TÍTULO

APPROACHING THE RELATIONSHIP BETWEEN ENTREPRENEURSHIP AND INNOVATION FROM DIFFERENT ANGLES

APROXIMÁNDONOS A LA RELACIÓN ENTRE EL EMPRENDIMIENTO Y LA INNOVACIÓN DESDE DIFERENTES ÁNGULOS

AUTORA

Serhiy Lyalkov Lyalkova

Esta edición electrónica ha sido realizada en 2022

Fecha de lectura	30/05/2019
Instituciones	Universidad Internacional de Andalucía ; Universidad de Huelva
Director	Dr. D. José María Millán Tapia
Programa de Doctorado	Doctorado en Economía, Empresa, Finanzas y Computación
ISBN	978-84-7993-654-9
©	Serhiy Lyalkov Lyalkova
©	De esta edición: Universidad Internacional de Andalucía
Fecha documento	2019

Approaching the relationship between entrepreneurship and innovation from different angles

–Aproximándonos a la relación entre el emprendimiento y la innovación desde diferentes ángulos–

Serhiy Lyalkov Lyalkova

International University of Andalusia
Supervisor: Dr. José María Millán Tapia

February, 2019

Universidad Internacional de Andalucía, 2022

Universidad Internacional de Andalucía, 2022

A mi madre

Universidad Internacional de Andalucía, 2022

Index

Preface

The main goal of the present PhD thesis is to shed light about the relationship between innovation and entrepreneurship regarding internal and external factors as well as unravel the effects that entail in self-employment. It is submitted to the *International University of Andalusia*.

This main topic emerged after finishing my Master's thesis at the *University of Huelva and International University of Andalusia* regarding the inequalities in adoption and use of ICT (Information and Communication Technologies) by individuals. Subsequently, due to the transmitted motivation of Emilio Congregado, I decided to started the current research written under the supervision of José María Millán, who introduce my in the topic of entrepreneurship, spotting the highly interesting gap related with innovation and entrepreneurship. My most sincere appreciation to him regarding the help, patience, effort and knowledge provided.

Likewise, I would like express my gratitude to the Department of Economics of University of Huelva and the Master's faculty staff and colleagues, in particular, Antonio Golpe, Jesus Iglesias, Emilio Congregado, Patricia Pichardo, José Carlos Vidés, Pedro Toscano, among others. I could not quantify how much I have learned from all of you.

I am also indebted to Ana Millan, André van Stel, Andrew Burke and Mónica Carmona for their valuable contributions on different parts of this dissertation.

Finally, I would like to express my sincere thanks to my friends and my family for their support during this journey, specially to my mother Alla and my grandmother Nina, whose constant effort and dedication have shaped me as person. Wholehearted thanks, this dissertation is dedicated to the most important women in my life.

Serhiy Lyalkov
Huelva, February 2019

Universidad Internacional de Andalucía, 2022

Part I: Introduction

Universidad Internacional de Andalucía, 2022

Chapter 1: Introduction

1.1. Introduction

During the last century, the concept of innovation and entrepreneurship have aroused the interest of scholars and researchers. Accordingly to European Commission, innovation is the key for the economic development, growth, wealth and job creation, as well as, a source of competitiveness increaser in the current global economy. Firstly, it was established that these advances were conditioned by the resources available in terms of labour and physical capital, later the knowledge was included as another factor in the equation, which proper and efficient use lead to the innovation and this in turn to endogenous growth and development. Several factors, such as expenditures on Research and Development (R&D), subsidies, tax credits and Intellectual Property Rights (IPR), among others, determine the level of knowledge stock, and consequently, innovation across different countries. Mentioned factors, jointly with the available human capital, allow the innovation raising due to knowledge spillovers, supported by universities, spin-offs, incumbent firms among others agents, boosting ideal environment for the growth of business opportunities. Additionally, this mechanism requires managerial and organizational skills to empower its exploitation, commonly provided by entrepreneurship, both innovative, creating and developing new ideas; and imitative, commercializing the already existing products or services. Thereupon, the existence of differences in their behaviour arouse interest and certain questions, such as, the impact of innovation determinants on the quality and allocation of entrepreneurship, as well as the performance level of these different types.

All along the present dissertation the proposed topic is unrevealed. Based on data referring to countries of the European Union, is proposed an exhaustive analysis of empirical nature, focused on clarifying the relationship between innovation and entrepreneurship, covering both internal and ex-

ternal determinants in order to clarify the effects on entrepreneurship related with three main questions:

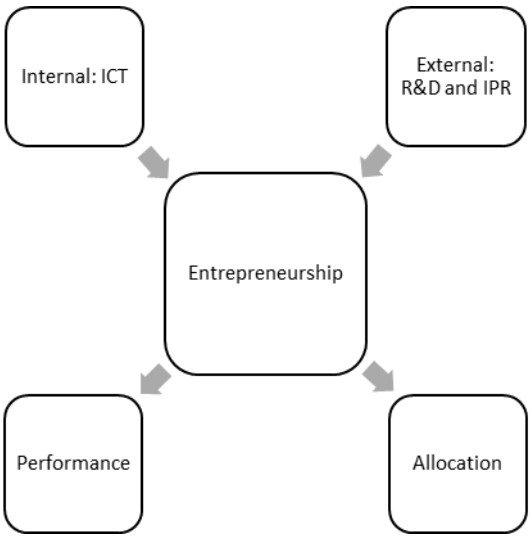
i. The performance variation.
ii. The allocation of the different types of entrepreneurship.
iii. The quality of the entrepreneurship.

The main purpose of this research is to understand how the entrepreneurial market behaves under the effect of the key factors that determine innovation levels. To shed light on these issues, Information and Communication Technologies (ICT) is used as a key internal determinant in the process of innovation in entrepreneurship. Nowadays the availability of digital skills and the capability of access and use could condition the firm performance, productivity levels and allow highlight by being competitive. However, the persistence of inequalities regarding these matters is widely studied and already established as "digital divide". In the main, the digital gap impacts negatively the whole population of individuals in current society, including SMEs and self-employers, consequently reducing their capacity of growth and development. The existence of barriers augmenting the reluctance to adoption and use is broad, from high costs of integration, lack of digital literacy to managerial attitude, achieving hamper the process. Thus, is necessary to distinguish the profiles of entrepreneurs who adopt and use the mentioned technologies, and which not. As well as, figure out the main barriers that hamper the adoption and use, in order to reduce the below mentioned breach and foster policies focused on its promotion among entrepreneurship. Uncover the type of relationship existing between adaptation and use versus economic performance, e.g., entrepreneurial earnings, would boost the awareness of its potential benefits. Most of the previous studies focused on productivity, on large companies or on seeking to respond to the effects of direct investment. In this case, we will focus on micro businesses, mostly self-employed with dependent or independent employees; regarding the implementation and use of ICTs and measure the returns in monetary terms.

As external determinants, we use (i) country-level expenditures on Research and Development (R&D) as well as (ii) the Intellectual Property Rights, e.g. trademarks and patents. A response will be given regarding how variations between these variables, amount assigned on investment or strictness of legislation, shape the structure of the entrepreneurial and self-employment market, plus quantify impact on the direct performance.

Likewise, due to the heterogeneity of our data, we will carry out a comparative analysis between countries included in the Euro zone, considering the unemployment rate to avoid the possible biases resulting from the economic cycle. Therefore, the analysis of external determinants is performed in regard to investment in Research and Development (R & D) and Intellectual Property Rights, as instruments of knowledge transmission and catalysts of innovation, mind that their variations impact positively in distinct strata of entrepreneurship. According to previous analysis, higher R & D investment and stricter Intellectual Property Rights are the necessary conditions to achieve optimal development and economic growth, increasing the dissemination of knowledge with the consequent increase of opportunities and protection level of the assets already created, respectively. In this research, we will go further by conditionally analysing the plausible effects of these variables on the different types of entrepreneurship, and how regarding the levels achieved determine the proportion of them, plus their influence on performance measured in terms of earnings, allowing conceptualize the quality of the entrepreneurial market.

Fig. 3. Scheme of dissertation.



For the fulfilment of the objectives proposed, we will make use of microdata from the European Survey on working conditions (EWCS), and more specifically, using the fifth and sixth waves (2010-2015), being the first waves that capture the heterogeneity of entrepreneurship. These data

are collected and offered by the European agency Eurofound (European Foundation for the Improvement of Living and Working Conditions). Additionally, we will use the Executive Opinion Survey of the World Economic Forum (WEF-EOS) and the data regarding Intellectual Property Rights published by the World Intellectual Property Organization (WIPO).

This work is of empirical quality and a variety of models will be made to explain the phenomenon from different angles adding a robustness determinant mandatory for studies of this nature.

1.2. Chapter overview

The current thesis consists of four main parts. First, across the second chapter, Information and Communication Technologies as a determinant of the digital divide in entrepreneurship is analysed, figuring out the reasons of adoption, use and frequency regarding the different types of self-employment, controlled by the economic sector, education attainment, jobs tenure and other demographic variables. Additionally, regarding the thresholds of adoption and use, the direct impact con potential earnings across the considered types of self-employment is quantified. For that purpose, the proposition of justify the nonlinear relationship between the adoption of ICT and the generated yields is unrevealed, understanding how the step from not using to using grants greater benefits.

In the third chapter, an empirical analysis focused on support the additional explanatory function of the registered trademarks, together with the main indicator, the patents, of the business activity is analysed. Commonly, patents are related to the innovative process in the strictest sense due to original, non-trivial and productive inventions which usually belongs to larger companies instead of SMEs. On the other hand, trademarks target is to distinguish and protect the reputation of goods, services and corporate identities, in summary, the commercial capability. With regard to the extrapolation in terms of entrepreneurship, the innovative process is highly related with the Schumpeterian entrepreneurs, creative and disruptive ones, in counter part of Kizrenian entrepreneurs characterized by the function of opportunists or speculative agents who turn the innovation into the market through the entrepreneurial behaviour and commercialization. The lack of patents related with the small business aware the possibility of establishing a positive relationship between the number of registered trademarks in a country given the proportion of Kirznerian self-employed workforce.

The discussion continues along the fourth chapter with the previously raised question regarding the allocation of entrepreneurship, on this occasion, focusing on the plausible effects on the quality, understood as contribution to contribution to growth, progress and development measured in terms of performance, of the self-employed workforce through the exposure to the knowledge spillovers and market opportunities generated by determinants of innovation process. For this purpose, is analysed the impact of expenditures on Research and Development, measured as percentage of GDP, on the different proportions of the self-employment market, conditioned by the (i) occupational status, self-employed with dependent workers, self-employed independent self-employed and dependent self-employed; and the entrepreneurship motivation, for being excluded from the labour market and searching for it, that is, necessity entrepreneurship; and the result of an idea or business opportunity, see, opportunity entrepreneurship. The ultimate goal is to figure out and conceptualize the determinants of high-quality entrepreneurship.

Finally, in the fifth chapter, the empirical analysis seeks to uncover the relationship between investment in R & D, Intellectual Property Rights and individual level entrepreneurial earnings. R&D expenditures is widely considered as indicator of knowledge stock level regarding opportunities creation, technological progress and regional growth, conditioned by knowledge spillovers, whose dissemination is hampered o promoted in the relation of Intellectual Property Rights strictness favouring the distribution of innovative or imitative entrepreneurship as well as performance and contribution to the economy. Thus, unravel the shaping moderator effect of IPRs is essential to understand the relationship between knowledge stock investment, measured in R&D expenditures, and the quality of entrepreneurship measured in entrepreneurial earnings.

The sixth and final chapter is dedicated to the final conclusions, the implications derived from the analyses as well as limitations.

1.3. Publications

The presented chapters are submitted on several journals.

Chapter 2, ***'Digital Divide' among European entrepreneurs: who benefits most from ICT adoption and intensity of use***, jointly with Burke, A.,

A. Millán, J.M. Millán, and A. van Stel is submitted and under review in *Journal of Business Research.*

Chapter 3, ***Trademarks as indicator of Kirznerian entrepreneurship****,* jointly with M. Carmona, E. Congregado, A. Millán and J.M. Millán is under second review in *Industry and Innovation.*

Chapter 4*,* ***How does country R&D change the allocation of self-employment across different types***, jointly with Burke, A., A. Millán, J.M. Millán and A. van Stel is accepted and going to be published in *Small Business Economics*.

