benefit from them (Li et al., 2021). Employees have an important, yet frequently tacit knowledge of the innovation process, which enables them to identify problems and develop solutions. Further, the innovative ideas of employees are relatively cheap (if not free) and context-dependent, therefore they are not easily copied by competitors (De Spiegelaere et al., 2016; Robinson & Schroeder, 2004), which can give firms a competitive advantage. Existing literature underscores how innovation requires knowledge and describes the innovative process as knowledge management (Andries

& Czarnitzki, 2014). Moreover, studies suggest that employees have the potential to contribute to small firm innovation by bringing about innovative and disruptive ideas, which is further supported by the fact that some small firm managers consider employees an important resource and asset, and a prerequisite for innovation (Lichtenstein & Brush, 2001; Appelbaum, Bailey, Berg, & Kalleberg, 2000; De Spiegelaere et al., 2016; Andries & Czarnitzki, 2014; Roper et al. 1996).

2.3.Innovative Work Behaviour (IWB)

Innovative work behaviour (IWB) is defined as "all employee behaviour directed at the generation, introduction and/or application (within role, group or organisation) of ideas, processes, products or procedures, new to the relevant unit of adoption that significantly benefit the relevant unit of adoption" (Farr, J. & Ford, C., 1990; De Spiegelaere et al., 2016). Other researchers define IWB as a bundle of creative ideas that are applied in the workplace and can deliver better outcomes (Li et al., 2021). IWB is a broader definition of proactiveness constructs such as proactive work behaviour (Parker et al., 2006) and personal initiative (Frese et al., 1996; Afsar et al., 2014) which focus on an individual's inclination to implement ideas proactively. It is enhanced through different mechanisms, such as organizational climate (Shanker et al., 2017), personality traits (Woods et al., 2018), supervisor support (Mishra et al., 2017) and organizational trust (Yu et al., 2018; Li et al., 2021). Therefore, creating an environment where employees can carry out innovative ideas is key for promoting a firm innovative performance.

Leaders can create an environment without direct supervision, which is a driver of IWB (Wat & Shaffer, 2005; Houghton & Yoho, 2005). The latter makes employees feel empowered and helps them find meaning in their work, making them more intrinsically motivated, increasing firm innovation ultimately (Berg & Hallberg, 1999; Krishnan, 2012; Jung & Sosik, 2002; Laschinger et al., 2004; Afsar et al., 2014). Accordingly, IWB is expected to produce some kind of output and benefit to the firm (Afsar & Badir, 2014).

2.4.Transformational Leadership (TL)

In line with the power of leaders to create an environment that drives IWB, Burns (1978) defined transformational leadership (TL) as "leaders inducing followers to act for certain goals that represent the values and the motivations, the wants and the needs, and the aspirations and expectations of both leaders and followers". TL has been largely studied since its origins in 1973, and many studies highlight its implications for business development (Díaz-Sáenz, 2011; Jung, Wu & Chow, 2008). For instance, there is a positive effect of CEO TL on organizational

innovation (Jung, et al.,2008), and the degree of TL exhibited by CEOs affects goal importance congruence, ultimately affecting firm innovation performance (Colbert, Kristof-Brown, Bradley & Barrick, 2008). Therefore, increased TL can lead to increased motivation across employees, which can be reflected in increased innovative behaviours (Colbert, et al., 2008).

2.5.Psychological Empowerment (PE)

Following the arguments of IWB and TL, Psychological Empowerment (PE) characterizes the employee's cognitive state by increased intrinsic motivation, perceptions of competence and self-determination (Deci, Connell & Ryan, 1989). PE entails the individual's perception that they can instigate novel and innovative positive changes (Ramamoorthy et al., 2005), and can be used to predict employee creativity, increasing creative process engagement and intrinsic motivation. In addition, research on the relationship between psychological empowerment and innovative work behaviour finds a positive relationship between both (Garcia-Morales et al. 2008).

2.6.Start-ups vs. Established Firms

Start-ups and established firms play different roles in the economy and greatly differ in terms of organizational characteristics. Schumpeter (1942) already started studying the differing roles that start-ups and established firms play in generating economic growth and innovation. Later other studies, like the one by Sauermann (2017), found that not only do start-ups and established firms have differences in resources and coordination, but also in the way the firms are structured, and operate and how these deal with challenges. For instance, start-ups have flatter organizational structures, a risk-taking nature and a customer-centric approach, while established firms have more hierarchical levels, a risk-averse nature and a product-centric approach (Sauermann, 2017).

2.6.1. Start-ups as drivers of innovation

Start-ups are known to be drivers of innovation (Statista, 2023). They are at the forefront of world change, pushing boundaries and changing the landscape of business and society in ways never imagined (Altun, 2021). Unlike some established firms, start-ups have a global impact by fostering collaboration and leveraging technology, enriching the solutions they offer (HustleHub, 2023). Corporations such as Facebook or Tesla anticipated that it would be start-ups who would come up with the 'next big thing', creating unprecedented market spaces and disrupting entire industries (Weiblen, T., & Chesbrough, H. W, 2015). By 2021, around 98 cities

across 28 different countries in Europe had developed a 'unicorn' – a start-up valued at least $1bn (Thornhill, 2024). Start-ups not only create and strengthen economic growth but also create value that is nearly on par with the G7's GDP economies. In addition, the amount of start-up funding surpassed $600bln in 2021, and the number of unicorns in 2022 was well past 1,000 (Jurgens, J., 2022). Also, during the first half of 2021, European start-ups captured 20% of the global capital, an increase of around 14% since 2019 (BITE Consulting Services, 2022). This fast-changing nature of work is also affecting the settings in which employees want to work. They are seeking greater flexibility and self-determination, and more individualised work schedules (Theurer et al., 2018)

2.6.2. The culture of innovation

One defining characteristic of the start-ups is their innovation culture (HustleHub, 2023). Unlike most established firms, they can innovate, take risks and experiment without hesitating. This risk-averse culture incentivizes employees to think outside the box and come up with groundbreaking ideas. A positive aspect of the risky culture is that start-ups do not see failure as a setback, but as a valuable lesson on their way to success (HustleHub, 2023). Start-ups embrace failure and see it as a part of the learning and innovation process, they can allow themselves to make mistakes because they can try new ways of doing them quickly (Vinodh, 2023). Moreover, unlike large established firms, start-ups are known for having limited access to financial capital, which at times can make it hard for them to get off the ground and achieve their goals (FasterCapital, 2024). However, the risky culture and their resilience make them successful in adapting to dynamic environments, learning and preparing, and remerging stronger after the challenges they faced (HustleHub, 2023). Next to that, start-ups are promoting a new entrepreneurial mindset, developing their innovativeness, creativity, and risk-taking approaches to doing business. "With start-ups leading the way, the future of entrepreneurship looks bright, and the possibilities for innovation and growth are endless" (AIContentfy, 2023).

2.6.3. Employee differences

With the premise that different jobs offer different bundles of job attributes, such as intellectual challenge, motivation or job security, Sauermann (2017) argues that the type of employees between start-ups and established differ as well. In line with this, different types of organizations should attract employees with different motives as well (Agarwal & Ohyama, 2013; Stern, 2004; Sauermann, 2017). Job security, financial income, autonomy and independence, responsibility and intellectual challenge are the five dimensions in which employees in start-ups and established firms greatly differ (Sauermann, 2017). First, start-ups and established firms differ

in terms of the job security they can offer to their employees. While established firms have become more stable over time and can offer greater security, start-ups are subject to more risk and uncertainty, which translates into less job security. For this reason, risk-taking employees tend to seek less stable jobs, which are often found in start-ups (Sauermann, 2017). Second, regarding financial income, larger firms usually offer higher wages than small firms. Reasons for this are that higher wages are related to higher levels of resources, which start-ups often lack. Moreover, in established firms, employees have lower levels of certain non-pecuniary job attributes (not related to financial rewards), resulting in needing to compensate for these differences. The lower levels of salary in start-ups can be offset by higher levels of variable pay, which can be more easily measured in the context of start-ups because employees work more closely and it is easier to observe their efforts and output. Accordingly, start-ups have higher growth and development potential, which may result in higher salaries eventually (Sauermann, 2017). Third, in line with the focus of this study, employees in start-ups may enjoy higher levels of autonomy and independence (Sauermann, 2017). Benz and Frey (2008) find that employees in start-ups get higher utility (job satisfaction and self-determination) than employees in established firms when granted more autonomy. While extrinsic motivation is usually tied to financial rewards, intrinsic motivation is linked to motivation based on autonomy and intellectual change, which is more connected to creativity and innovation (Sauermann, 2017). In their study, Sauermann and Cohen (2010) find a strong relationship between intrinsic motivation and innovative performance in start-ups. Fourth, it is likely that employees in established firms have fewer opportunities to work on different areas, given that the large amount of resources they own allows them to focus on a specific task. However, because of the lack of resources, start-up teams tend to be multidisciplinary, where employees are working on managerial tasks as well. Assuming the levels of responsibility that the two types of employees seek, employees in start-ups are expected to have higher preferences for responsibility than employees in larger firms (Sauermann, 2017). Finally, given the innovative nature of start-ups, it is often these firms that introduce new technologies into the market, suggesting a higher intellectual challenge for the employees. Therefore, employees in start-ups often seek more challenges than employees in established firms, which aligns with the risk-taking and disruptive nature of start-ups (Sauermann, 2017).