Chapter 5, ***The moderating role of IPR on the relationship between country-level R&D and individual-level entrepreneurial performance***, jointly with Van Stel, A., A. Millán and J.M. Millán is under second review in *Journal of Technology Transfer*.

Part II: ICT and Entrepreneurs

Universidad Internacional de Andalucía, 2022

Chapter 2: 'Digital divide' among European entrepreneurs: Who benefits most from ICT implementation?

We investigate which types of entrepreneurs (independent own-account workers – IOA, self-employed with employees – SEwE, and dependent self-employed workers – DSEW) adopt and use ICT more frequently in their businesses, while controlling for sector of economic activity and other relevant controls. Moreover, we examine the relationship between ICT usage frequency and entrepreneurial performance as captured by earnings. Using recent survey data for 35 European countries, we find that earnings rise with ICT usage frequency, but that this relationship is non-linear in the sense that the first step (from 'never use ICT' to 'almost never use ICT'), which captures ICT adoption, has the biggest impact on earnings. Moreover, we find that the increase in earnings associated with ICT adoption and usage is bigger for SEwE and DSEW compared to IOA. The result for DSEW indicates a catch-up effect as this group was found to lag behind in ICT usage. Finally, we find an indirect negative inertia effect of job tenure on ICT usage and earnings as entrepreneurs who run their business already for a longer time, less often adopt and use ICT in their businesses. Policy implications are discussed.

2.1. Introduction

The worldwide diffusion of the information and communication technology (ICT) has increased over the last decade at breakneck speed. Digital skills are needed to participate in today's modern societies and to improve one's economic situation. However, there are huge inequalities in access and adoption of ICT, affecting not only households but also businesses. Many scholars have defined this phenomenon as "digital divide". Differences in usage of ICT among firms are likely to affect firm performance. However, although many studies exist on performance effects of

ICT in large firms (Devaraj and Kohli, 2003), less is known about ICT effects in (very) small firms let alone in one-man businesses operated by own-account workers. In this paper we investigate the relationship between ICT implementation by entrepreneurs and their performance (as measured by earnings) while focusing on three specific elements in this relationship.

First, we make a distinction between ICT adoption (i.e. whether or not ICT is used at all in daily business operations) versus usage frequency (i.e. frequent versus infrequent use) as we consider that the first step (adoption) may have more impact on earnings than variations in ICT usage frequency at more advanced levels. This may especially be the case for one-man businesses where ICT usage may be less usual. Second, we consider that the relationship may differ between different types of entrepreneurs, in particular self-employed with employees (SEwE), independent own-account self-employed (IOA) and dependent self-employed workers (DSEW). Third, we pay attention to the potential role of inertia effects, i.e. a reluctance to implement ICT in daily business operations as a result of being used to operating in a certain way (e.g. hanging on to old habits involving older techniques). Such inertia effects, in turn, may negatively impact entrepreneurial performance in the long run.

We investigate our research questions by means of estimation of econometric models which use a big micro database allowing us to quantify the importance of ICT adoption and usage for the earnings of entrepreneurs. In particular, we use data of entrepreneurs in 35 European countries for the years 2010 and 2015. Although it is intuitive that ICT implementation will increase business earnings of entrepreneurs, to our knowledge this relationship has never been quantified.

We contribute to extant literature in several ways. First, whereas most studies of ICT effects focus on large firms (Bayo-Moriones et al., 2013) or SMEs (e.g. Barba-Sánchez et al., 2007; Arendt, 2008; Alam and Noor, 2009), the present paper focuses on the segment of the smallest firms (mostly micro firms with less than ten employees), as the vast majority of entrepreneurs captured by our data base either operate on their own (IOA and DSEW) or operate a small micro business (most SEwEs). Smaller firms may use a different approach to ICT adoption and usage compared to larger firms (Lucchetti and Sterlacchini, 2004). Second, and strongly related to the first contribution, although extant literature on barriers and effects of ICT usage employs the firm-level as unit of observation (e.g. Hol-

lenstein, 2004; Hempell, 2005; Alam and Noor, 2009; Haller and Siedschlag, 2011), in the present paper we use the individual-level as unit of observation. Third, whereas many studies in the field of ICT effects focus on the effects of investments in ICT, the present paper follows the seminal paper by Devaraj and Kohli (2003), who argued that actual usage of ICT within the firm may be more relevant for firm performance than the amount of investments spent on ICT. Fourth, most authors studying ICT effects rely on ICT impacts within the business as perceived by managers (Campo et al., 2011; Bayo-Moriones et al., 2013). The present paper uses a more objective performance measure, i.e. entrepreneurial earnings. Fifth, to our knowledge the present paper is the first to investigate non-linear effects of ICT adoption and usage on entrepreneurial performance and to allow for differential ICT effects on earnings for different types of entrepreneurs. Just as small and large firms may use different approaches towards ICT, different types of entrepreneurs (IOA, SEwE and DSEW) may also deal with ICT in different ways. This, in turn may imply different ICT-performance relationships between different types of entrepreneurs.

The set-up of the paper is as follows. Section 2 discusses the literature and derives hypotheses. This is followed by the data and methods sections, the results and the conclusions and policy implications.

2.2. Literature review and hypotheses

ICT adoption and usage by different types of entrepreneurs

Information and communication technologies (ICTs) can serve a number of functions in an organisation. In terms of financial performance, it can be seen as a means of enhancing productivity thereby raising profits for any given business opportunity being exploited. Moreover, it may enhance information systems (intra-company, but also externally with suppliers, customers and government), and it may facilitate market expansion. In short, ICT may serve as an efficiency enhancing driver of business performance and competitiveness (Bharadwaj, 2000; Liang et al., 2010; Stiroh, 2002; Levy and Powell, 2003; Zwick, 2003; Bertschek and Kaiser, 2004; Matteucci et al., 2005; Ong and Ismail, 2008). However, ICT may help fulfill organizational targets in non-profit organisations as well (Gombault et al., 2016).

In cases where ICT has the potential to enhance firm productivity, adoption depends on both sufficient financial resources to pay for inputs such as ICTs and complementary resources (e.g. human capital), operations systems and management techniques necessary in order to adopt, integrate and successfully operate an ICT system (Milgrom and Roberts, 1990). So a well-resourced firm is more likely to have the ability to adopt ICTs. In addition, a business with high complementary skills is also more likely to be aware of higher productivity benefits of ICTs and hence more likely to want to adopt them.

But ICTs can also play an entrepreneurial-enabling role in helping a business to exploit a new profit opportunity (Mozas-Moral et al., 2016). This is especially the case when a new profit opportunity necessitates a new configuration of technological resources to exploit it and in particular, when ICTs are pivotal components of these necessary resources required (Giotopoulos et al., 2017). As with productivity, more agile businesses with sufficient finance and complementary resources necessary for the successful adoption of ICTs are more likely to have the ability (i.e. option) of adopting it.

Considering both the productivity and entrepreneurial motives for adopting ICTs, it seems that in most cases one would expect adoption to be higher among independent rather than dependent self-employed. The former are likely to be more aware of the benefits and more able to adopt ICTs to enhance their business performance. By contrast, dependent self-employed are by definition dependent on an existing profit opportunity and hence unable to find and/or exploit another one to make them less depending on their main customer (Román et al., 2011). On the other hand, self-employed with employees are typically better resourced than independent own-account workers and hence in a better position to adopt ICTs. Our discussion so far leads to hypotheses 1a and 1b.

H1a: Independent own-account self-employed adopt and use ICT more often at work than dependent self-employed workers.

H1b: Self-employed with employees adopt and use ICT more often at work than independent own-account self-employed.

The relationship between ICT adoption and usage and entrepreneurial performance

Of course, if the productivity and entrepreneurial performance enhancing effects that firms expect to derive from adopting ICTs actually materialise then one would expect a positive performance effect of ICT adoption but also of a higher ICT usage frequency (Yunis et al., 2018).

H2: There is a direct positive relationship between ICT adoption and usage frequency at work and entrepreneurial performance.

It is notable among empirical studies that finding categorical evidence to support this hypothesis has proved to be difficult with many contrasting results (Dedrick et al.; 2003, Melville et al., 2004; Liang et al., 2010; Bayo-Moriones et al., 2013). In fact, part of the problem could be attributable to the fact there might not be a continuous positive relationship between ICTs use and performance simply because the main effect might be a discrete impact which occurs at the threshold when a firm first starts to adopt ICTs. In the case of productivity gains from ICTs, this might occur because even something as simple as first adoption of email or smart phones can have a dramatic productivity effect in terms of lowering costs, increasing communication volume/speed and lowering the time span required to execute any particular function. Likewise, in the case of the entrepreneurial effect, even simple minimalistic adoptions of ICTs to exploit new markets – such as digital payments or a new website – can open up significantly new customer bases for firms. Finally, a threshold performance effect may also occur because the simple act of adopting ICTs for the first time may indicate a relaxation of financial constraints and/or the acquisition of new skills or systems, complementary to the newly adopted ICTs, but which enhance performance in their own right.

As a counterargument, in cases where it takes time for the productivity and entrepreneurial performance enhancing benefits to occur this lagged effect may lead to minimal productivity or performance gains at the initial threshold point of ICT adoption (Brynjolfsson et al., 2002, Lee and Kim, 2006 and Das et al., 2011).

Nevertheless, we deem it possible that there are decreasing marginal returns in implementing ICT, i.e. the impact on performance of adopting ICT (i.e. first implementation of ICT systems in the business) may be bigger than the performance impact of using ICT with a higher frequency (compared to a lower frequency).

H3: There is a threshold performance effect from adoption of ICT which is manifested by a discrete increase in entrepreneurial performance at the initial point of ICT adoption.

Next, the external environment may affect the adoption of ICTs and hence indirectly influence firm performance. Highly competitive and disruptive economic environments may shift firms out of their comfort zone and put pressure on them to catch-up (Leibenstein, 1966). Indeed, an 'innovate or die' continuous innovation environment. Firms that don't innovate will suffer in such circumstances. If entrepreneurs adopt and internalise such an attitude of continuous change, a longer job tenure will be a benefit to them as they are used to changing their ways all the time, compared to entrepreneurs who just started their business. In that case, the entrepreneur's job tenure (i.e. the time he or she is already running the business) will be positively related to ICT adoption and use. If, in addition, there is a positive performance effect of ICT (see hypothesis 2), longer job tenure will indirectly have a positive influence on performance.

H4a: There is an indirect positive relationship between job tenure, ICT adoption and entrepreneurial performance.

But by contrast, firms may also fall victim to inertia effects (Hannan and Freeman, 1984). In particular, we consider that entrepreneurs who run their business already for a longer time (as measured by job tenure), may be less willing to change the operations of the business by implementing ICT (i.e., a negative relationship between job tenure and ICT adoption). It is in the nature of human beings to hang on to old habits rather than changing their ways of doing things. This holds for the behavior of individuals in everyday life (e.g. using mobile banking rather than traditional ways of banking; Choudrie et al., 2018) as well as for the behavior of entrepreneurs in the way they run their firms (Hannan and Freeman, 1984) [1]. It may be that in the short term, long job tenure positively impacts performance (as the entrepreneurs are very good in how they are currently running the business), but that in the long term, the reluctance of implementing ICT may negatively influence earnings.

[1] Such inertia effects may occur particularly in a low competitive environment which may allow firms to accumulate monopolistic supernormal profits which takes off the pressure to innovate (see Audretsch et al., 2001, for an overview of these countervailing influences of the competitive environment on innovation).

H4b: There is an indirect negative relationship between job tenure, ICT adoption and entrepreneurial performance.

Finally, we consider that the relationship between ICT and performance may differ across types of entrepreneurs. In particular, for certain types, e.g. employer entrepreneurs, there is much more to be gained from a proper implementation of ICT than for solo self-employed. This is because in bigger firms, the management of (the bigger amount of) resources is much more complex and hence the benefit of using ICT is also bigger (Flamholtz and Brzezinski, 2016). On the other hand, for self-employment types where ICT use is less usual (e.g. dependent self-employed workers), a catch-up effect may occur because in a pool of competitors where ICT usage is unusual, ICT may be used as a way to stand out from the crowd, and using ICT may have a bigger impact on performance in such circumstances (compared to a pool of competitor entrepreneurs who are all used to using ICT). These arguments give rise to our final two hypotheses.

H5a: The (positive) relationship between ICT adoption and usage frequency on the one hand and entrepreneurial performance on the other hand, is stronger for self-employed with employees than for independent own-account self-employed.

H5b: The (positive) relationship between ICT adoption and usage frequency on the one hand and entrepreneurial performance on the other hand, is stronger for dependent self-employed workers than for independent own-account self-employed.

These hypotheses illustrate that while the motivation to adopt ICTs can be fairly straightforward, the actual rate of adoption and impact on performance is likely to highlight a greater deal of heterogeneity across entrepreneurs and their contextual circumstances. We now move on to test the validity of our hypotheses.

2.3. Data and methods

Data and sample

We use data from waves 5 and 6 of the European Working Conditions Survey for 35 European countries, including the EU-28 together –EWCS 2010 and 2015– (Eurofound, 2012, 2016, 2018). This survey is carried out

every five years by the EU Agency Eurofound (European Foundation for the Improvement of Living and Working Conditions)[2] and offers key work-related information on 44,000 workers (including both employees and self-employed individuals) covering 35 European countries.[3] These workers are interviewed about several working condition aspects, including physical environment, workplace design, working hours, work organization and social relationships in the workplace. Depending on country size and national arrangements, the sample ranges from 1,000 to 4,000 workers per country. Our final sample includes men and women aged 18 to 65 who are classified as self-employed individuals. All individuals working part-time, i.e., working under 15 hours per week, are excluded. The final dataset, after removing cases with missing data for any of the relevant variables, yields 7,094 observations.

Dependent variables

ICT adoption and use frequency at work

Workers in the EWCS are asked whether his or her main paid job involves working with computers, laptops, smartphones, etc. This variable ranges from level 1 to 7. It equals 1 for individuals answering never and 7 for individuals answering all of the time. This discrete ordered variable serves us to operationalize use frequency. As regards adoption, we operationalize it by means of a binary variable equalling 1 for workers with (at least) some use of ICTs (levels 2 to 7 in previous scale).

Net monthly earnings

Workers in the EWCS are asked to refer to his/her average net earnings in recent months and, in case he/she doesn't know, are asked to give an estimate.[4] The variable is defined in PPP dollars of 2015 and converted to natural logarithms.

[2] This Foundation is an autonomous body of the European Union, created to assist in the formulation of future policy on social and work-related matters. Further information can be found on the Foundation website at www.eurofound.europa.eu.

[3] This set includes the EU-28 together, 5 candidate countries (Albania, the Former Yugoslav Republic of Macedonia, Montenegro, Serbia and Turkey) and 2 EFTA countries (Norway and Switzerland).

[4] The interviewer is asked to explain, if necessary, that net monthly earnings are the earnings at one's disposal after taxes and social security contributions.

Focal variables

Occupational status

Conditional on self-classification, the EWCS allows identifying the entrepreneur main activity status: (i) self-employed with employees (SEwE); (ii) independent own-account self-employed workers (IOA); and (iii) dependent self-employed worker (DSEW). In this sense, the heterogeneous nature of the situations involved in the DSEW category and the lack of reliable data make the analysis of this topic a challenging task. Precisely to overcome this issue, we use data from the EWCS 2010 and 2015, which are the first waves in the EWCS series allowing identification of the group of DSEW. We refer here to those individuals who work exclusively (or mainly) for a specific firm –as opposed to IOA who work for different clients-firms–. Hence, they are economic dependent in the sense that they generate their whole (or a substantial part of their) income from this business relationship and, obviously, take the entrepreneurial risk.[5] In both waves, an additional question is asked to those respondents who previously indicated being self-employed without employees, i.e., whether his/her firm generally has more than one client. Thus, those self-employed without employees answering negatively are considered DSEW whereas those answering positively are considered IOA.

ICT adoption and use frequency at work

In order to capture differentiated effects of ICTs use frequency at work on earning, two strategies are followed. On one hand, we simply use the discrete ordered variable ranging from 1 to 7. On the other hand, we transform the scale from level 1 to 7 into a set of 7 binary variables, one per value of our scale. As levels 2 to 7 imply (at least) some use of ICT, we operationalize adoption as the step from level 1 to 2.

[5] The growth of the *gig economy*, typified by online platforms and isolated independent workers, is seriosly contributing to the general trend towards increasing the phenomenon of DSEW (Stanford, 2017; Stewart and Stanford, 2017). Unfortunately, these workers are usually beyond the scope of labour law (Muehlberger and Bertolini, 2008; Román et al., 2011), collective bargaining and trade union representation (Supiot, 2001; ILO, 2003). The situation faced by these vulnerable workers is being widely discussed in international political and legal forums (ILO, 2003; EU Commission, 2006; Eichhorst et al., 2013; OECD, 2014).

Control variables

In order to isolate the effect of our hypotheses-related variables, the empirical models also include the following set of explanatory variables: educational attainment, job-related aspects (tenure, working hours, business sector), some demographic indicators (gender, immigrant, age, cohabitation status, children, and health status) and information at the household level (household ability to make ends meet). We also include a dummy for the year 2015 (vs. 2010) and national unemployment rates in order to control for the business cycle. Finally, we also account for structural differences between countries. [6]

Estimation methods

Various analyses are part of this study. Regarding ICT use frequency at work, discrete choice models (binary and ordered logit) are used. To explore earnings OLS regressions are used. [7] In all applications we use both single-level and multi-level (hierarchical) set-ups. As stated previously, our data consist of 2 cross-sectional panel data sets, grouped by country, i.e., EWCS 2010 and 2015. To correct for biases in parameter estimates resulting from country groupings, we use multilevel (hierarchical) models (Guo and Zhao, 2000). A precondition for running such a model is that significant between-group (in this case, countries) variance exists for the dependent variable (Hofmann, 1997; Bliese, 2000; Hofmann et al., 2000; Autio and Acs, 2010). We therefore perform ANOVAs with both ICT use frequency at work and net monthly earnings as dependent variables and country group membership as the predictors. The intraclass correlation (ICC) coefficients indicate that the country-level variance for the working time quality index is, (i) nontrivial, (ii) highly significant, and (iii) within the normal range (about 17%) that can be expected of grouped data of this nature (Bliese, 2000). Hence, using multilevel models is legitimate.

[6] Detailed definitions of all our variables are presented in the Appendix.

[7] Regarding earnings from self-employment, a considerable proportion of observations are zeros in some human population surveys (see e.g. Van Stel et al., 2018). In these cases the entrepreneur either only earns just enough to cover business expenses or might suffer losses (which are censored). This feature violates the linearity assumption so that the least squares method is inappropriate. As usual under these circumstances, earnings equations are estimated by means of *tobit* models (Tobin, 1958). This feature does not occur with our sample and, hence, using OLS seems a better option.

2.4. Results

Descriptive analysis

First, we aim to explore how occupational status within self-employment affects ICT adoption and usage frequency. Table 1 below shows the associated figures for the individuals in our sample.

Table 1. Descriptive statistics on ICT use frequency at work by occupational status

	ICT use frequency at work (1-7)												
	Obs.	Mean	Std. Dev.	Percentiles			Frequency distribution						
				25th	50th	75th	1	2	3	4	5	6	7
All self-employment	7,094	2.90	2.18	1	2	4	42.5	12.2	15.1	6.0	4.3	6.6	13.3
Occupational status													
Self-employed with employees	2,126	3.54	2.19	1	3	6	26.0	12.6	19.4	8.9	6.3	10.0	16.8
Independent own-account self-employed	4,130	2.79	2.17	1	2	4	45.4	12.3	14.6	5.1	3.8	5.9	12.9
Dependent self-employed worker	838	1.86	1.70	1	1	2	70.1	10.7	6.6	2.5	2.3	1.6	6.3

We observe, in coherence with our Hypotheses 1a and 1b, that SEwE are the most likely to use ICT at work, followed by IOA and DSEW. Furthermore, we find that a remarkably high percentage (42.5%) of self-employed states that they never use ICT during their daily business operations. This figure, however, varies substantially among occupational statuses. Thus, it rises above 70% for DSEW whereas it lies at 45% and 26% for IOA and SEwE, respectively.

Second, we focus on the relationship between ICT use and entrepreneurial earnings. Table 2 below shows some descriptive statistics by occupational status and ICT adoption that help to establish preliminary associations.

Table 2. Some descriptive statistics by occupational status and ICT adoption

	All self-employment		Self-employed with employees		Independent own-account self-		Dependent self-employed	
No. observations	7,094		2,126		4,130		838	
ICT adoption	Yes 57.5%	No 42.5%	Yes 74.0%	No 26.0%	Yes 54.6%	No 45.4%	Yes 29.9%	No 70.1%
Educational attainment								
Basic education [a]	3.9%	20.7%	2.9%	15.2%	4.3%	21.2%	6.8%	24.4%
Secondary education [a]	56.3%	70.6%	57.0%	72.1%	55.4%	70.5%	61.0%	69.8%
Tertiary education [a]	39.8%	8.7%	40.2%	12.7%	40.3%	8.4%	32.3%	5.8%
Job characteristics								
Tenure *(1-53)*	11.5 (*9.4*)	14.2 (*11.0*)	12.8 (*9.4*)	14.0 (*10.7*)	10.7 (*9.3*)	13.7 (*10.7*)	10.4 (*9.3*)	15.8 (*12.3*)
Working hours (*15-98*)	46.4 (*14.0*)	48.2 (*16.9*)	49.0 (*13.0*)	52.3 (*15.1*)	44.8 (*14.3*)	48.5 (*17.1*)	44.1 (*14.3*)	43.4 (*16.7*)
Entrepreneurial earnings								
Net monthly earnings –in PPP $ of 2015–	2,548.2 (*2,279.9*)	1,447.3 (*1,239.0*)	3,074.3 (*2,592.0*)	1,962.9 (*1,612.2*)	2,232.8 (*1,988.5*)	1,419.4 (*1,136.5*)	2,082.0 (*2,004.9*)	1,051.7 (*953.4*)

Notes: [a] Dummy variable; For dummy variables, mean values are presented. For continuous variables, mean values and standard deviations (in brackets) are presented. Data source: EWCS 2010, 2015.

We observe that earning of those self-employed who adopted ICT at work are markedly higher than those of self-employed not using ICT at work at all, which gives support to our Hypothesis 2. This difference remains noticeably high, irrespective of the occupational status (i.e., SEwE, IOA and DSEW) we concentrate on. In coherence with this result, we also observe that those self-employed who adopted ICT have higher educational attainment than those not using ICT. In addition, we observe that those self-employed who adopted ICT have shorter tenures than those not using ICT, which may in part be explained by age, i.e., younger entrepreneurs may be expected to adopt ICT at work with higher likelihood. Finally, an interesting result emerges as regards working hours. Thus, we observe how those self-employed who adopted ICT work shorter hours than those not using ICT. We associate this result to the large efficiency gains associated to ICT use.

Multivariate analysis

Although our univariate analysis seems to support the validity of some of our hypotheses, a conditional analysis is needed to draw robust conclusions, which is precisely the main aim of this section. In particular, section 4.2.1 presents our main results as regards the determinants of ICT adoption

and usage frequency at work whereas section 4.2.2 concentrates on our results about net monthly earnings. Finally, section 4.2.3 presents some robustness checks which are part of the analysis.

ICT adoption and usage frequency

Table 3 below shows the results from 4 specifications (Models 1-4) as regards the determinants of ICT adoption and usage frequency at work, with special focus on the role of different occupational statuses within self-employment.