2.6.4. Disruption of traditional industries

Traditionally, industries were dominated by big companies with large market shares and financial resources. However, start-ups have emerged with a disruptive approach to traditional industries, identifying gaps and filling them with new solutions (Sheetal, 2023). With creativity and determination, start-ups can disrupt even the most traditional industries, fostering competition and forcing larger companies to adapt or risk becoming obsolete otherwise (Sheetal, 2023; Ridoy, 2023). These firms embody the spirit of entrepreneurship and inspire others to follow their ideas and take risks (Ridoy, 2023). Additionally, start-ups have adopted a sustainable approach to innovation, known as sustainable innovation, which is focused on reconciling the needs of present and future generations, and ensuring that the progress today does not come at the expense of future generations (Santosh, 2024). Santosh (2024) noted, *"From harnessing renewable energy to pioneering zero-waste production methods and developing platforms that promote the sharing economy, start-ups are not just participating in the market, they are actively reshaping it to align with the principles of sustainability*". The disruption of traditional industries brings about growth in different ways. For example, disruptive start-ups create jobs in technology, transportation or healthcare. These industries often require knowledge-intensive inputs, providing job opportunities for employees (Tahir, 2023). Start-ups also create new markets and increase competition, attracting both domestic and foreign investors. The new technologies created by start-ups also increase productivity in traditional industries, which can benefit from such developments to streamline processes and improve efficiency (Tahir, 2023). In this regard, employee management becomes crucial for start-ups to remain competitive in the current business landscape and keep developing disruptive innovations (Santosh, 2024). Therefore, the proper use of intellectual capital in start-ups, by leveraging autonomy and motivation among employees, can lead to greater levels of innovation across start-ups (Andries & Czarnitzki, 2014).

2.6.5. Flat organizational structures

Another key factor that helps start-ups succeed in the contemporaneous competitive environment is their flat organizational design. An appropriate organizational structure can determine their long-term triumph or failure (Salina, 2024). Unlike the vertical and highly hierarchical structures of large established firms, start-ups have adopted flatter organizational structures, with fewer levels between the top and bottom of the hierarchies. These structures provide start-ups with greater flexibility and agility, allowing decisions to be made faster and speeding up information flows. Another advantage of a flat organizational structure is that it

helps involve employees in the most important decisions and processes of the firm, creating a sense of belonging and increasing engagement among employees (Salina, 2024). With fewer hierarchical layers, employees feel closer to their managers and feel like they can share their ideas. These attitudes increase employee motivation, they feel more valued and tend to engage more in the start-up goals, which enhances innovation performance ultimately (Salina, 2024).

2.6.6. Multidisciplinary teams

The adoption of a risky culture and flat organizational structures often lead to multidisciplinary teams as well. Those teams are small, self-managed and multifunctional, in an autonomous structure that also allows for collaboration across teams, building the backbone of a lean and agile firm (Salina, 2024). A multidisciplinary approach involves bringing together people with different backgrounds, skills and expertise to work towards a common goal (Brightscout, 2023). A particular characteristic of multidisciplinary teams is that they are sometimes created after the dissolution of a squad (Viardot, 2020). A squad is a small group of employees with diverse backgrounds and skills who work together to accomplish a specific objective. Squads have a short lifespan, and after the objective is accomplished, the group dissolves and each member goes back to their original unit (Viardot, 2020). This approach allows the sharing of expertise and skills previously gained in the squad to be transferred to more established multidisciplinary teams, enriching the inputs of the team and the solutions they offer (Viardot, 2020). According to Pessan (2024), the variety in the teams also allows for more efficient problem-solving and generates more creative ideas emanating from different sources of knowledge. Moreover, diverse teams tend to increase creativity and think outside the box, an essential feature in the start-up context. Finally, multidisciplinary teams allow for greater flexibility and adaptability due to the increased variety of skills that all the team members bring, in which pivot strategies and new opportunities can be leveraged. All these characteristics of multidisciplinary teams allow them to make more robust decisions based on the knowledge and background of the team members (Pessan, 2024).

2.6.7. Customer-centric approach

Unlike many established firms, start-ups are able to understand the needs of different customers and develop products that meet their needs. This customer-centric approach deviates from the traditional product-centric approach that established firms often seek (Sainna, 2023). In a product-centric approach, established firms focus on the creation, development and optimisation of their products, and the advantages of this approach entail product excellence, limited innovation and clear market positioning. However, the disadvantages of this approach make the

customer-centric approach a better strategy for start-ups. Potential drawbacks of a product-centric approach are limited customer understanding, rigidity and increased competition (Sainna, 2023). On the other hand, start-ups adopt a customer-centric approach to meet the needs of the changing business environment. In the digital age, where information is more readily available and choices are unlimited, consumers have become more demanding. A customer-centric approach allows for increased customer loyalty, increased customer lifetime value and positive brand reception, which is exactly what start-ups need in the early stages of their lives (Sainna, 2023).

In line with the theories of Innovative Work Behaviour (IWB), Transformational leadership (TL) and Psychological Empowerment (PE), and the differences between start-ups and established firms, many factors contribute to increased employee autonomy in the context of start-ups. Complex relationships exist between employees' self-perception at the workplace and influential factors increasing motivation, which ultimately results in innovative behaviours. Despite the interest of researchers in studying the implications of IWB, TL and PE for employee motivation and innovative behaviour, little attention has been given to how they ultimately affect firm innovation performance. Research that stresses the importance of this relationship, states that these behaviours are crucial to the growth and competitiveness of organizations (Afsar et al, 2014; Hennessey & Amabile, 2010). While Hennessey and Amabile (2010) confirmed the implications that employee intrinsic motivation has on creative tasks and IWB, Bass (1999) stated that transformational leaders inspire and motivate employees, which is expected to ultimately affect firm innovation performance. Accordingly, by psychologically empowering employees, leaders are also able to foster environments where risk-taking and proactive attitudes thrive (Theurer et al., 2018). The presented literature and theories emphasize the pivotal role of employees as sources of innovation and competitive advantage for firms. However, the existing studies fail to address the focus of this study, that is, start-ups. Data on employee autonomy and firm innovation is largely studied in individual countries' economies, which makes it hard to generalise these studies (Andries & Czarnitzki, 2014; Dhar, R., 2016; Klaas et al., 2010; Demircioğlu, 2020). Other studies also focus on specific industries, such as manufacturing, construction or transportation (Andries & Czarnitzki, 2014), limiting the relevance of the findings in the contemporaneous business landscape. Although the studies are limited in the extent to which they can be applicable, they show a positive relationship between employee autonomy and firm innovation. Accordingly, the increased differences between start-up firms and established firms, lead to expecting different results in both contexts when employee

autonomy is granted, hence the focus of this research on start-up innovation performance. Start-ups offer significantly different features that lead to theorising the effect of employee autonomy on innovation performance yielding significantly different results in the context of start-ups as well. Although the extant literature is limited to which it can be applied in the context of start-ups, the studies serve as the baseline to derive the expected findings of this research. Accordingly, the extensive implications of start-ups and their critical role as drivers of innovation and economic growth, leave a gap to study the effects of employee autonomy on start-up innovation performance. It is therefore assumed that when employees can work freely without the direct supervision of their managers, they will show more work innovative behaviour, leading to increased start-up innovation performance. From the theory, the main hypothesis of this study is derived below (H1).

H1: *Giving employees more autonomy increases start-up innovation performance.*

3. Empirical strategy

3.1. Data collection and description

To accurately address the hypothesis derived from the theoretical framework and therefore answer the research question *"What are the effects of employee autonomy on start-up innovation performance?"* a quantitative analysis is deemed appropriate. A quantitative analysis allows to study the direct effect of an independent variable on a dependent variable while holding other variables constant (Bhandari, 2023). This research aims to study the effect of employee autonomy on three different measures of firm innovation while holding factors such as motivation, employee involvement and monitoring constant. The sample used in this study is derived from the European Company Survey from 2019 (ECS, 2019), which studies the practices and policies of firms in Europe and comprises data from 21,869 companies and measures 385 variables. Data from the ECS is collected from management representatives, and it benefits from both internal and external validity, ensuring the quality of the data (Desiere, S., & Lenaerts, K., 2020). To answer the main hypothesis, a sub-sample derived from the ECS was used. The sample was cleaned to only contain data from start-ups, resulting in 2,075 observations on average. Therefore, the start-ups in this study represent 100% of the observations. The number of companies suffices the sample size for the generalizability of the results. To clean the observations for start-ups, only firms that are 10 years or younger and that have between 10 and 49 employees are considered start-ups. The choice of these measures has

been made according to the variables of the study, and such characteristics represent the smallest form of a firm from the data. This research is studied using the statistical software STATA.

Because the data used in this study is secondary, it is important to consider some limitations and biases. First, the firms of this study are a minimum of 10 years old, therefore, observations on younger firms do not exist and are expected to affect the results of this study and its generalizability to start-ups. Accordingly, firms in this study have a minimum of 10-49 employees. Given that this characteristic can be also found in small businesses, it also represents a limitation in the generalizability of the results to not only start-ups. Moreover, the respondents of this study are managers, therefore, their perceptions regarding the activities and feelings of non-managerial employees might differ from the perspectives of non-managers, leading to biases in their answers. Some respondents skipped some questions used in this study, resulting in missing values. The subsample therefore is comprised of a maximum of 2,075 observations, and the number of observations differs across variables, with some missing values.

Dependent variables

The main dependent variable of this study is the *start-up innovation*. In this study, three main dependent variables are measuring firm innovation: product innovation, process innovation and marketing innovation. *Product innovation* measures the extent to which a new product or service has been introduced to the market and/or the firm since 2016. *Process innovation* measures the extent to which a new process has been introduced or changed, either for producing goods or supplying services since 2016. The variable *marketing innovation* measures the extent to which the firm has introduced any new or significantly changed marketing methods since 2016. These are dummy variables and take the value 1 if the firm indicates that it undertook any kind of innovation activity (product, process and marketing) either for the firm or for the market, and zero otherwise. Because the type of innovation that a firm engages in can differ, using three different types of innovation will allow for identifying possible differences in the extent to which firms innovate.

Independent and control variables

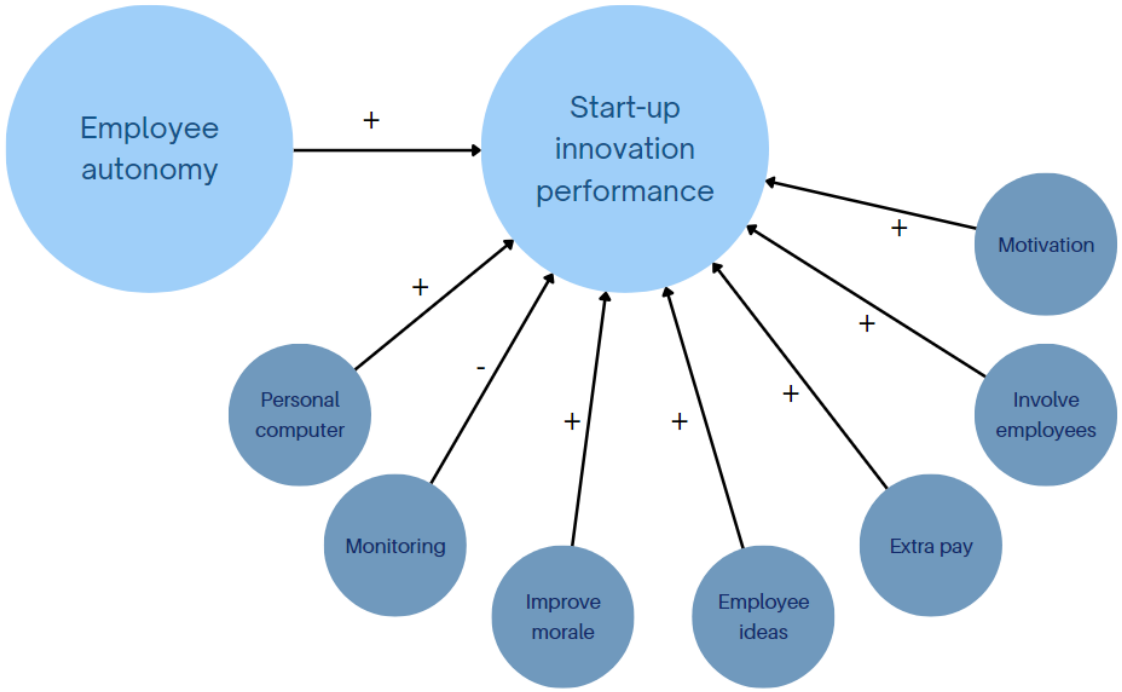
The main independent variable of this study is *employee autonomy*. It is a dummy variable that measures the extent to which managers control how employees carry out their tasks. It takes the value of 1 if the respondent answered, ‘Managers create an environment in which employees can autonomously carry out their tasks’ and 0 if the respondent answered, ‘Managers control whether employees follow the tasks assigned to them’. Approximately, 69% of the managers

create an environment in which employees can divide their tasks. This variable is considered the most appropriate and representative of employee autonomy given the nature of data. Descriptive statistics of the variables are presented in Table 1 on page 17. Appendix 1 depicts the variables used and the constructs they measure. Appendix 2 depicts the variables used in this study, their name in the survey and the categories that each variable contains. The survey further offers a large variety of control variables, which indirectly affect the level of employee autonomy and the innovation performance of start-ups. The choice of the control variables has been made based on the theories proposed in the theoretical framework and the most suitable variables from the ECS. Extant literature and theories highlight the importance of considering work-environmental factors (Sainna, 2023; Salina, 2024).

Because start-ups often lack the resources to provide their employees with tools to carry out their jobs (FasterCapital, 2024), the variable *personal computer* is included in the model, measuring what percentage of the employees use a personal computer to carry out their daily tasks. Moreover, monitoring employees is expected to have a negative effect on employee autonomy, which can ultimately affect start-up innovation (Thiel, et al., 2022). Therefore, the variable *monitoring* measures if start-ups use data analytics to monitor employee performance. The variable *improve morale* measures how important is for the firm to improve employee morale (Li et al., 2021). In line with the theory proposed, employee ideas are unique ideas important for the competitive advantage of the firm (Li et al., 2021). Therefore, the variable *employee ideas* measures how important it is for the start-up to increase the capacity of employees to articulate ideas about improvement. Next, the variable *extra pay* measures if the employees receive any extra pay linked to their individual performance, and the variable *involve employees* measures how important it is for the start-up to involve employees in work organisation changes (Sauermann, 2017). Finally, because the motivation of employees can also affect the level of effort they put into their work, ultimately affecting innovation performance, the variable *motivation* is included in the model, and it measures how motivated the employees of the start-up are.

Figure 1 shows the expected relationship between employee autonomy on start-up innovation. Based on the literature review and the theoretical framework, other variables are expected to also affect start-up innovation performance. The expected direction of the effects is reflected with a + / - sign.

Figure 1. Expected effect of the variables of the study on start-up innovation performance.



3.1.1. Data analysis tools and data handling

The survey structure and its questions suggest using the statistical software STATA to run an Ordinary Least Square regression analysis. Ordinary Least Squares (OLS) is the most appropriate method for different reasons. First, its simplicity is in line with the limitations of this study and allows for a proper understanding of the relationships of the variables. Moreover, its efficiency is key in developing a thorough analysis, and OLS provides the Best Linear Unbiased Estimates (BLUE) when certain assumptions hold. It is also easy to interpret and is a flexible and scalable method for more complex data (StudySmarter, 2024).

Before running the regression, the data has been cleaned. The observations where respondents chose the option 'Skip' were turned into missing values to avoid biases in the results. The remainder of the variables that have not been used in this study have been deleted from the data to avoid biases. Additionally, this study contains observations for firms considered start-ups only. Firms considered start-ups are a maximum of 10 years old and have between 10 and 49 employees. Finally, the three measures of innovation were turned into dummy variables taking the value of 1 if start-ups had introduced any, or changed product, process or marketing activities since 2016, and zero otherwise.

3.1.2. Summary statistics & frequencies table

Means and standard deviations of the variables of the study are reported in Table 1. The table shows the summary statistics after data cleaning. Therefore, the table represents the observations

of the subsample obtained. Because most of the variables used in the study are categorical, it is more appropriate to look at the frequencies of every category under each variable. Table 2 shows the frequency of every category. Appendix 4 provides a codebook of the commands used in STATA to obtain the results of the tables and regressions that follow.

First, regarding *product innovation*, only 34% of the firms innovated since 2016. 31% of the firms innovated in processes (*process innovation*) since 2016, and 28% of the firms innovated in marketing (*marketing innovation*) since 2016. In what concerns *employee autonomy,* 68.73% of the managers create an environment where employees can autonomously carry out their tasks, which means that most of the firms in this study give autonomy to their employees. In terms of using a *personal computer*, 24.47% of the firms say that all their employees use a personal computer. Moreover, 67% of the firms do not use data analytics to monitor their employees (*monitoring*). 45.46% of the firms consider it fairly important to improve employee morale (*improve morale*). In 51.27% of firms, it is important to increase the capacity of employees to articulate ideas about improvement (employee ideas). In general, 40.74% of the firms do not link any extra pay to the individual performance of the employees (*extra pay*). In addition, 42.04% of the firms involve their employees in work organisation to a moderate extent (*involve employees*), and 66.49% of the firms think their employees are fairly motivated (*motivation*).

Table 1. Summary statistics of the main variables of this study.

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Firm size	2311	1	0	1	1
Firm age	2311	1	0	1	1
Product innovation	2299	.344	.475	0	1
Process innovation	2293	.314	.464	0	1
Marketing innovation	2294	.284	.451	0	1
Autonomy	2290	.687	.464	0	1
Personal computer	2309	3.88	2.163	1	7
Monitoring	2306	1.67	.47	1	2
Improve morale	2213	1.683	.696	1	4
Employee ideas	2208	1.872	.719	1	4
Extra pay	2219	2.85	2.15	1	7
Involve employee	2269	2.075	.892	1	4
Motivation	2298	2.005	.61	1	4

Table 2. Frequencies and percentages.

Variable	Categories	Frequency	Percent	Cum.
Product innovation				
	No innovation	1,507	65.55	65.55
	Innovation	792	34.45	100.00
	Total	2,299	100.00	
Process innovation				
	No innovation	1,574	68.64	68.64
	Innovation	719	31.36	100.00
	Total	2,293	100.00	
Marketing innovation				
	No innovation	1,643	71.62	71.62
	Innovation	651	28.38	100.00
	Total	2,294	100.00	
Autonomy				
	Managers control	716	31.27	31.27
	Managers do not control	1,574	68.73	100.00
	Total	2,290	100.00	
Personal computer				
	None at all	283	12.26	12.26
	less than 20%	533	23.08	35.34
	20% to 39%	444	19.23	54.57
	40% to 59%	216	9.35	63.92
	60% to 79%	149	6.45	70.38
	80% to 99%	119	5.15	75.53
	All	565	24.47	100.00
	Total	2,309	100.00	
Monitoring				
	Yes	761	33.00	33.00
	No	1,545	67.00	100.00
	Total	2,306	100.00	
Improve Morale				
	Very important	969	43.79	43.79
	Fairly important	1,006	45.46	89.25
	Not very important	209	9.44	98.69
	Not at all important	29	1.31	100.00
	Total	2,213	100.00	
Employee ideas				
	Very important	696	31.52	31.52
	Fairly important	1,132	51.27	82.79
	Not very important	346	15.67	98.46
	Not at all important	34	1.54	100.00
	Total	2,208	100.00	
Extra pay				
	None at all	904	40.74	40.74
	less than 20%	398	17.94	58.68
	20% to 39%	260	11.72	70.39
	40% to 59%	134	6.04	76.43

	60% to 79%	123	5.54	81.97
	80% to 99%	106	4.78	86.75
	All	294	13.25	100.00
	Total	2,219	100.00	
Involve employees				
	To a great extent	656	28.91	28.91
	To a moderate extent	954	42.04	70.96
	To a small extent	491	21.64	92.60
	Not at all important	168	7.40	100.00
	Total	2,269	100.00	
Motivation				
	Very motivated	393	17.10	17.10
	Fairly motivated	1,528	66.49	83.59
	Not very motivated	349	15.19	98.78
	Not at all motivated	28	1.22	100.00
	Total	2,298	100.00	

3.1.3. Correlations

Correlation coefficients between the variables of this study are reported in Table 3. The results of the correlations indicate that there are some positive and negative relationships between variables. As expected from the theory, there is a positive correlation between employee autonomy and each of the three different measures of innovation (product, process and marketing), and using a personal computer also has a positive correlation with the three measures of innovation. Using data analytics to monitor employee performance has a negative relationship with the three measures of innovation. However, improving employee morale and increasing their ability to articulate ideas for improvement have a negative correlation with innovation measures. These values are good indicators to go onto the next part, the regression analysis.