Table 3. Determinants of ICT adoption and use frequency at work –Binary and ordered discrete choice models–

# Specification	**1**			**2**		
Model	*Binary logit*			*Multilevel binary logit*		
Average predicted probability (*y*)	P[ICT adoption] = 0.575			P[ICT adoption] = 0.621		
Independent variables (*x*)	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$%	t-statistic	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$%	t-statistic
Focal variable: occupational status						
Self-employed with employees [a]	0.104	18.17	9.29***	0.110	17.71	8.99***
Independent own-account self-employed [a]						
Dependent self-employed worker [a]	-0.093	-16.16	-5.44***	-0.104	-16.72	-5.44***
Educational attainment						
Basic education [a] (*ref.*)						
Secondary education [a]	0.098	16.97	4.71***	0.111	17.83	4.88***
Tertiary education [a]	0.307	53.38	13.00***	0.321	51.63	11.92***
Job characteristics						
Tenure *(1-53)*	-0.002	-0.43	-4.13***	-0.003	-0.43	-4.07***
Working hours (*15-98*)	6.5E-03	1.12	4.50***	0.007	1.11	4.45***
Working hours (squared)	-5.9E-05	-0.01	-4.22***	-6.4E-05	-0.01	-4.21***
Wave						
2010 [a] (*ref.*)						
2015 [a]	0.043	7.45	4.08***	0.048	7.66	4.21***
Business cycle						
National unemployment rate *(4.3-24.9)*	0.003	0.50	1.31	7.5E-05	0.01	0.03
Demographic characteristics						
Female [a]	-0.062	-10.79	-5.72***	-0.067	-10.83	-5.63***
Immigrant [a]	-0.026	-4.46	-1.49	-0.025	-4.00	-1.33
Age (*18-65*)	-1.0E-03	-0.18	-1.73*	-1.0E-03	-0.16	-1.59
Cohabiting [a]	6.7E-04	0.12	0.06	4.4E-04	0.07	0.03
Number of children under 14	0.006	1.11	0.54	0.008	1.21	0.60
Health (1-5)	0.008	1.31	1.10	0.008	1.33	1.13
Ends meet (1-6)	0.031	5.46	7.72***	0.035	5.63	7.78***
Business sector dummies [b]	Yes			Yes		
Country dummies [c]	Yes			Yes		
Log likelihood	-3,319.7			-3,390.6		

# Specification	3					
Model	*Ordered logit*					
Average predicted probability (*y*)	P[ICT use freq. = 1] = 0.558			P[ICT use freq. = 7] = 0.081		
Independent variables (*x*)	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$ %	t-statistic
Focal variable: occupational status						
Self-employed with employees [a]	-0.080	-18.75	-8.99***	0.045	34.76	8.61***
Independent own-account self-employed [a] (*ref.*)						
Dependent self-employed worker [a]	0.082	19.38	5.19***	-0.035	-26.79	-5.80***
Educational attainment						
Basic education [a] (*ref.*)						
Secondary education [a]	-0.112	-26.23	-5.36***	0.034	26.31	6.41***
Tertiary education [a]	-0.315	-74.03	-14.11***	0.158	121.18	18.82***
Job characteristics						
Tenure *(1-53)*	0.003	0.61	5.15***	-1.4E-03	-1.10	-5.12***
Working hours (*15-98*)	-0.005	-1.28	-4.36***	0.003	2.30	4.34***
Working hours (squared)	5.2E-05	0.01	4.20***	-2.9E-05	-0.02	-4.18***
Wave						
2010 [a] (*ref.*)						
2015 [a]	-0.024	-5.52	-2.75***	0.013	9.83	2.76***
Business cycle						
National unemployment rate *(4.3-24.9)*	-0.002	-0.37	-0.82	8.6E-04	0.66	0.82
Demographic characteristics						
Female [a]	0.059	13.92	6.63***	-0.032	-24.35	-6.75***
Immigrant [a]	0.017	3.97	1.26	-0.009	-6.95	-1.29
Age (*18-65*)	9.0E-04	0.21	1.87*	-5.0E-04	-0.38	-1.87*
Cohabiting [a]	0.009	2.01	0.87	-0.005	-3.61	-0.86
Number of children under 14	0.002	0.45	0.20	-1.1E-03	-0.81	-0.20
Health (1-5)	-0.006	-1.29	-0.98	0.003	2.31	0.98
Ends meet (1-6)	-0.031	-7.21	-8.81***	0.017	12.91	8.64***
Business sector dummies [b]	Yes					
Country dummies [c]	Yes					
Log likelihood	-9,983.6					

# Specification	4					
Model	*Multilevel ordered logit*					
Average predicted probability (*y*)	P[ICT use freq. = 1] = 0.558			P[ICT use freq. = 7] = 0.081		
Independent variables (*x*)	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$ %	t-statistic
Focal variable: occupational status						
Self-employed with employees [a]	-0.081	-14.50	-8.47***	0.030	37.08	7.96***
Independent own-account self-employed [a] (*ref.*)						
Dependent self-employed worker [a]	0.078	13.93	5.28***	-0.022	-27.70	-5.60***
Educational attainment						
Basic education [a] (*ref.*)						
Secondary education [a]	-0.108	-19.36	-5.80***	0.023	29.05	6.18***
Tertiary education [a]	-0.321	-57.56	-13.05***	0.105	130.07	12.84***
Job characteristics						
Tenure *(1-53)*	0.003	0.48	5.14***	-9.5E-04	-1.18	-5.04***

Working hours (*15-98*)	-0.006	-1.02	-4.44***	0.002	2.52	4.35***
Working hours (squared)	5.6E-05	0.01	4.36***	-2.0E-05	-0.02	-4.27***
Wave						
2010 [a] (*ref.*)						
2015 [a]	-0.025	-4.40	-2.85***	0.009	10.83	2.85***
Business cycle						
National unemployment rate *(4.3-24.9)*	-6.9E-04	-0.12	-0.37	2.5E-04	0.31	0.37
Demographic characteristics						
Female [a]	0.057	10.23	6.38***	-0.020	-24.72	-6.36***
Immigrant [a]	0.013	2.28	0.96	-0.004	-5.56	-0.97
Age (*18-65*)	6.2E-04	0.11	1.29	-2.2E-04	-0.28	-1.29
Cohabiting [a]	0.009	1.61	0.90	-0.003	-3.99	-0.90
Number of children under 14	5.8E-04	0.10	0.06	-2.1E-04	-0.26	-0.06
Health (1-5)	-0.006	-1.01	-1.00	0.002	2.50	1.00
Ends meet (1-6)	-0.031	-5.63	-8.48***	0.011	13.93	8.04***
Business sector dummies [b]	Yes					
Country dummies [c]	Yes					
Log likelihood	-10,082.4					

Notes: N = 7,094; For continuous variables, *dy/dx* captures absolute marginal effects whereas [(*dy/dx*)/*y*]% refers to marginal effects, but expressed in relative terms with respect to predicted probabilities. In the context of dummy variables, these reflects the impact for a discrete change of the dummy variable from 0 to 1; * $0.1 > p \geq 0.05$; ** $0.05 > p \geq 0.01$; *** $p < 0.01$; [a] Dummy variable; [b] 10 business sector dummies are used. See the Appendix for a definition; [c] 35 European country dummies are used; The maximum correlation is 0.55 (between age and tenure), and the VIFs values (from specification 1) range from 1.03 to 1.79. Thus, multicollinearity does not pose a concern, especially in consideration of the large size of our sample; Data source: EWCS 2010, 2015

Models 1 and 2 use ICT adoption as a binary choice (i.e., yes or no) as dependent variable and, hence, utilize binary logit models. In contrast, models 3 and 4 employ ICT use frequency (1-7) as an ordered dependent variable and, therefore, apply discrete choice ordered logit models. These models generate results for each frequency of ICT use but, for the clarity of our exposition, we will only present results as regards the probability that self-employed (i) never use ICTs at work (ICT use frequency = 1), and (ii) use ICTs at work all of the time (ICT use frequency = 7). At the top of each model, the predicted probabilities of ICT adoption and use frequency for the sample means are indicated. Below, the effects of the explanatory variables on these predicted probabilities are presented in terms of marginal effects (not coefficients). These marginal effects are expressed in levels, and also in relative terms (with respect to the predicted probabilities for the sample means). Additionally, t-statistics associated with marginal effects are reported in each model.

Consistent with Hypothesis 1a, our results demonstrate how the predicted probability of ICT adoption is about 17% lower for DSEW, when compared with IOA (Model 2). In addition, our results show how the predicted probability of ICT adoption is about 18% higher for SEwE, when compared with IOA, which gives support to our Hypothesis 1b. Both Hypotheses 1a and 1b are also supported when turning our attention to ICT use frequency. In particular, when focusing on the predicted probability of never

using ICT (ICT use frequency = 1), this probability is observed to increase by about 14% for DSEW and decrease by 14.5% for SEwE, when compared with IOA (Model 4, left panel). As regards the predicted probability of using ICT at work all of the time (ICT use frequency = 7), we find that this probability decreases by about 28% for DSEW and increases by approximately 37% for SEwE, when compared with IOA (Model 4, right panel).

The effects of other covariates are also analysed. Our findings indicate that the relationship between education and ICT adoption and use frequency is positive. As regards tenure, we observe that longer tenures are negatively related with both ICT adoption and use frequency, which supports the aforementioned inertia effect which firms may fall victim to. The relationship between working hours and ICT adoption and use is observed to exhibit an inversed U-shaped pattern, where the turning point is reached when the number of working hours per week exceeds 54. Otherwise stated, the likelihood of not using ICT at work increases once past this number of working hours per week. Entrepreneurs are also more likely to adopt and use ICT in 2015, when compared with 2010 data, which is coherent with the progressive incorporation of ICT use in all life facets that the society experiences. Finally, we also observe a lower ICT adoption and use for some particular groups such as females, older individuals and those with lower ability to make ends meet.

The relationship between ICT usage frequency and entrepreneurial earnings

Table 4 below shows the results from 4 specifications (Models 5-8) as regards net monthly entrepreneurial earnings, with special focus on the role of ICT use frequency. Models 5 and 6 use ICT use frequency in levels as their focal variable. In contrast, Models 7-8 employ a set of dummies to capture ICT usage level. These results are presented as follows. Average predicted earnings are indicated at the top of each specification. These predicted earnings help to understand the relative importance of our marginal effects presented below. Thus, each specification is presented in a two-column format. The first column shows semi-elasticities in the form of [(dy/dx)/y]%., i.e., percentage changes of earnings caused by unit changes of the respective explanatory variables, whereas t-statistics associated with these effects are presented in the second column.