Table 3. Pairwise correlations.

Pairwise correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Product innovation	1.000										
(2) Process innovation	0.5310	1.000									
(3) Marketing innovation	0.3103	0.3386	1.000								
(4) Autonomy	0.0772	0.0872	0.0726	1.000							
(5) Personal computer	0.2081	0.1415	0.1437	0.2135	1.000						
(6) Monitoring	-0.1177	-0.1421	-0.1549	0.0017	-0.0768	1.000					
(7) Improve morale	-0.0331	-0.0604	-0.0825	-0.1079	0.0188	0.0718	1.000				
(8) Employee ideas	-0.0933	-0.0997	-0.1183	-0.1175	-0.0620	0.0873	0.4759	1.000			
(9) Extra pay	0.0611	0.0635	0.0186	0.0247	0.0480	-0.1134	-0.0272	-0.0518	1.000		
(10) Involve employees	-0.1597	-0.1687	-0.1571	-0.1280	-0.1284	0.1284	0.1881	0.2463	-0.0671	1.000	
(11) Motivation	-0.0641	-0.0761	-0.0904	-0.2024	-0.1575	0.0192	0.1729	0.2416	-0.0561	0.1732	1.000

3.2. Data analysis

Simple regression models with dependent variables and employee autonomy

Given that the correlation table shows a positive relationship between employee autonomy and the three measures of innovation, it is crucial to study the isolated effect of employee autonomy on product, process and marketing innovation. Therefore, three basic models have been developed, (1; 2; 3).

(1) $Product\_Innovation = \beta 0 + \beta 1 Autonomy + e$

(2) $Process\_Innovation = \beta 0 + \beta 1 Autonomy + e$

(3) $Marketing\_Innovation = \beta 0 + \beta 1 Autonomy + e$

Table 4. *OLS simple models with one independent variable.*

Variables	(1) **Product innovation**	(2) **Process innovation**	(3) **Marketing innovation**
Autonomy	0.0793***	0.0874***	0.0708***
	(0.0215)	(0.0210)	(0.0204)
Constant	0.292***	0.255***	0.237***
	(0.0178)	(0.0174)	(0.0169)
Observations	2,279	2,273	2,273
R-squared	0.006	0.008	0.005

Note: Standard errors in parentheses. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1

From Table 4, when autonomy increases by one unit, there is a 7.93 p.p. increase in product innovation which is significant ($p<0.01$). Moreover, when autonomy increases by one unit, process innovation increases on average by 8.74 p.p. and it is significant ($p<0.01$). Finally, when autonomy increases by one unit, marketing innovation increases on average by 7.08 p.p., which is also significant ($p<0.01$). The findings indicate that when employees have the freedom to work autonomously, they might be more creative or effective in their roles, leading to an increased innovation performance within start-ups. The three coefficients of autonomy mean that when the effect of autonomy is isolated, the effect is positive and significant for every measure of innovation. However, the effect of autonomy on innovation cannot be isolated given that in real life there can be many different factors affecting the level of innovation. Next, three models have been developed using the rest of the control variables previously explained, which can affect the level of innovation performance of a firm indirectly.

Main regression models with all controls

Table 5 reports the coefficient estimates, standard errors statistical significance of the main independent variable *autonomy* and the rest of the control variables added. For simplicity, the regression model shown below shows only one measure of innovation (*innovation*), however, the OLS regression model is run for the three different measures of innovation in Table 5.

$$Innovation = \beta 0 + \beta 1 Autonomy + \beta 2 PersonalComputer + \beta 3 Monitoring + \beta 4 ImproveMorale + \beta 5 EmployeeIdeas + \beta 6 ExtraPay + \beta 7 InvolveEmployee + \beta 8 Motivation + e$$

Table 5. OLS models including other control variables.

Variables	(1) **Product innovation**	(2) **Process innovation**	(3) **Marketing innovation**
Autonomy	0.0248	0.0446**	0.0226
	(0.0232)	(0.0227)	(0.0219)
Personal computer	0.0382***	0.0217***	0.0223***
	(0.00488)	(0.00478)	(0.00461)
Monitoring	-0.0870***	-0.112***	-0.121***
	(0.0219)	(0.0214)	(0.0206)
Improve morale	0.0120	-0.00488	-0.0168
	(0.0168)	(0.0165)	(0.0158)
Employee ideas	-0.0354**	-0.0280*	-0.0284*
	(0.0166)	(0.0163)	(0.0157)
Extra pay	0.00700	0.00811*	-0.00388
	(0.00480)	(0.00470)	(0.00453)
Involve employees	-0.0552***	-0.0535***	-0.0525***
	(0.0122)	(0.0120)	(0.0115)
Motivation	0.00741	-0.0170	-0.0308*
	(0.0180)	(0.0177)	(0.0170)
Constant	0.461***	0.574***	0.645***
	(0.0670)	(0.0657)	(0.0632)
Observations	2,075	2,073	2,074
R-squared	0.066	0.057	0.062

Note: Standard errors in parentheses. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1

4. Results and Interpretation

The findings from Table 5 demonstrate that the beta coefficients of the effects of employee autonomy on the three different measures of innovation (product, process and marketing) remain positive. The effect of employee autonomy on product innovation is positive (0.0248), although insignificant. Employee autonomy and process innovation have a positive relationship (0.0446) and is significant ($p<0.05$). Last, employee autonomy has a positive effect on marketing innovation (0.0226), although insignificant. While the effects on process and marketing

innovation reject the H1 that more employee autonomy increases the start-up level of innovation, the effects on process innovation support H1.

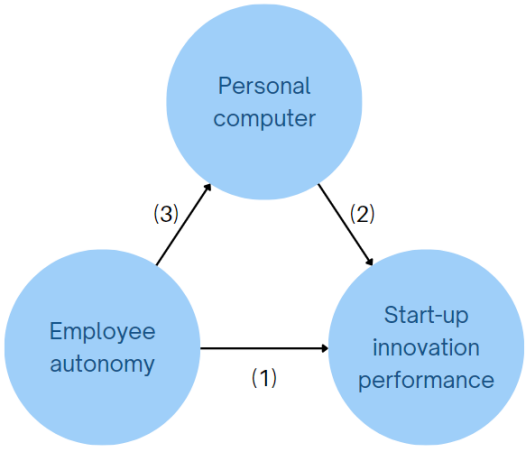
Using a personal computer at the workplace has a positive significant effect on product innovation (0.0382, $p<0.01$). The effect of a personal computer is also positive under process innovation (0.0217), and significant ($p<0.01$). Accordingly, the effect of a personal computer is also positive (0.0223) and significant ($p<0.01$) under marketing innovation. Monitoring employees has a negative significant effect on every type of innovation, being stronger its effect under marketing innovation. The effects of employee ideas and involving them in how the tasks are organised have negative significant effects, which deviate from the expected findings derived from the theory.

Because the focus of this study is the effect of employee autonomy on start-up innovation and the results from Table 5 deviate from the expected findings, a step-by-step regression analysis adding one control variable at a time has been carried out to identify the variable that can be taking the effect of autonomy, either confounding the effect or mediating it. Based on that, a mediation analysis of the variable personal computer has been carried out. Additionally, Appendix 3 shows a moderator analysis carried out for the variable personal computer. Given the insignificant results and their irrelevance within this thesis, the results are disregarded for the scope of this research.

4.1. Mediation analysis

Using the seminal work of Baron and Kenny (1986) as the baseline for this analysis, a mediation analysis has been carried out. According to the researchers, the effect of a mediator variable is to represent the generative mechanism through which the focal independent variable is able to influence the dependent variable of interest. In general, a given variable is considered a mediator to the extent that it accounts for the relationship between the independent and the dependent variables. In a mediation analysis, this study assumes a three-variable system, such that there are three different paths affecting the outcome variable autonomy. The basic causal relationship is depicted in Figure 2. The paths are (1) the direct impact of the independent variable on the outcome variable, (2) the impact of the mediator on the outcome variable, and (3) the impact of the independent variable on the mediator.

Figure 2. Mediation effect of a personal computer on start-up innovation performance.



According to Judd and Kenny (1981), a mediation analysis can be carried out using a series of regressions. First, regressing the mediator on the independent variable (Table 6), second, regressing the dependent variable on the independent variable (Table 4) and third, regressing the dependent variable on both the independent variable on the mediator (Table 7). Judd and Kenny suggest for a mediation effect to hold, the independent variable must affect the mediator in Table 6; the independent variable must affect the dependent variable in Table 4; and the mediator must affect the dependent variable in Table 7.

Table 6. OLS regression of the independent variable in the mediator variable.

Variables	(1) **Personal computer**
Autonomy	0.997***
	(0.0954)
Constant	3.202***
	(0.0791)
Observations	2,288
R-squared	0.046

Note: Standard errors in parentheses. Statistical significance
*** p<0.01, ** p<0.05, * p<0.1

Results of Table 6 show a positive and significant effect of the independent variable on the mediator variable, which is in line with the mediation analysis proposed by Baron and Kenny. The next step is to regress the dependent variable on the independent variable. The latter has been previously analysed to predict the effect of the larger regression on innovation. Table 4 shows the results of such analysis and demonstrates a positive and significant effect for

autonomy on each of the three measures of autonomy. Finally, Table 7 shows the analysis of the dependent variable on the independent variable and the mediator.

Table 7. OLS regression of the effects of the independent variable and mediator on the dependent variable.

	(1)	(2)	(3)
Variables	**Product innovation**	**Process innovation**	**Marketing innovation**
Autonomy	0.0354	0.0595***	0.0430**
	(0.0216)	(0.0213)	(0.0207)
Personal computer	0.0435***	0.0276***	0.0277***
	(0.00462)	(0.00456)	(0.00445)
Constant	0.154***	0.167***	0.149***
	(0.0229)	(0.0226)	(0.0220)
Observations	2,278	2,271	2,272
R-squared	0.043	0.023	0.022

Note: Standard errors in parentheses, significance: *** p<0.01, ** p<0.05, * p<0.1

The findings demonstrate that the effect of the mediator is positive and significant in the three forms of innovation. When the three aforementioned scenarios hold, the effects of the independent variable on the dependent variable should be less strong in Table 7 (product: $\beta = 0.0354$; process: $\beta = 0.0595$; and marketing: $\beta = 0.0430$) than in Table 4 (product: $\beta = 0.0793$; process: $\beta = 0.0874$; and marketing: $\beta = 0.0708$) which holds. Perfect mediation would hold if the independent variable had no effect when the mediator was controlled, which is not the case for this study.

Moreover, because the independent variable is assumed to cause the mediator, these two variables should be correlated, which is true for this study (the correlation coefficient between autonomy and personal computer is 0.2134). This correlation results in multicollinearity when the effects of the independent variable and the mediator on the dependent variable are estimated, which results in reduced power in the coefficients of autonomy in Table 7.

5. Discussion

This research studies the effect of employee autonomy on start-up level of innovation performance under the scenarios of product, process and marketing innovation (Hypothesis 1). Using data from the European Company Survey of 2019 it is examined how employee autonomy affects start-up innovation performance. The main findings of this study support Hypothesis 1 that giving employees more autonomy increases start-up innovation performance, but only under process innovation. However, the results of the analysis fail to accept H1 that employee autonomy increases product and marketing innovation. Several mechanisms can explain the significant results only under process innovation and the lack of supporting evidence in the case of product and marketing innovations.

Operational efficiency and start-up structure

First, process innovation involves the implementation of new or improvement of production processes. From the literature review (Ridoy, 2023; Sauermann, 2017), it is known that start-ups are highly adaptive and operate in dynamic environments, therefore, it makes them particularly suitable for constant process innovations that suit the changing needs of their environments. Start-ups often operate with limited resources; therefore, autonomous employees are more likely to try innovative ways of operating to achieve efficiency and reduce costs.

Second, flat organizational structures also contribute to enhanced processes because employees can make decisions on how to change their ways of operating if certain processes are not working, without the approval of their managers. These rapid agility and adaptability increase firm performance; therefore, process innovation is always required. Third, in line with the theories of transformational leadership, innovative work behaviour and psychological empowerment (Li et al., 2021; Colbert, et al., 2008), employees who feel more motivated tend to show greater levels of commitment and work engagement. In the context of start-ups, where teams are small and trust is fostered, employees may feel ownership of the start-up as their own, leading to them taking more risks, increasing process innovation. Fourth, the COVID-19 pandemic gave rise to an increased number of start-ups, especially in the tech and software industries. A reason for innovation within processes can be that innovation within tech and software companies is a pre-existing feature rather than a reactive skill to the changing business environment. This view underscores the idea that innovative firms attract and select more innovative employees, rather than requiring their employees to be more innovative. Therefore, having innovative employees is a selection process rather than a treatment to remain

competitive. The latter is in line with the proposed theories that start-ups and established firms seek different types of employees, and different employees seek different companies to work at (Agarwal & Ohyama, 2013; Stern, 2004; Sauermann, 2017). Fifth, because start-ups tend to grant their employees more autonomy, it is also more appealing for innovative risk-taking employees to seek environments where they can experiment and face new challenges. Therefore, highly innovative employees will seek innovative firms. This aligns with the theories of start-up cultures that their risk-taking and creative natures tend to attract employees who seek less comfort and more challenges.Sixth, the rise of tech and software companies also explains the significant results of process innovation. Nowadays, there is more availability of technological tools that ease the innovation process and are cheap to use. Artificial Intelligence, Machine Learning and the Internet of Things (IoT) are low-cost tools that start-ups can implement to improve their processes. Moreover, data analytics and collaborative technologies such as cloud computing foster process innovativeness in the way that many processes can be automated and improved.

Innovation in product and marketing

The reasons for process innovation contrast with product and marketing innovation. With the customer-centric approach, start-ups can develop products that better suit the needs of the customer given that they have access to real-time data on their needs. However, knowledge of customer needs does not mean rapid adaptability. In fact, the limited resources of start-ups, make it harder for these firms to make investments to adapt to the changing needs of their customers. Moreover, gaining information on customer needs and researching them is time-consuming and requires more resources, and it often requires more adherence to regulatory standards.

The same line of reasoning applies to marketing innovation. The rise of technologies and their cost-saving nature makes it easier to target new customers, for instance with social media. However, the extent to which start-ups can invest in marketing innovations remains limited to the existence of technological tools that can be used to market new customers. The latter means that start-ups will only innovate if they have access and the ability to invest in these tools, which are often expensive, limiting their capacity to innovate. Additionally, developing a proper marketing strategy often requires large investments, which start-ups do not own.

The effects of a personal computer

The findings of the main regression analysis also led to study the mediation effect of the use of personal computers. The results of the mediation analysis suggest, in general, that giving employees autonomy increases product, process and marketing innovation, but only when they use their personal computers. This section delves deeper into the potential explanations of this relationship.

From the results, it is found that, when it is not controlled for other factors, employee autonomy increases the level of innovation performance of start-ups under the three types of innovation. However, when it is controlled for other factors, like the use of a personal computer, employee motivation or extra pay linked to performance, the effects of employee autonomy become inherent only under process innovation. In the latter case, the use of a personal computer increases innovation performance in the three scenarios when other factors are also controlled (Table 5). This positive relationship between start-up innovation and the use of personal computers at the workplace can have several explanations: there is a mediation effect of the variable personal computer, or there is omitted variable bias.

On the one hand, the model might have suffered from omitted variable bias at first when examining the isolated effect of autonomy on innovation. Personal computers can be a critical tool for innovation, especially in today's business environment. Therefore, autonomy is channelled using a personal computer and becomes significant only when employees have access to it. Moreover, it gives the employees more autonomy in the sense that they do not depend on the start-up resources to carry out innovative activities. Personal computers also enhance and enable communication to be seamless. This ability to communicate fast and efficiently increases innovation. The bias occurs when the enhanced communication driven by computers is not taken into account in the main analysis. Other effects of having a personal computer can be better operational efficiency or the adoption of new technologies that come with the use of personal computers. The ability of firms to operate more efficiently with technological tools such as computers or the use of Artificial Intelligence or the Internet of Things can enhance the innovative performance of start-ups. Hence, not taking these factors into account in the main regression can lead to omitted variable bias.

On the other hand, the mediation effect theory was used to explain the statistical effects of personal computers on start-up innovation performance. Based on the seminal work of Baron

and Kenny (1986), a mediation effect analysis of the variable personal computer was conducted. From the results of Table 7, it can be concluded that a mediation effect exists. In this case, the use of a personal computer partially mediates the relationship between autonomy and innovation. As previously explained in the case of process innovation, it can be the case that the use of a personal computer is a self-selection effect rather than a treatment. The latter means that using a personal computer increases innovation, but just because employees in jobs that require to be more innovative, happen to use a personal computer. A distinction can be made between two types of jobs. White-collar jobs, in which usually more innovative behaviour is required, may happen to be more innovative with the use of a personal computer, but only because the jobs require innovativeness. These types of jobs are usually jobs in offices for tech or software startups. However, in the case of blue-collar employees, using personal computers might be insignificant because blue-collar jobs do not require them to be innovative, so it does not matter whether employees use a personal computer or not. For instance, jobs in manufacturing, construction or transportation might not benefit from employees using a personal computer. In summary, the effect of personal computers on every type of innovation can have diverse reasons. Under product innovation, it can be that in software and tech companies, testing a new product can be easily done with the use of a personal computer. Accordingly, a personal computer increases the availability of tools for developing software products. In the case of process innovation, it allows for optimization and automation of processes in highly innovative software and tech start-ups. Finally, in the case of marketing innovation, it provides a variety of digital tools such as social media and data analytics that allow for the proper development of marketing practices.

The results align with the previously mentioned theory of the mediation effect that the effect of employee autonomy is channelled through the use of personal computers. Employees with more autonomy might be more likely to use personal computers in ways that enhance start-up innovation, this is why when in the absence of a mediation analysis, the effect of autonomy is almost negligible in Table 5.