Table 4. Determinants of net monthly earnings –OLS and multilevel linear regressions–

# Specification	**5**		**6**		**7**		**8**	
Model	*OLS*		*Multilevel linear regression*		*OLS*		*Multilevel linear regression*	
Predicted earnings (y) *–in*	2,080.3		2,066.7		2,080.3		2,066.7	
Independent variables (*x*)	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy/dx}{y}$ %	t-statistic
Focal variable: ICT use frequency at work								
ICT use frequency at work (1-	2.2	5.03***	2.3	5.15***				
1 Never [a] (*ref.*)								
2 Almost never [a]					10.5	3.97***	10.7	4.10***
3 Around ¼ of the time [a]					14.7	5.64***	15.0	5.78***
4 Around half of the time [a]					17.5	4.84***	17.7	4.91***
5 Around ¾ of the time [a]					19.4	4.73***	19.6	4.80***
6 Almost all of the time [a]					15.5	4.37***	15.8	4.46***
7 All of the time [a]					12.8	4.39***	13.0	4.49***
Occupational status								
Self-employed with	26.6	14.62***	26.6	14.66***	25.7	14.12***	25.8	14.17***
Independent own-account								
Dependent self-employed	-8.9	-3.41***	-9.0	-3.47***	-8.1	-3.10***	-8.2	-3.15***
Educational attainment								
Basic education [a] (*ref.*)								
Secondary education [a]	24.0	8.19***	23.9	8.27***	22.9	7.80***	22.7	7.82***
Tertiary education [a]	45.4	13.22***	45.4	13.32***	44.0	12.78***	43.8	12.84***
Job tenure								
Tenure *(1-53)*	1.4	5.27***	1.4	5.30***	1.3	5.18***	1.3	5.21***
Tenure (squared)	-0.02	-3.62***	-0.02	-3.60***	-0.02	-3.49***	-0.02	-3.47***
Working hours (*15-98*)	2.7	11.08***	2.7	11.11***	2.6	10.95***	2.6	10.97***
Working hours (squared)	-0.02	-8.70***	-0.02	-8.73***	-0.02	-8.57***	-0.02	-8.59***
Wave								
2010 [a] (*ref.*)								
2015 [a]	-5.3	-3.08***	-5.1	-2.95***	-5.9	-3.41***	-5.7	-3.30***
Business cycle								
National unemployment rate	-2.2	-5.61***	-2.4	-6.50***	-2.2	-5.67***	-2.4	-6.57***
Demographic characteristics								
Female [a]	-24.3	-13.57***	-24.4	-13.68***	-24.0	-13.46***	-24.1	-13.58***
Immigrant [a]	-3.9	-1.37	-3.7	-1.30	-3.6	-1.29	-3.4	-1.23
Age (*18-65*)	1.5	2.55**	1.4	2.53**	1.4	2.46**	1.4	2.42**
Age (squared)	-0.02	-2.48**	-0.02	-2.45**	-0.02	-2.39**	-0.02	-2.35**
Cohabiting [a]	5.8	2.86***	5.8	2.86***	5.8	2.86***	5.8	2.87***
Number of children under 14	1.0	0.51	1.1	0.54	0.9	0.47	1.0	0.50
Health (1-5)	7.5	6.89***	7.6	6.99***	7.3	6.73***	7.4	6.84***
Business sector dummies [b]	Yes		Yes		Yes		Yes	
Country dummies [c]	Yes		Yes		Yes		Yes	
Log likelihood	---		-7,071.1		---		-7,054.9	

Notes: N = 7,094; Our dependent variable is the natural logarithm of monthly net earnings. Accordingly, we interpret the regression coefficients as semi-elasticities in the form of [(*dy/dx*)/*y*]%., i.e., they show the percentage changes of earnings caused by unit changes of the respective explanatory variables. In the context of dummy variables, these reflects the impact for a discrete change of the dummy variable from 0 to 1; * $0.1 > p \geq 0.05$; ** $0.05 > p \geq 0.01$; *** $p < 0.01$; [a] Dummy variable; [b] 10 business sector dummies are used. See the Appendix for a definition; [c] 35 European country dummies are used; The maximum correlation is 0.55 (between age and tenure), and the VIFs values (from specification 5) range from 1.03 to 1.79. Thus, multicollinearity does not pose a concern, especially in consideration of the large size of our sample; Data source: EWCS 2010, 2015.

Not surprisingly, our results show a positive relationship between ICT frequency use and entrepreneurial earnings. In particular, we observe how each additional level of ICT use (in our scale from 1 to 7) increases earnings by 2.3% (Model 6), which is consistent with our Hypothesis 2. Furthermore, this positive relationship, in combination with the previous evidence obtained as regards inertia, i.e., a negative impact of an entrepreneur's job tenure on ICT use (derived from Table 3), is coherent with our Hypothesis 4b (and rejects Hypothesis 4a). [8] Therefore, our results support the existence of an indirect negative relationship between job tenure, ICT adoption and entrepreneurial performance.

However, the positive relationship between ICT frequency use and entrepreneurial earnings is observed to be non-linear in the sense that the increase in earnings associated with the first adoption of ICT (the step from never using ICT –level 1– to almost never using ICT –level 2–) is by far the largest, compared with further advancements on the ICT use ladder (Model 8). Indeed, we observe that the first adoption of ICT increases earnings by about 11%, whereas further ICT use intensity does not generate statistically significant increases in earnings.[9] Precisely this absence of significant differences in earnings confirms our Hypothesis 3, as regards the threshold performance effect from adoption of ICT.

[8] We carried out a series of *Sobel-Goodman mediation tests* (Stata's *sgmediation* procedure; Sobel, 1982; MacKinnon et al., 2002) to examine whether ICT use frequency had significant mediating effects between job tenure and entrepreneurial earnings. These tests showed that, after controlling for the other covariates, the mediation effects of ICT use frequency was highly significant. Of the total effect of job tenure on entrepreneurial earnings (*c*), approximately -5% was *inconsistently* mediated. Otherwise stated, the relationship between job tenure and entrepreneurial earnings is positive due to the net effect of 2 different sub-effects of opposite sign: (i) a direct and positive effect of job tenure on earnings (*c*'); and (ii) an indirect and negative effect ($a \cdot b$) related with the fact that job tenure decreases ICT use (*a*) and that those with lower ICT use have lower earnings (and vice versa) (*b*).

[9] The results from Wald tests do not reject any of the null hypotheses of equal coefficients (level 2 = level 3; level 3 = 4; level 4 = level 5; level 5 = level 6 and level 6 = level 7).

For other covariates, we observe that SEwE have the highest earnings whereas DSEW have the lowest. Education, tenure and the number of working hours increase earnings from entrepreneurship, as expected. As regards tenure, the quadratic term begins to dominate the linear term when the length of self-employment spell exceeds 29 years. Concerning the number of working hours, the turning point is reached at 65 working hours per week, indicating that, beyond this number of hours, additional entrepreneurial efforts are no longer productive. Higher unemployment rates are associated with lower earnings, which is also expected. We also find that females earn less than their male counterparts. Regarding the age of the entrepreneur, we find a non-linear, inverted U-shaped impact on earnings where the turning point is reached when the entrepreneur is 45 years old. Cohabiting individuals report higher earnings than those living without partner whereas no effect of children on earnings is observed. Reporting good health also seems to be positively associated with earnings from entrepreneurship.

Table 5 below also focuses on the impact of ICT use frequency on entrepreneurial earnings but distinguishes among occupational statuses within self-employment. To this end, 6 additional specifications are presented (Models 9-14). Models 9-10, 11-12 and 13-14 concentrate on SEwE, IOA and DSEW, respectively. Models 9, 11 and 13 use ICT use frequency in levels as their focal variable whereas Models 10, 12 and 14 employ a set of dummies to capture ICT usage level. The same set-up used to present results as in Table 4 is used.

Table 5. Determinants of net monthly earnings for each occupational status within self-employment –Multilevel linear regressions–

# Specification	**9**		**10**		**11**	
Occupational status	Self-employed with employees		Self-employed with employees		Independent own-account self-employed	
No. observations	2,126		2,126		4,130	
Predicted earnings (y) *–in PPP $ of 2015–*	2,851.0		2,861.6		1,882.1	
Independent variables (*x*)	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy/dx}{y}$ %	t-statistic
Focal variable: ICT use frequency at work *(variable in levels is for specif. 9, 11, 13; dummies are for specif. 10, 12, 14)*						
ICT use frequency at work (1-7)	4.3	6.38***			1.0	1.63
1 Never [a] (*ref.*)						
2 Almost never [a]			18.5	4.06***		
3 Around ¼ of the time [a]			19.3	4.60***		
4 Around half of the time [a]			30.2	5.70***		
5 Around ¾ of the time [a]			27.5	4.65***		
6 Almost all of the time [a]			22.8	4.38***		
7 All of the time [a]			31.2	6.81***		

Educational attainment						
Basic education [a] (*ref.*)						
Secondary education [a]	19.2	3.20***	17.7	2.94***	26.0	6.87***
Tertiary education [a]	38.7	5.98***	36.7	5.66***	48.6	10.68***
Job tenure						
Tenure *(1-53)*	1.3	3.02***	1.4	3.05***	1.3	3.66***
Tenure (squared)	-0.02	-1.58	-0.02	-1.50	-0.02	-2.47**
Working hours (*15-98*)	1.8	3.69***	1.7	3.52***	2.9	9.25***
Working hours (squared)	-0.01	-2.90***	-0.01	-2.75***	-0.02	-7.21***
Wave						
2010 [a] (*ref.*)						
2015 [a]	-5.3	-1.86*	-5.6	-1.98**	-4.4	-1.89*
Business cycle						
National unemployment rate *(4.3-24.9)*	-2.9	-5.26***	-3.0	-5.38***	-2.3	-4.56***
Demographic characteristics						
Female [a]	-26.5	-8.74***	-26.0	-8.60***	-23.2	-9.60***
Immigrant [a]	-4.8	-1.04	-4.7	-1.02	-2.1	-0.55
Age (*18-65*)	1.6	1.57	1.4	1.37	1.2	1.58
Age (squared)	-0.02	-1.32	-0.01	-1.15	-0.01	-1.49
Cohabiting [a]	-1.0	-0.29	-0.6	-0.17	7.2	2.70***
Number of children under 14	2.6	0.80	2.5	0.77	3.1	1.15
Health (1-5)	6.5	3.52***	6.3	3.38***	8.4	5.80***
Business sector dummies [b]	Yes		Yes		Yes	
Country dummies [c]	Yes		Yes		Yes	
Log likelihood	-1,925.5		-1,915.7		-4,247.9	

# Specification	**12**		**13**		**14**	
Occupational status	Independent own-account self-employed		Dependent self-employed worker		Dependent self-employed worker	
No. observations	4,130		838		838	
Predicted earnings (y) *–in PPP $ of 2015–*	1,883.7		1,283.2		1,278.2	
Independent variables (*x*)	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy/dx}{y}$ %	t-statistic
Focal variable: ICT use frequency at work *(variable in levels is for specif. 9, 11, 13;*						
ICT use frequency at work (1-7)			4.4	2.52**		
1 Never [a] (*ref.*)						
2 Almost never [a]	6.0	1.71*			19.3	2.45**
3 Around ¼ of the time [a]	13.8	3.95***			22.4	2.17**
4 Around half of the time [a]	10.3	2.01**			8.0	0.52
5 Around ¾ of the time [a]	16.9	2.89***			24.0	1.46
6 Almost all of the time [a]	11.4	2.28**			16.4	0.84
7 All of the time [a]	3.1	0.78			26.1	2.23**
Educational attainment						
Basic education [a] (*ref.*)						
Secondary education [a]	24.7	6.50***	18.3	2.47**	18.0	2.44**
Tertiary education [a]	47.0	10.30***	39.3	3.88***	39.4	3.89***
Job tenure						
Tenure *(1-53)*	1.3	3.60***	1.0	1.43	1.0	1.36
Tenure (squared)	-0.02	-2.41**	-0.02	-1.01	-0.02	-0.91
Working hours (*15-98*)	2.8	9.16***	3.0	4.60***	2.9	4.47***
Working hours (squared)	-0.02	-7.13***	-0.02	-3.66***	-0.02	-3.55***

Wave						
2010 [a] (*ref.*)						
2015 [a]	-5.1	-2.17**	2.4	0.46	2.3	0.44
Business cycle						
National unemployment rate *(4.3-24.9)*	-2.3	-4.57***	-3.9	-4.34***	-3.8	-4.21***
Demographic characteristics						
Female [a]	-23.2	-9.63***	-27.1	-5.14***	-26.4	-4.99***
Immigrant [a]	-1.9	-0.51	-3.3	-0.36	-1.6	-0.18
Age (*18-65*)	1.2	1.55	1.3	0.83	1.4	0.87
Age (squared)	-0.01	-1.48	-0.02	-1.04	-0.02	-1.06
Cohabiting [a]	7.2	2.72***	9.9	1.64	10.1	1.68*
Number of children under 14	2.9	1.07	-5.7	-0.92	-5.5	-0.89
Health (1-5)	8.1	5.64***	7.6	2.30**	8.0	2.41**
Business sector dummies [b]	Yes		Yes		Yes	
Country dummies [c]	Yes		Yes		Yes	
Log likelihood	-4,237.6		-858.2		-855.4	

Notes: Our dependent variable is the natural logarithm of monthly net earnings. Accordingly, we interpret the regression coefficients as semi-elasticities in the form of [(*dy/dx*)/*y*]%., i.e., they show the percentage changes of earnings caused by unit changes of the respective explanatory variables. In the context of dummy variables, these reflects the impact for a discrete change of the dummy variable from 0 to 1; * $0.1 > p \geq 0.05$; ** $0.05 > p \geq 0.01$; *** $p < 0.01$; [a] Dummy variable; [b] 10 business sector dummies are used. See the Appendix for a definition; [c] 35 European country dummies are used; For self-employed with employees, the maximum correlation is 0.60 (between age and tenure), and the VIFs values (from specification 9) range from 1.02 to 1.88. For independent own-account self-employed, the maximum correlation is 0.53 (between age and tenure), and the VIFs values (from specification 11) range from 1.04 to 1.76. For dependent self-employed worker, the maximum correlation is 0.50 (between age and tenure), and the VIFs values (from specification 13) range from 1.08 to 1.80. Thus, multicollinearity does not pose a concern, especially in consideration of the large size of our sample; Data source: EWCS 2010, 2015.