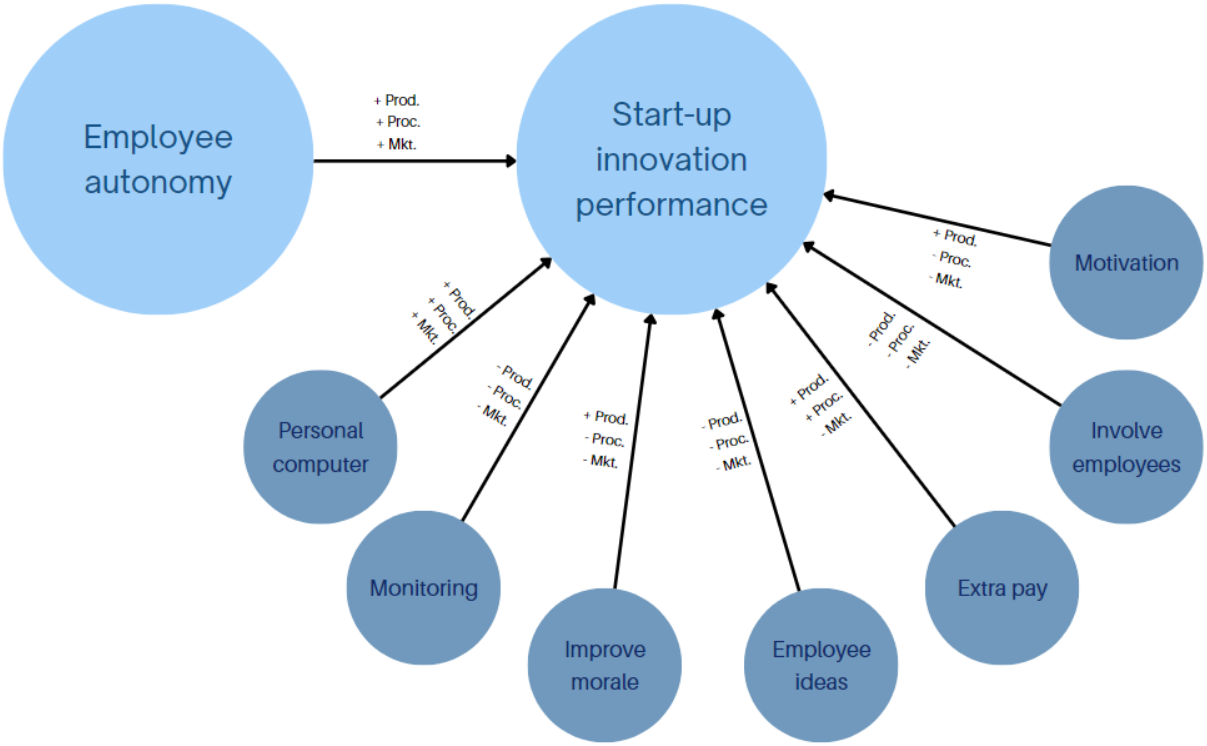
Control variables

Regarding the effects of other control variables, the researcher illustrates possible reasons for the results. Figure 3 depicts the direction of the effects of every variable on innovation, given in Table 5. Monitoring employees has a negative effect on the level of start-up innovation

performance and is significant in the three scenarios. This relationship can be explained using the Agency Theory, in which agents (in this case the employees), when monitored, will feel that they are not trusted by their principals (managers) and will put in less effort, diminishing start-up innovation (Adam Smith, 1776). Moreover, improving employee morale (variable *morale*) is also expected to have a positive effect on start-up innovation given the theory of Psychological Empowerment elaborated in the theoretical framework. It is theorised in this study that empowering employees by improving their morale has a positive effect on innovation ultimately, due to the increased intrinsic motivation of the employees. The findings of this study, however, contradict the expected findings. A reason for this can be a misalignment between purpose and action. Firms of the study might ensure that improving employee morale is important for the competitive advantage of the firm, however, the extent to which practices improving morale are implemented remains unknown. Another reason for the negative effects can be a misalignment of the incentives. Start-ups might be trying to improve the morale of their employees by means that do not align with the expected results, such as short-term rewards or comforting them rather than fostering a culture of problem-solving and risk-taking.

The effects of the variable *employee ideas* also come unexpectedly. From Table 5, it is seen that increasing the capacity of employees to articulate ideas about improvement yields significant negative results on start-up innovation performance. This is unexpected, given that according to the theory by Hackman and Oldham (1980), firms rely on employees as unique sources of innovation. A reason for this can be that although start-ups foster an environment where ideas can be shared, the ideas that emanate from the employees are not good enough to improve the innovation performance of start-ups. Accordingly, there can be a mismatch between purpose and action, where start-ups consider that increasing the capacity of their employees is important for the competitive advantage of the firm, but in practice, the ideas are not implemented.

Figure 3. Effects of the independent variables on the dependent variable.



The variable *extra pay,* that is linking extra pay to the individual performance of the employees has differing effects under the three types of innovation. While product and marketing innovation have an insignificant effect, process innovation has a positive significant effect. These results can be explained by the fact that is easier to measure an improvement in processes (clear metrics such as output produced, efficiency, and cost reductions), than in product or marketing processes. Moreover, process innovation is sought continuously, while product and marketing innovation might have longer time horizons, making it easier to link extra pay to process innovation than to product or marketing innovation. Also, process innovation entails less risk-taking. A process in a start-up can be easily adopted without much risk or financial resources, given that the changes remain within the team. On the contrary, changing the product or marketing activities entails a higher risk and more financial means.

The variable *Involve employees* also displays unexpected results. For every type of innovation, involving employees in how the work is organised to give the firm a more competitive advantage, has negative significant effects. Again, the reason for such results can be a misalignment between purpose and action. While the respondent firms might consider involving employees in the work organisation important, they might not do it in practice. Another reason might be that again the culture of risk-taking and employee involvement does not yield significant results because there can be consensus problems and the tasks are not efficiently

allocated. Employees can also focus too much on the right division of tasks while deviating from the focus on innovativeness. This is also in line with another reason, that is their lack of expertise. In a start-up, many processes rely on trial and error and learning from mistakes, however, when the responsibility of allocating tasks is delegated to employees with little to no experience in leading a firm, it can lead to suboptimal results.

The variable *motivation* also yields unexpected results. According to the theory of innovative work behaviour (IWB) and psychological empowerment (PE), a variable on the levels of motivation of the employees was added, expecting it to have a significant positive effect on innovation. The theories proposed in the literature review and the theoretical framework suggest that motivated employees tend to engage more in the workplace, put in more effort, and consequently be more creative, leading to more firm innovation. In this study, despite the 66.49% of the firms that believe that their employees are motivated, the effects of such a variable are negative and insignificant overall. In this case, firms might be focusing too much on short-term rewards such as performance pay, which ultimately reduces intrinsic motivation because the incentive comes from outside. Although there might be motivated employees, their efforts can be focused on other activities such as efficiency, administration or financial numbers. An important aspect to have in mind regarding employee motivation is that strategies focused on enhancing individual innovation might mitigate collaboration, which is crucial under the product and marketing innovation processes.

5.1. Implications

This work adds insights to the extant literature both in theory and practice, providing additional knowledge to the relationship between employee autonomy and start-up innovation.

5.1.1. Theoretical implications

This study expands the body of literature on Transformational Leadership (TL), Psychological Empowerment (PE), and Innovative Work Behaviour (IWB), emphasizing the pivotal role of employees as sources of innovation. It provides empirical evidence that employees act as drivers of innovation and become a crucial asset for the competitive advantage of start-ups. Moreover, this study underscores the importance of environmental factors at the workplace that enhance or diminish the innovative behaviour of employees. Further, this study suggests that the effects of employee autonomy may vary regarding the start-up characteristics, such as the use of technologies, organizational structure, hierarchy, company culture or industry in which the start-

up operates. Finally, this study highlights the importance of employee-centric approaches to innovation, especially in contexts of limited resources.

5.1.2. Practical Implications

The practical implications of this study are primarily relevant for start-up leaders and managers, helping them to further understand the importance of employee autonomy and its implications in start-up innovation. Because this study builds on traditional theories of employee autonomy combined with the timely relevance of start-ups, its findings can be used to develop new strategies to enhance employee autonomy and start-up innovation performance, while overcoming potential obstacles along the way. This research also provides knowledge on the implementation of human resources practices and highlights the importance of employee motivation in the workplace. Start-up incubators can also benefit from the findings of this study to develop programs that support start-ups in giving their employees more autonomy and freedom.

5.1. Limitations

While this study provides valuable insights into the topics of employee autonomy and start-up innovation, it is important to highlight some limitations.

First, some construct measurements of the study present a limitation. While the dataset used in this study comes from a reliable secondary source, some of the variables fail to measure the intended constructs. The variable *start-up* was defined keeping only the observations of the firms that were 10 years or younger and that had between 10 and 49 employees. However, firms that are a minimum of 10 years old is a broader concept than the 0-6 years concept accepted by the researcher. In addition, firms having between 10 and 49 employees may also contain observations of small non-start-up businesses, which may affect the results of this study. Start-ups can also contain from 1 to 9 employees failing to capture even smaller firms. Future research should create a better construct for start-ups, making sure that it comprises only characteristics of start-ups in age and number of employees, for instance, firms that are between 0 and 6 years and have between 1 to 49 employees.

The variable *employee autonomy* measures only if the managers create an environment in which employees can autonomously carry out their tasks. However, the researcher believes that this variable fails to measure other ways of employee autonomy such as being able to contribute to ideas in the workplace, working location, and schedule flexibility. It also fails to measure if the

employees can organise their own working space or how they carry out their activities. Therefore, the variable *employee autonomy* lacks other forms of autonomy that can affect innovation as well. The study by De Spiegelaere et al., (2016) finds three different measures of employee autonomy, namely work method autonomy, work scheduling autonomy and work time autonomy. The three measures of autonomy help create a better construct that measures other dimensions of autonomy, therefore, using it would suit better this study.