Our results show a positive relationship between ICT frequency use and entrepreneurial earnings for SEwE and DSEW. In particular, we observe how each additional level of ICT use (in our scale from 1 to 7) increases earnings by more than 4% for both groups (Models 9 and 13). Conversely, we observe that the relationship between ICT frequency use and entrepreneurial earnings for IOA is considerably weaker, i.e., only marginally significant (Model 11). These results are, hence, consistent with our Hypotheses 5a and 5b. Similar to what we observed for the whole sample (Table 4), this positive relationship is observed to be non-linear for SEwE, IOA and DSEW, where the first adoption of ICT is by far the most relevant for earnings (Models 10 and 14). [10] Precisely this non-linearity provides addi-

[10] For IOA (Model 12), the non-linear pattern is somewhat less pronounced. In particular, the step from level 2 to level 3 is revealed to be as significant as the step from level 1 to level 2, in light of the results we obtained from additional Wald tests.
These tests showed that, after controlling for the other covariates, the mediation effects of ICT use frequency was highly significant. Of the total effect of job tenure on entrepreneurial earnings (*c*), approximately -5% was *inconsistently* mediated. Otherwise stated, the relationship between job tenure and entrepreneurial earnings is positive due to the net effect of 2 different sub-effects of opposite sign: (i) a direct and positive effect of job tenure on earnings (*c*'); and (ii) an indirect and negative effect ($a \cdot b$) related with the

tional support to our Hypothesis 3. As regards other covariates, our results are, in general, consistent with those obtained for the whole sample (Table 4).

Robustness checks

We perform several robustness checks. First, although we present only a few models in Tables 3–5, a complete stepwise regression approach (in which models incorporate covariates one by one) was followed, which serves as a robustness check for the results obtained in previous models. Second, our results are robust to the use of correction for biases in parameter estimates resulting from country groupings (i.e., multilevel – hierarchical– models). These approaches indicate no major changes relative to simple pooled regressions. Third, the robustness of our t-statistics was verified by re-estimating them from variance–covariance matrices of the coefficients obtained by bootstrapping. Finally, as we have previously argued, well-resourced firms are better equipped to adopt and implement ICT than more financially constrained firms. Hence, the relationship between ICT adoption and earnings may potentially reflect a reversed effect as higher earnings facilitate adoption of ICT. To control for this possibility we performed a robustness test in which we added in the earnings equations a variable measuring the household ability to make ends meet. [11] Our results, are, robust to this alternative specification. All results regarding these robustness checks are available upon request.

2.5. Conclusions and policy implications

Adoption and usage of ICT by entrepreneurs may improve the performance of their firms. However, successful ICT implementation is by no means straightforward. There may be barriers like a misfit with the current business, a minimum level of digital skills that employees are required to have, possibly a high cost of implementation, and a possible reluctance to adopt ICT due to a conservative managerial culture. These barriers may make a business refrain from a proper ICT implementation (Arendt 2008;

fact that job tenure decreases ICT use (*a*) and that those with lower ICT use have lower earnings (and vice versa) (*b*).

[11] This variable ('Ends meet') was already found to influence ICT adoption and usage frequency (see Table 3), capturing the impact of financial means to afford ICT adoption. Hence, when this variable is included in the earnings equations, the ICT variables should capture a 'pure' ICT effect on earnings as any potential 'reversed' (i.e. financial resources) effect should be captured by the make ends meet variable.

Barba-Sánchez et al., 2007; Harindranath et al. 2008; Sin Tan et al., 2010). In fact we found that for our sample of entrepreneurs in 35 European countries, 42.5% indicated to 'never use ICT during their daily business operations', i.e. 42.5% did not adopt ICT in their firms. This percentage was even 70 among dependent self-employed workers and still 26 among self-employed with employees.

We also examined the relationship between ICT usage frequency and entrepreneurial performance as captured by earnings, and found empirical support for a positive link. Remarkably, we found that this relationship is non-linear in the sense that the first step (from 'never use ICT' to 'almost never use ICT'), which captures ICT adoption, has the biggest impact on earnings. We also found evidence for an indirect negative relationship between job tenure, ICT adoption and entrepreneurial performance in the sense that job tenure was found to be negatively related to ICT adoption and usage frequence (indicating an inertia effect), while ICT adoption and usage are positively related to performance.

Finally, our analysis also revealed that the positive relationship between ICT and performance was stronger for self-employed with employees (SEwE) and dependent self-employed workers (DSEW) than for independent own-account self-employed (IOA). Regarding SEwEs, this indicates that ICT adoption and usage is particularly efficient in relatively larger businesses (i.e. firms with employees) as ICTs can help in managing the greater complexity of such firms. The result for DSEW points at a catching up effect as this group adopts ICT less often than other groups of entrepreneurs (only 30% of DSEW has adopted ICT in their firms, against 55% for IOA and 74% for SEwE). Hence, in such a context, there is relatively much to be gained by adopting ICT as it helps entrepreneurs perform more efficiently than the majority of their competitors.

Our research has implications for researchers, entrepreneurs and policy makers. Regarding the first group, our research shows the importance of ICT adoption and usage for entrepreneurial performance in terms of earnings. Hence, entrepreneurship researchers working in the field of firm performance may consider including ICT-related control variable in their models. Regarding the second group, our research shows that (particularly lower-educated) entrepreneurs with long job tenures are at risk of falling victim to inertia effects, i.e. a reluctance to implement new ICT solutions resulting from unwillingness to change daily business operations or unawareness of the importance of doing so. Such inertia effects may hamper firm performance in the long run. Hence, it may be a good idea for entre-

preneurs who already run their businesses for a longer time to have their business checked on efficient usage of ICT, possibly by an external expert. This may be especially advisable for IOA and DSEW as these types of entrepreneurs work alone and hence do not naturally receive feedback on their daily business operations. Moreover, our results are especially interesting for entrepreneurs who did not adopt ICT in their businesses yet (i.e. the 42% who indicate that they do not use ICT at all), as we find that ICT adoption, even if it is just a first step from 'never use ICT' towards the level of 'almost never use ICT', already implies a relatively big increase in entrepreneurial earnings.

This last finding also has implications for policy makers as it suggests that there is a lot of potential for economic growth by convincing entrepreneurs to adopt ICT solutions in their businesses, even if it only implies limited usage of ICT. Examples may be the occasional use of a smart phone or laptop, or, perhaps a slightly bigger step, the use of a software package to organise one's financial administration. Even limited ICT adoption may make entrepreneurs work more efficiently and hence increases the potential to generate economic value. In this sense, our analysis suggests that there is especially much room for improvement among DSEW.

Another area of interest for policy makers concerns the inertia effects described above. It is intuitive that inertia effects are more likely to occur among older entrepreneurs. However, our empirical analysis suggests that job tenure is the leading mechanism here, and not the age of the entrepreneur per se. In particular, we find a much stronger negative impact on ICT adoption and usage for job tenure than for age, while the VIF factors indicate the estimations do not suffer from multicollinearity. Hence, our analysis suggests that a middle-aged entrepreneur running his or her business already for 10 or more years is more likely to fall victim to inertia effects than a senior entrepreneur starting a new business. Governments may encourage entrepreneurs to have an expert make a recurrent check on their business' ICT environment, in order to see whether they are still up-to-date or whether efficiency gains are possible by adopting the latest ICTs.

A limitation of our paper is that the main variables in our analysis, i.e. entrepreneurial earnings and ICT usage frequency are self-reported. Especially regarding ICT use, future research may focus on asking additional survey questions to see what is behind the remarkably high percentage of entrepreneurs indicating not to use ICT in their daily business operations.

Moreover, the cross-sectional nature of our data base prevents longitudinal research. Such research would be highly interesting as it enables to see what happens to entrepreneurial performance over time after certain ICTs have been adopted by an entrepreneur. Finally, future research should focus on differentiating between different sorts of ICT to see whether certain types of ICT adoptions have bigger performance effects than others.

In spite of these limitations, we believe we have made an important contribution to the field of ICT performance effects, especially with regard to the segment of the smallest businesses and solo entrepreneurs.

2.6 References

Alam, S.S. and Noor, M.K.M. 2009. ICT adoption in small and medium enterprises: an empirical evidence of service sectors in Malaysia, *International Journal of Business and Management*, 4(2), 112–125. https://doi.org/10.5539/ijbm.v4n2p112.

Arendt, L. 2008. Barriers to ICT adoption in SMEs: how to bridge the digital divide?, *Journal of Systems and Information Technology*, 10(2), 93–108. https://doi.org/10.1108/13287260810897738.

Audretsch D.B., Baumol W.J. and Burke A.E. 2001. Competition policy in dynamic markets, *International Journal of Industrial Organization*, 19(5), 613–634. https://doi.org/10.1016/S0167-7187(00)00086-2.

Autio, E. and Acs, Z. 2010. Intellectual property protection and the formation of entrepreneurial growth aspirations, *Strategic Entrepreneurship Journal*, 4(3), 234–251. https://doi.org/10.1002/sej.93.

Barba-Sánchez, V., Martínez-Ruiz, M.P., and Jiménez-Zarco, A.I. 2007. Drivers, benefits and challenges of ICT adoption by small and medium sized enterprises (SMEs): a Literature Review, *Problems and Perspectives in Management*, 5(1), 103–114. https://businessperspectives.org/journals?task=callelement&format=raw&item_id=574&element=e46cdb75-ca7e-4c69-97ee-741acaab6046&method=download&args[0]=0

Bayo-Moriones, A., Billón, M., and Lera-López, F. 2013. Perceived performance effects of ICT in manufacturing SMEs, *Industrial Management & Data Systems*, 113(1), 117–135. https://doi.org/10.1108/02635571311289700.

Bertschek, I., and Kaiser, U. 2004. Productivity effects of organizational change: microeconometric evidence, *Management Science*, 50(3), 394–404. http://dx.doi.org/10.1287/mnsc.1030.0195.

Bharadwaj, A. 2000. A resource-based perspective on information technology capability and firm performance: an empirical investigation, *Management Information Systems Quarterly*, 24(1), 169–193. https://doi.org/10.2307/3250983.

Bliese, P.D. 2000. Within-group agreement, non-independence, and reliability: implications for data aggregation and analysis. In: K.J. Klein and S.W.J. Kozlowski (Eds.), *Multilevel Theory, Research, and Methods in Organizations: Foundations, Extensions, and New Directions*, San Francisco, CA: Jossey-Bass, 349–381.

Campo, S., Rubio, N., and Yagüe, M.J. 2010. Information technology use and firm's perceived performance in supply chain management, *Journal of Business-to-Business Marketing*, 17(4), 336–364. https://doi.org/10.1080/10517120903574649.

Choudrie, J., Junior, C. O., McKenna, B., and Richter, S. 2018. Understanding and conceptualising the adoption, use and diffusion of mobile banking in older adults: A research agenda and conceptual framework, *Journal of Business Research*, *88*, 449–465. https://doi.org/10.1016/j.jbusres.2017.11.029

Das, S., Yaylacicegi, U. and Menon, N. 2011. The effect of information technology investments in healthcare: a longitudinal study of its lag, duration, and economic value, *IEEE Transactions on Engineering Management*, 58(1), 124–138. https://doi.org/10.1109/TEM.2010.2048906.

Dedrick, J., Gurbaxani, V. and Kraemer, K.L. 2003. Information technology and economic performance: a critical review of empirical evidence, *ACM Computing Surveys*, 35(1), 1–28. https://doi.org/10.1145/641865.641866.

Devaraj, S., and Kohli, R. 2003. Performance impacts of information technology: is actual usage the missing link?, *Management Science*, 49(3), 273–289. https://doi.org/10.1287/mnsc.49.3.273.12736.

Eichhorst, W., Braga, M., Mühlberger, U., Gerard, M., Horvath, T., Kahanec, M., Kahancová, M., Kendzia, M., Martišková, M., Monti, P., Pedersen, J.L., Stanley, J., Vandeweghe, B., Wehner, C. and White, C. 2013. Social protection rights of economically dependent self-employed workers, Policy Department A - Economic and Scientific Policy, Brussels: European Parliament. http://www.europarl.europa.eu/RegData/etudes/etudes/join/2013/507449/IPOL-EMPL_ET%282013%29507449_EN.pdf (accessed 1 December 2018).

European Commission (2006). Green Paper. Modernising labour law to meet the challenges of the 21st century. Brussels. http://www.europarl.europa.eu/meetdocs/2004_2009/documents/com/com_com(2006)0708_/com_com(2006)0708_en.pdf (accessed 1 December 2018).

Eurofound 2012. Fifth European Working Conditions Survey – Overview report. Luxembourg: Publications Office of the European Union. https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1182en.pdf. (accessed 1 December 2018).

Eurofound 2016. Sixth European Working Conditions Survey – Overview report. Luxembourg: Publications Office of the European Union. https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1634en.pdf (accessed 1 December 2018).

Eurofound 2018. European Working Conditions Survey Integrated Data File, 1991-2015. [data collection]. 6th Edition. UK Data Service. SN: 7363. http://doi.org/10.5255/UKDA-SN-7363-6.

Flamholtz, E.G. and Brzezinski, D. 2016. Strategic organizational development and growing pains: Empirical evidence from Europe, *International Review of Entrepreneurship*, 14(1), 51–68.

Giotopoulos, I., Kontolaimou, A., Korra, E., and Tsakanikas, A. 2017. What drives ICT adoption by SMEs? Evidence from a large-scale survey in Greece. *Journal of Business Research*, 81, 60–69. https://doi.org/10.1016/j.jbusres.2017.08.007.

Gombault, A., Allal-Chérif, O., and Décamps, A. 2016. ICT adoption in heritage organizations: crossing the chasm. *Journal of Business Research*, 69(11), 5135–5140. https://doi.org/10.1016/j.jbusres.2016.04.093.

Guo, G. and Zhao, H. 2000. Multilevel modeling for binary data, *Annual Review of Sociology*, 26, 441–462. https://doi.org/10.1146/annurev.soc.26.1.441.

Hannan, M.T., and Freeman, J. 1984. Structural inertia and organizational change. *American Sociological Review*, 49(2), 149–164. https://doi.org/10.1016/10.2307/2095567.

Harindranath, G. Dyerson, R. and Barnes, D. 2008. ICT adoption and use in UK SMEs: a failure of initiatives?, *The Electronic Journal Information Systems Evaluation*, 11(2), 91–96. http://www.ejise.com/issue/download.html?idArticle=724.

Haller, S. and Siedschlag, I. 2011. Determinants of ICT adoption: evidence from firm-level data, *Applied Economics*, 43(26), 3775–3788. https://doi.org/10.1080/00036841003724411.

Hollenstein, H. 2004. Determinants of the adoption of Information and Communication Technologies (ICT), *Structural Change and Economic Dynamics*, 15(3), 315–342. https://doi.org/10.1016/j.strueco.2004.01.003.

Hempell, T. 2005. What's spurious, what's real? Measuring the productivity impacts of ICT at the firm-level, *Empirical Economics*, 30(2), 427–464. https://doi.org/10.1007/s00181-005-0248-6

Hofmann D.A. 1997. An overview of the logic and rationale of hierarchical linear models, *Journal of Management*, 23(6), 723–744. https://doi.org/10.1177/014920639702300602.

Hofmann, D.A, Griffin, M.A, and Gavin, M.B. 2000. The application of hierarchical linear modeling to organizational research. In: K.J. Klein and S.W.J. Kozlowski (Eds.), *Multilevel Theory, Research, and Methods in Organizations: Foundations, Extensions, and New Directions*, San Francisco, CA: Jossey-Bass, 467–511.

ILO 2003. The scope of the employment relationship. Report V. Paper presented at the International Labour Conference, 91st Session, Geneva. http://www.ilo.org/public/english/standards/relm/ilc/ilc91/pdf/rep-v.pdf (accessed 1 December 2018)

Lee, S. and Kim, S.H. 2006. A lag effect of IT investment on firm performance, *Information Resources Management Journal*, 19(1), 43–69. https://doi.org/10.4018/irmj.2006010103.

Leibenstein, H. (1966), Allocative efficiency vs. "X-efficiency", *American Economic Review*, 56(3), 392–415. https://www.jstor.org/stable/1823775.

Levy, M. and Powell, P. 2003. Exploring SME internet adoption: towards a contingent model, *Electronic Markets*, 13(2), 173–181. https://doi.org/10.1080/1019678032000067163.

Liang, T., You, B. and Liu, C. 2010. A resource-based perspective on information technology and firm performance: a meta analysis, *Industrial Management and Data Systems*, 110(8), 1138–1158. https://doi.org/10.1108/02635571011077807.

Licht, G. and Moch, D. 1999. Innovation and information technology in services. *The Canadian Journal of Economics / Revue canadienne d'Economique*, 32(2), 363–383. https://doi.org/10.2307/136427.

Lucchetti, R., and Sterlacchini, A. 2004. The adoption of ICT among SMEs: evidence from an Italian survey, *Small Business Economics*, 23(2), 151–168. https://doi.org/10.1023/B:SBEJ.0000027667.55821.53.

MacKinnon, D.P., Lockwood, C.M., Hoffman, J.M., West, S.G., and Sheets V. 2002. A comparison of methods to test mediation and other intervening variable effects, *Psychol Methods*, 7(1), 83–104. http://dx.doi.org/10.1037/1082-989X.7.1.83.

Matteucci, N., O'Mahony, M., Robinson, C. and Zwick, T. 2005. Productivity, workplace performance and ict: industry and firm-level evidence for Europe and the US, *Scottish Journal of Political Economy*, 52(3), 359–386. https://doi.org/10.1111/j.0036-9292.2005.00349.x.

Melville, N., Kraemer, K.L. and Gurbaxani, V. 2004. Information technology and organizational performance: an integrative model of IT business value, *Management Information Systems Quarterly*, 28(2), 283–322. https://doi.org/10.2307/25148636.

Milgrom, P. and Roberts, J. 1990. The economics of modern manufacturing: technology, strategy and organization, *American Economic Review*, 80(3), 511–528. https://www.jstor.org/stable/2006681.

Mozas-Moral, A., Moral-Pajares, E., Medina-Viruel, M.J., and Bernal-Jurado, E. 2016. Manager's educational background and ICT use as antecedents of export decisions: A crisp set QCA analysis. *Journal of Business Research*, 69(4), 1333–1335. https://doi.org/10.1016/j.jbusres.2015.10.102.

Muehlberger, U. and Bertolini, S. 2008. The organizational governance of work relationships between employment and self-employment, *Socio-Economic Review*, 6(3), 449–472. https://doi.org/10.1093/ser/mwm026.

Ong, J.W. and Ismail, H.B. 2008. Sustainable competitive advantage through information technology competence: resource-based view on small and medium enterprises, Communications of the International Business Information Management Association (IBIMA), Volume 1, 62–70. https://ibimapublishing.com/articles/CIBIMA/2008/320097/320097.pdf (accessed 1 December 2018).

OECD 2014. The Employment Outlook, chapter 4, Paris. http://dx.doi.org/10.1787/empl_outlook-2014-en.

Román, C., Congregado, E. and Millán, J.M. 2011. Dependent self-employment as a way to evade employment protection legislation, *Small Business Economics*, 37(3), 363–392. https://doi.org/10.1007/s11187-009-9241-3.

Stewart, A. and Stanford, J. 2017. Regulating work in the gig economy: what are the options?, *The Economic and Labour Relations Review*, 28(3), 420–437. https://doi.org/10.1177/1035304617722461.

Stanford, J. 2017. The resurgence of gig work: historical and theoretical perspectives, *The Economic and Labour Relations Review*, 28(3), 382–401. https://doi.org/10.1177/1035304617724303.

Sin Tan, K., Choy Chong, S., Lin, B., and Cyril Eze, U. 2010. Internet-based ICT adoption among SMEs. Demographic versus benefits, barriers, and adoption intention, *Journal of Enterprise Information Management*, 23(1), 27–55. https://doi.org/10.1108/17410391011008897.

Sobel, M.E. 1982. Asymptotic confidence intervals for indirect effects in structural equation models. In: S. Leinhart (Ed.), *Sociological Methodology*, San Francisco, CA: Jossey-Bass, 290–312.

Stiroh, K.J. 2002. Are ICT spillovers driving the new economy?, *The Review of Income and Wealth*, 48(1), 33–57. https://doi.org/10.1111/1475-4991.00039.

Supiot, A. 2001. *Beyond Employment. Changes in Work and the Future of Labour Law in Europe*. Oxford: Oxford University Press.

Tobin, J. 1958. Estimation of relationships for limited dependent variables, *Econometrica*, 26(1), 24–36. https://doi.org/10.2307/1907382.

Van Stel, A., Millán A, Millán, J.M. and Román, C. 2018. The relationship between start-up motive and earnings over the course of the entrepreneur's business tenure, *Journal of Evolutionary Economics*, 28(1), 103–123. https://doi.org/10.1007/s00191-017-0499-3.

Yunis, M., Tarhini, A., and Kassar, A. 2018. The role of ICT and innovation in enhancing organizational performance: the catalysing effect of corporate entrepreneurship, *Journal of Business Research*, 88, 344–356. https://doi.org/10.1016/j.jbusres.2017.12.030.

Zwick, T. 2003. The impact of ICT investment on establishment productivity. *National Institute Economic Review*, 184(1), 99–110. https://doi.org/10.1177/0027950103184001009.

Appendix. Variable definitions

Variable	Description
	Dependent variables
ICT use	
ICT use frequency at work	Variable ranging from 1 to 7. The scale refers to the individual ICT (i.e., computers, laptops, smartphones, etc.) use frequency at work. It equals 1 for individuals answering *never* and 7 for individuals answering *all of the time*. This information is also used to generate our focal variables in our earnings equations.
ICT adoption	Dummy equals 1 for workers who declare using ICT at work (levels 2 to 7 in previous scale).
Earnings	
Net monthly earnings - PPP $ of 2015 (logs)	Average net earnings in recent months. The variable is defined in PPP $ of 2015 and converted to natural logarithms.
	Main independent variables
Occupational status within self-employment	
Self-employed with employees	Dummy equals 1 for workers who declare being self-employed with employees.
Independent own-account self-employed worker	Dummy equals 1 for workers who declare being self-employed without employees and answer positively to the question on whether he/she generally has more than one client or customer.
Dependent self-employed worker	Dummy equals 1 for workers who declare being self-employed without employees and answer negatively to the question on whether he/she generally has more than one client or customer.
ICT use frequency at work	
ICT use frequency at work	Variable ranging from 1 to 7. The scale refers to the individual ICT (i.e., computers, laptops, smartphones, etc.) use frequency at work. It equals 1 for individuals answering *never* and 7 for individuals answering *all of the time*.
1 Never [a] (*ref.*)	Dummy equals 1 for workers who state they *never* use ICTs during their daily business operations.
2 Almost never [a]	Dummy equals 1 for workers who state they *almost never* use ICTs during their daily business operations.
3 Around ¼ of the time [a]	Dummy equals 1 for workers who state they use ICTs *around ¼ of the time* during their daily business operations.
4 Around half of the time [a]	Dummy equals 1 for workers who state they use ICTs *around half of the time* during their daily business operations.
5 Around ¾ of the time [a]	Dummy equals 1 for workers who state they use ICTs *around ¾ of the* time during their daily business operations.
6 Almost all of the time [a]	Dummy equals 1 for workers who state they use ICTs *almost all of the time* during their daily business operations.
7 All of the time [a]	Dummy equals 1 for workers who state they use ICTs *all of the time* during their daily business operations.
	Control variables
Educational attainment	
Basic education	Dummy equals 1 for workers with less than lower secondary education (ISCED-1997, 0-1).
Secondary education	Dummy equals 1 for workers with, at least, lower secondary education but non-tertiary education (ISCED-1997, 2-4).
Tertiary education	Dummy equals 1 for workers with tertiary education (ISCED-1997, 5-6).