The variable *morale* measures the importance that the firms attribute to improving the morale of their employees. However, this variable does not measure to what extent the employees have morale that can affect the firm positively, which may lead to unexpected results in the regression analysis. In line with this, the variable *employee ideas* measures the importance that the firm gives to increasing the capacity of the employees to articulate ideas, but does not provide a measurement of the employees that articulate their ideas in the workplace. Finally, the variable motivation measures how motivated firms think their employees are. In this case, the firm might have the wrong belief about the motivation of their employees, failing to capture the real levels of motivation of the employees.

Second, future studies should add more control variables that affect the settings of employee autonomy and start-up innovation, given that the time and resource constraints of this study limit the ability of the researcher to study the impact of other important factors.

Third, while the data of this study comes from the European Company Survey of 2019, some aspects of the research limit its generalizability. The *start-up* variable fails to only measure the desired construct, therefore, some of the findings might be hard to extrapolate to solely start-ups, given that the sample is thought to comprise observations of small firms as well. Moreover, the survey was carried out with European companies only, which might limit the application of this study to other regions, considering the differences in cultures and practices across the globe.

Fourth, this study uses cross-sectional data, failing to capture the effects of employee autonomy on start-up innovation in the long term.

Fifth, this study is limited by time and resources, resulting in the omission of potentially relevant variables such as industry or type of hierarchy of the firm.

5.2. Future research directions

Considering the results and the limitations highlighted, this study can benefit from future improvements. As explained in the limitations, more accurate definitions of start-up and employee autonomy are needed. Future research should measure start-ups being between 0 and

6 years old and having between 1 and 49 employees. Moreover, an in-depth analysis of the control variables is needed, and adding additional variables could add value to the research. For example, variables measuring the industry in which the start-up operates, the company culture, leadership style or hierarchy structure.

In line with the results of the three types of innovation, it is also crucial that future research studies how they can be enhanced, and which factors increase each of them in start-ups. Accordingly, studying the differences in innovation across industries can deliver further insights into the mediating role of using a personal computer. For example, there can be a difference in innovation performance related to the different types of jobs in start-ups.

Given that the data of this study is cross-sectional, a longitudinal study can add additional insights into the effects of employee autonomy on start-up innovation in the long term, given that other factors such as the development of the business and growth can have a moderator effect between autonomy and innovation.

In addition, future studies should develop two different surveys where the perspectives of leaders and the perspectives of employees are captured. This way, there will not be biases in terms of what the leaders believe and what the actual situation is regarding employee motivation and morale. In line with this, it is also important to stress the need to create more accurate scales of the involvement of employees in the development of new ideas and task allocation, given that this study fails to measure the actual involvement of employees in both cases and only measures the importance that start-ups attribute to those.

6. Conclusion

This study underscores the significance of employee autonomy in the context of start-up innovation performance. The findings reveal different effects of employee autonomy across the three types of innovation: product, process and marketing innovation. While there is significant empirical evidence for a positive effect of employee autonomy on process innovation in start-ups, this study fails to provide supporting evidence for a positive effect of employee autonomy in product and marketing innovations. Moreover, using a personal computer at the workplace mediates the relationship between employee autonomy and start-up innovation performance, and its effects are consistent across the three types of innovation. The overall impact of autonomy on process innovation is robust and relevant to the European business landscape. This study further highlights the potential relevance of work-related environmental factors that can enhance employee autonomy, such as organizational structure, hierarchy or the industry in

which the start-up operates. The theoretical implications of this study underscore the pivotal role of employees as sources of innovation to remain competitive, and the practical implications highlight the need to foster strategies that enhance employee autonomy. However, the limitations of this study suggest future research to study what factors limit the effect of employee autonomy on product and marketing innovation, highlighting the importance of resource constraints and the fast-changing business environment.

7. References

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8. Appendix

Appendix 1. Variables and constructs

Construct	Question in survey	Definition	Name in dataset	Type of variable
Firm size	Size Group Updated	Firm size.	scr_size_grp	Categorical
Firm age	Age of the establishment in categories	Firm age.	est_age	Categorical
Product innovation	Since 2016, has this establishment introduced any new or significantly changed products or services?	Introduction of new products or significant change of the existing ones.	innoprod	Dummy
Process innovation	Since 2016, has this establishment introduced any new/changed processes either for producing goods or supplying services?	Introduction or change of processes either for producing goods or supplying services.	innoproc	Dummy
Marketing innovation	Since 2016, has this establishment introduced any new or significantly changed marketing methods?	Introduction or change of marketing methods.	innomark	Dummy
Employee Autonomy	Which of these two statements best describes the general approach to management at this establishment?	Autonomy that the employee has to carry out his activities without the control of a manager.	supchek	Categorical
Use of personal computer	How many employees in this establishment use personal computers or laptops to carry out their daily tasks?	Percentage of employees that use a personal computer to carry out their daily tasks.	ictcomp_d	Categorical
Monitoring	Does this establishment use data analytics to monitor employee performance?	Extent to which the firm monitors the performance of its employees.	itperfmon	Categorical
Improving employee morale	Improving employee morale - important for providing training to employees	Importance that the firm gives to improving employee morale	trmot	Categorical
Hearing Employee ideas	Increasing the capacity of employees to articulate ideas about improvement - important for providing training to employees	The extent to which the firm thinks is important to increase the capacity of the employees to articulate ideas about improvement.	trinn	Categorical
Extra pay linked to performance	Variable extra pay linked to individual performance - employees received variable pay	Percentage of employees that receive extra pay linked to their individual performance in the firm.	vpinper_d	Categorical
Involving employees in task allocation	To what extent does involving employees in work organisation changes give the establishment a competitive advantage?	Extent to which involving employees in how the work is organised gives the firm a competitive advantage.	eicomp	Categorical
Employee Motivation	Overall, how motivated do you think employees in this establishment are?	Extent to which the firm thinks their employees are motivated.	lowmot	Categorical

Appendix 2. Variables from the ECS2019 Data Dictionary

Pos. = 6 **Variable =** scr_size_grp **Variable label =** Size Group updated
This variable is *numeric*, the SPSS measurement level is *NOMINAL*
SPSS user missing values = -1.7976931348623155e+308 thru -1.0
Value label information for scr_size_grp
Value = 0.0 Label = 0-9 or No size provided
Value = 1.0 Label = Small (10-49)
Value = 2.0 Label = Medium (50-99, 50-199 or 50-249)
Value = 3.0 Label = Large (100+, 200+ or 250+)

Pos. = 385 **Variable =** est_age **Variable label =** Age of the establishment in categories
This variable is *numeric*, the SPSS measurement level is *NOMINAL*
SPSS user missing values = -3.0 thru None

Value label information for est_age
Value = 1.0 Label = 10 years or less
Value = 2.0 Label = 11 to 20 years
Value = 3.0 Label = 21 to 30 years
Value = 4.0 Label = more than 30 years
Value = -3.0 Label = skipped

Pos. = 25 **Variable = innoprod** **Variable label =** Since 2016, has this establishment introduced any new or significantly changed products or services?
This variable is *numeric*, the SPSS measurement level is *SCALE*
SPSS user missing values = -1.7976931348623155e+308 thru -1.0
Value label information for innoprod
Value = 1.0 Label = Yes, new to the market
Value = 2.0 Label = Yes, new to the establishment, but not new to the market
Value = 3.0 Label = No
Value = -3.0 Label = Skipped

Pos. = 26 **Variable = innoproc** **Variable label =** Since 2016, has this establishment introduced any new/changed processes either for producing goods or supplying services?
This variable is *numeric*, the SPSS measurement level is *SCALE*
SPSS user missing values = -1.7976931348623155e+308 thru -1.0
Value label information for innoproc
Value = 1.0 Label = Yes, new to the market
Value = 2.0 Label = Yes, new to the establishment, but not new to the market
Value = 3.0 Label = No
Value = -3.0 Label = Skipped

Pos. = 27 **Variable = innomark** **Variable label =** Since 2016, has this establishment introduced any new or significantly changed marketing methods?
This variable is *numeric*, the SPSS measurement level is *SCALE*
SPSS user missing values = -1.7976931348623155e+308 thru -1.0
Value label information for innomark
Value = 1.0 Label = Yes, new to the market
Value = 2.0 Label = Yes, new to the establishment, but not new to the market
Value = 3.0 Label = No
Value = -3.0 Label = Skipped

Pos. = 42 **Variable = supchek** **Variable label =** Which of these two statements best describes the general approach to management at this establishment?
This variable is *numeric*, the SPSS measurement level is *SCALE*
SPSS user missing values = -1.7976931348623155e+308 thru -1.0
Value label information for supchek
Value = 1.0 Label = Managers control whether employees follow the tasks assigned to them
Value = 2.0 Label = Managers create an environment in which employees can autonomously carry out their tasks
Value = -3.0 Label = Skipped

Pos. = 35 **Variable = ictcomp_d** **Variable label =** [ICTCOMP and WPSIZE_MM] - How many employees in this establishment use personal computers or laptops to carry out their daily tasks?
This variable is *numeric*, the SPSS measurement level is *SCALE*
SPSS user missing values = -1.7976931348623155e+308 thru -1.0
Value label information for ictcomp_d
Value = 1.0 Label = None at all
Value = 2.0 Label = Less than 20%
Value = 3.0 Label = 20% to 39%
Value = 4.0 Label = 40% to 59%
Value = 5.0 Label = 60% to 79%
Value = 6.0 Label = 80% to 99%
Value = 7.0 Label = All
Value = -3.0 Label = Skipped

Pos. = 39 **Variable = itperfmon** **Variable label =** Does this establishment use data analytics to monitor employee performance?
This variable is *numeric*, the SPSS measurement level is *SCALE*
SPSS user missing values = -1.7976931348623155e+308 thru -1.0
Value label information for itperfmon
Value = 1.0 Label = Yes

Value = 2.0 Label = No
Value = -3.0 Label = Skipped

Pos. = 68 **Variable = trinn** **Variable label =** Increasing the capacity of employees to articulate ideas about improvement - important for providing training to employees
This variable is *numeric*, the SPSS measurement level is *SCALE*
SPSS user missing values = -1.7976931348623155e+308 thru -1.0
Value label information for trinn
Value = 1.0 Label = Very important
Value = 2.0 Label = Fairly important
Value = 3.0 Label = Not very important
Value = 4.0 Label = Not at all important
Value = -3.0 Label = Skipped

Pos. = 69 **Variable = trmot** **Variable label =** Improving employee morale - important for providing training to employees
This variable is *numeric*, the SPSS measurement level is *SCALE*
SPSS user missing values = -1.7976931348623155e+308 thru -1.0
Value label information for trmot
Value = 1.0 Label = Very important
Value = 2.0 Label = Fairly important
Value = 3.0 Label = Not very important
Value = 4.0 Label = Not at all important
Value = -3.0 Label = Skipped

Pos. = 77 **Variable = vpinper_d** **Variable label =** [VPINPER and WPSIZE_MM] - Variable extra pay linked to individual performance - employees received variable pay
This variable is *numeric*, the SPSS measurement level is *SCALE*
SPSS user missing values = -1.7976931348623155e+308 thru -1.0
Value label information for vpinper_d
Value = 1.0 Label = None at all
Value = 2.0 Label = Less than 20%
Value = 3.0 Label = 20% to 39%
Value = 4.0 Label = 40% to 59%
Value = 5.0 Label = 60% to 79%
Value = 6.0 Label = 80% to 99%
Value = 7.0 Label = All
Value = -3.0 Label = Skipped

Pos. = 115 **Variable = eicomp** **Variable label =** To what extent does involving employees in work organisation changes give the establishment a competitive advantage?
This variable is *numeric*, the SPSS measurement level is *SCALE*
SPSS user missing values = -1.7976931348623155e+308 thru -1.0
Value label information for eicomp
Value = 1.0 Label = To a great extent
Value = 2.0 Label = To a moderate extent
Value = 3.0 Label = To a small extent
Value = 4.0 Label = Not at all
Value = -3.0 Label = Skipped

Pos. = 127 **Variable = lowmot** **Variable label =** Overall, how motivated do you think employees in this establishment are?
This variable is *numeric*, the SPSS measurement level is *SCALE*
SPSS user missing values = -1.7976931348623155e+308 thru -1.0
Value label information for lowmot
Value = 1.0 Label = Very motivated
Value = 2.0 Label = Fairly motivated
Value = 3.0 Label = Not very motivated
Value = 4.0 Label = Not at all motivated
Value = -3.0 Label = Skipped

Appendix 3. Moderator effect analysis of personal computer.

In line with the results of the main regression analysis. A moderator analysis is also carried out with the variable personal computer. This is done in an attempt to discover if the variable personal computer moderates the effect of employee autonomy on start-up innovation. Results

of Table 10 fail to demonstrate that autonomy combined with a personal computer does not give higher innovation levels. The results of the mediating effect in the main research show that personal computer has a mediating effect on innovation.

Table 9. . OLS models with autonomy and personal computer.

Variables	(1) Product innovation	(2) Process innovation	(3) Marketing innovation
Autonomy	0.0354	0.0595***	0.0430**
	(0.0216)	(0.0213)	(0.0207)
Personal computer	0.0435***	0.0276***	0.0277***
	(0.00462)	(0.00456)	(0.00445)
Constant	0.154***	0.167***	0.149***
	(0.0229)	(0.0226)	(0.0220)
Observations	2,278	2,271	2,272
R-squared	0.043	0.023	0.022

Note: Standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1

When adding the variable personal computer into the regression, the effect of autonomy on product innovation remains both positive and insignificant. However, the effects of autonomy on marketing innovation become significant ($p<0.05$). The effects of personal computer on the three types of innovation remain positive and significant as in the regression with all the moderators. However, the findings of Table 6 suggest that the effect of employee autonomy on innovation could be channeled through the use of personal computers. For this reason, an additional regression has been carried out after creating an interaction term between employee autonomy and the use of personal computers. Table 7 reports the OLS regression analysis results with the addition of the interaction term (*Auton*PersComputer*).

Table 10. OLS models with interaction term between autonomy and personal computer.

Variables	(1) Product innovation	(2) Process innovation	(3) Marketing innovation
Autonomy	0.00882	-0.0131	0.0826**
	(0.0431)	(0.0426)	(0.0414)
Personal computer	0.0376***	0.0115	0.0365***
	(0.00949)	(0.00935)	(0.00910)
Auton*PersComputer	0.00775	0.0211**	-0.0115
	(0.0109)	(0.0107)	(0.0104)
Constant	0.172***	0.219***	0.121***
	(0.0350)	(0.0346)	(0.0336)
Observations	2,278	2,271	2,272
R-squared	0.043	0.025	0.022

Note: Standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1

The results of table 7 suggest that when firms give employees more autonomy and they use their personal computer to carry out their activities the firms do not become more innovative on average. Despite the small positive effect of autonomy and the use of personal computers on process innovation, it cannot be said that the use of a personal computer mediates the effect of autonomy on innovation. The results section delves deeper into the reasons why there might exist this relationship.

Appendix 4. STATA coding. Do-file for regression analysis.

```
*Thesis Lucia Martinez Meseguer European Company Survey Dataset
* Data cleaning and seven tests
label data "Master thesis Lucia Martinez"

keep est_age scr_size_grp innoprod innoproc innomark supchek ictcomp_d
itperfmon trialerr trmot trinn vpinper_d eicomp lowmot

keep if scr_size_grp ==1
rename scr_size_grp firmsize

replace est_age  =. if est_age == -3
keep if est_age == 1
rename est_age firmage

*Turning the 'skipped' option into missing values for every variable
replace supchek = . if  supchek  == -3
replace ictcomp_d = . if ictcomp_d == -3
replace itperfmon = . if   itperfmon == -3
replace trialerr = . if  trialerr  == -3 | trialerr == -9
replace trmot =. if trmot == -3
replace trinn = . if trinn == -3
replace vpinper_d = . if vpinper_d   == -3
```

```
replace eicomp = . if eicomp == -3
replace lowmot =. if lowmot == -3

*Turning innovation variables into dummies
*Product innovation dummy
replace innoprod =. if innoprod == -3
rename innoprod productinnovation

replace productinnovation = 0 if productinnovation == 3
replace productinnovation = 1 if productinnovation == 1
replace productinnovation = 1 if productinnovation == 2
label define productinnovation_label 0 "no innovation" 1 "innovation"
label values productinnovation productinnovation_label

*Process innovation variable
replace innoproc =. if innoproc == -3
rename innoproc processinnovation
replace processinnovation = 0 if processinnovation == 3
replace processinnovation = 1 if processinnovation == 1
replace processinnovation = 1 if processinnovation == 2
tab processinnovation

label define processinnovation_label 0 "no innovation" 1 "innovation"
label values processinnovation processinnovation_label
tab processinnovation

*Marketing innovation dummy
replace innomark =. if innomark == -3
rename innomark marketinginnovation

replace marketinginnovation = 0 if marketinginnovation == 3
replace marketinginnovation = 1 if marketinginnovation == 1
replace marketinginnovation = 1 if marketinginnovation == 2
label define marketinginnovation_label 0 "no innovation" 1 "innovation"
label values marketinginnovation marketinginnovation_label

*Autonomy variable
rename supchek emp_autonomy
replace emp_autonomy = 0 if emp_autonomy == 1
replace emp_autonomy = 1 if emp_autonomy == 2
label define emp_autonomy_label 0 "managers control" 1 "managers do not
control"
label values emp_autonomy emp_autonomy_label
rename emp_autonomy autonomy

*Renaming the variables that we kept
rename ictcomp_d personalcomputer
rename itperfmon monitoring
rename trmot improvemorale
rename trinn employeeideas
rename vpinper_d extrapay
rename eicomp involveemployee
rename lowmot motivation

*Descriptive and correlation statistics
ssc install asdoc
```

```
asdoc summarize firmsize firmage productinnovation processinnovation
marketinginnovation autonomy personalcomputer monitoring improvemorale
employeeideas extrapay involveemployee motivation,
save(summary_statistics.doc)

pwcorr productinnovation processinnovation marketinginnovation autonomy
personalcomputer monitoring improvemorale employeeideas extrapay
involveemployee motivation

*Regression without controls Table 4
reg productinnovation autonomy
reg processinnovation autonomy
reg marketinginnovation autonomy

*Full regression Table 6
reg productinnovation autonomy personalcomputer monitoring improvemorale
employeeideas extrapay involveemployee motivation

reg processinnovation autonomy personalcomputer monitoring improvemorale
employeeideas extrapay involveemployee motivation

reg marketinginnovation autonomy personalcomputer monitoring
improvemorale employeeideas extrapay involveemployee motivation

*Regression with mediation effect Table 7
*1. Regressing mediator on independent variable
reg personalcomputer autonomy

*2. Regressing dependent on independent
reg productinnovation autonomy
reg processinnovation autonomy
reg marketinginnovation autonomy

*3. Regressing dependent on independent with mediator

reg productinnovation autonomy personalcomputer
reg processinnovation autonomy personalcomputer
reg marketinginnovation autonomy personalcomputer

*Regressions with moderating effect
reg productinnovation autonomy personalcomputer
reg productinnovation autonomy personalcomputer auto_computer
reg processinnovation autonomy personalcomputer
reg processinnovation autonomy personalcomputer auto_computer
reg marketinginnovation autonomy personalcomputer
reg marketinginnovation autonomy personalcomputer auto_computer
reg marketinginnovation autonomy personalcomputer
```