Job aspects	
Tenure	Years of experience in the company or organization.
Working hours	Working hours per week.
Business sector dummies	
Agriculture	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is A = Agriculture, forestry and fishing.
Industry	Dummy equals 1 for workers whose codes of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) are B = Mining and quarrying, C = Manufacturing, D = Electricity, gas, steam and air conditioning supply, and E = Water supply; sewerage, waste management and remediation activities.
Construction	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is F = Construction.
Commerce and hospitality	Dummy equals 1 for workers whose codes of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) are G = Wholesale and retail trade; repair of motor vehicles and motorcycles, and I = Accommodation and food service activities.
Transport	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is H = Transportation and storage.
Financial services	Dummy equals 1 for workers whose codes of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) are K = Financial and insurance activities, and L = Real estate activities.
Public administration and defence	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is O = Public administration and defence; compulsory social security.
Education	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is P = Education.
Health	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is Q = Human health and social work activities.
Other services	Dummy equals 1 for workers whose codes of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) are J = Information and communication, M = Professional, scientific and technical activities, N = Administrative and support service activities, R = Arts, entertainment and recreation, S = Other service activities, T = Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U = Activities of extraterritorial organisations and bodies.
Demographic characteristics	
Female	Dummy equals 1 for females.
Immigrant	Dummy equals 1 for citizens of a different country of that of residence.
Age	Age reported by the workers.
Cohabiting	Dummy equals 1 for individuals cohabiting with spouse/partner.
Children under 14	Dummy equals 1 for individuals cohabiting with any son or daughter aged under 14.
Health	Variable ranging from 1 to 5. The scale refers to the level of health declared by the worker. It equals 1 for individuals whose health is very bad and 5 for individuals whose health is very good.
Ends meet	Variable ranging from 1 to 6. The scale refers to the household ability to make ends meet. It equals 1 for households which make ends meet very easily and 6 for households which make ends meet with great difficulty.
Business cycle	
Unemployment rate	Harmonised annual unemployment rate (source: Eurostat).

Wave	
2015	Dummy equals 1 for observations corresponding to the EWCS 2015 and 0 for observations corresponding to the EWCS 2010.
Country dummies	35 dummies equalling 1 for individuals living in the named country: Albania, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Macedonia, Malta, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, and the United Kingdom.

Part III: Trademarks versus Patents

Universidad Internacional de Andalucía, 2022

Chapter 3: Trademarks and its association with Kirznerian entrepreneurs

Although trademarks are the most widely used form of Intellectual Property Rights (IPRs) by firms across all economic sectors worldwide, this indicator is a much less exploited information resource in empirical analysis compared with patents. Our work addresses this gap by investigating the relationship between trademark registration and entrepreneurial activity using data for 33 European countries. Our empirical results show a positive and significant relationship between the share of the self-employed workforce in a given country that can be considered 'entrepreneurial' –which we associate with the share of *Kirznerian entrepreneurs*– and trademark registration at the country level. These results have important implications for scholars, practitioners and policy makers, which are discussed in this work.

3.1. Introduction

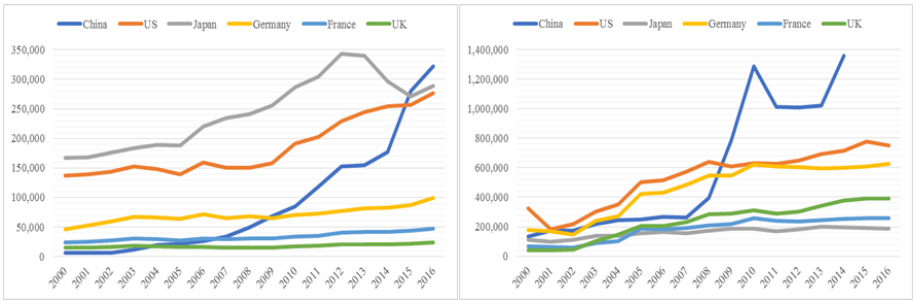
There is a large body of theoretical and empirical literature suggesting that Intellectual Property Rights (IPRs) make countries more innovative and consequently cause higher economic growth (Varsakelis 2001; Branstetter, Fishman, and Foley 2006; Kanwar 2006; Allred and Park 2007, Acs and Sanders, 2012). The rationale is that, presumably, the protection provided to innovators by IPRs guarantees their economic rents, which stimulate investment in knowledge and innovation and, subsequently, economic growth.

Both patents and trademarks are IPR indicators which are positively correlated with innovation performance and provide an insight into ongoing processes of industrial change (Mendonça, Pereira, and Godinho 2004; Mendonça 2012). While patents are typically related to original, non-trivial and productive inventions (i.e., technological aspects of a

firm's business model), trademarks such as brand names and logos are registered to distinguish and protect the reputation of goods, services and corporate identities (i.e., marketing aspects) (Mendonça, Pereira, and Godinho 2004; Srinivasan, Lilien, and Rangaswamy 2008; Mendonça 2012; De Vries et al. 2017). Hence, these indicators provide complementary information on the industrial composition in a given region: patent counts are a pointer of technological expertise and trademark statistics are an indicator of commercial capability (Mendonça 2012).

Specifically, trademarks are of great interest for social science research, as they are not only an important aspect of contemporary culture worldwide (Mendonça, Pereira, and Godinho 2004) but also the most widely used form of IPRs by firms across all economic sectors worldwide (WIPO 2017). Figure 1 below shows the evolution of both indicators for selected economies in the period 2000-16.[1]

Fig. 1. Total patent (*left panel*) and trademark (*right panel*) registrations for selected countries. *Source*: WIPO IP Statistics Database.



In this line, the increasing importance of trademarks has recently spawned research investigating (i) the patterns of firms' usage of trademarks in relation to their innovation activities and new products, (ii) trademarks' relations to firms' economic performance and productivity, and (iii) the interplay between social costs and value of trademarks (see Malmberg 2005, and Schautschick and Greenhalgh 2016 for reviews). Furthermore, trademark-based indicators show promise for advancing research agendas concerned with (i) the rates and directions of product

[1] The observed differences in favour of trademark registration figures can be explained (at least) by (i) their comparatively lower cost and (ii) the absence of novelty requirement for trademark registration.

innovations in different industrial sectors, (ii) international patterns of specialisation, (iii) links between technological and marketing activities; and (iv) the evolution of economic organisations and structures (Mendonça, Pereira, and Godinho 2004).

However, although both patents and trademarks allow for complementary readings, patents have been used for decades in empirical analysis, whereas trademark data is a much less exploited information resource (Mendonça 2012). Thus, patents are commonplace in standard economic benchmarking publications (e.g. OECD or World Bank reports), whereas trademarks use as a country-level indicator has been very limited.[2] In particular, fundamental aspects of the function of trademark data as an additional indicator of innovative and entrepreneurial activity remain unexplored. Addressing this research gap is precisely the main aim of this work.

This work contributes to this scant literature by assessing the appropriateness of trademark data as a source of qualitative information about the self-employed workforce within a particular country or region. In this sense, there are some arguments for assuming certain properties of trademark data reveal hidden information about the self-employment population in a given economy. Thus, the majority of enterprises (between 70% and 95%) in all OECD countries are micro-businesses (i.e., enterprises with fewer than ten employees) and the share of SMEs over the population of enterprises rises above 99% (OECD 2019a). Therefore, the proportion of individuals within the self-employment population running SMEs is very large. However, the propensity to patent is rather low in SMEs (Blind et al. 2006; Leiponen and Byma 2007; Thomä and Bizer 2013; Flikkema, De Man, and Castaldi 2014) and, hence, patents cannot adequately measure innovation in SMEs (Kleinknecht 2000). In contrast to patents, trademarks can be used to capture the "softer" non-technological types of innovation, i.e., service, marketing and organizational innovation, which are more probable within the SME framework (Flikkema, De Man, and Castaldi 2014). Under a microeconomic theoretical framework, the *Schumpeterian* entrepreneur (1912, 1942) would be more likely linked with R&D efforts and patent registration activity in large firms, while the *Kirznerian* entrepreneur (1973) would be more likely associated with trademark registration practices within the SME and self-employment

[2] Some notable exceptions are presented in subsection 2.1 below.

framework.[3] Therefore, irrespective of the (rather low) share of technologically innovative or Schumpeterian entrepreneurs in a given economy,[4] an association is expected between trademark data and the relative weight of Kirznerian entrepreneurial activities over total self-employment in a given economy.

More specifically, this paper explores whether registered trademarks at the country level can be linked to the existing heterogeneity within entrepreneurship in 33 European countries. To this aim, an *ad hoc* country-level dataset covering the periods 2010 and 2015 is generated and linear regression models are used. As dependent variables, we use information on registered patents and trademarks provided by the *World Intellectual Property Organization* (WIPO). To account for this entrepreneurial heterogeneity, and based on microdata drawn from the *European Working Conditions Survey*, we use as covariates different groups of self-employed workers, from more to less entrepreneurial in a Kirznerian sense. Our proxies for Kirznerian entrepreneurs are self-employed with employees and opportunity entrepreneurs. Conversely, our proxies for less entrepreneurial forms of self-employment are dependent self-employed workers (i.e., self-employed without employees who generally has only one client) and necessity entrepreneurs. For all countries in our sample, this micro-level information is turned into macro-level data by estimating the share of self-employed workers belonging to the different groups of self-employed workers. Our regressions also include information about expenditure on R&D activities provided by Eurostat. As regards the evidence obtained, we observe how both our proxies for Kirznerian entrepreneurs are positively and statistically associated with trademark registration at the country level. Conversely, none of our groups of self-employed workers, from more to less entrepreneurial in a Kirznerian sense, seems to be statistically associated with patent registration activities at the country level. Our results have important implications for academics, practitioners and policy makers.

[3] There is also a growing body of empirical literature exploring the different impact of entrepreneurship on regional economic growth depending on whether regional entrepreneurship is based on technological innovations (Schumpeterian type) or opportunity discoveries (Kirznerian type) (see e.g. Sundqvist et al. 2012, Aparicio, Urbano, and Audretsch 2016, and Ferreira et al. 2017 as recent examples).

[4] Most entrepreneurs don't employ personnel, are home-based, and earn low incomes (Shane 2009).

The remainder of the paper is structured as follows: Section 2 provides background information from which our general hypothesis is derived. Section 3 describes our data and variables. Section 4 presents the descriptive analysis and multivariate results, and Section 5 concludes with a discussion of implications, limitations of this study and suggestions regarding possible directions for future research.

3.2. Background

Four elements are part of the background of this study. First, a small review of studies using trademarks as a country-level indicator is presented. Second, a brief review of Schumpeterian and Kirznerian views of entrepreneurship is provided. Next, we present the existing relationship between these two types of entrepreneurs and some particular IPR indicators such as patents and trademarks and derive our proposed relationship between Kirznerian entrepreneurship and trademarks (i.e., the general hypothesis to be tested in this work). Finally, possible operationalizations of Kirznerian entrepreneurship are discussed.

Trademarks as a country-level indicator

In contrast to patents, the use of trademark data as a country-level indicator in the economic literature has been scarce and sporadic. The more notable exceptions, to our knowledge, are presented below.

Thus, Fink, Javorcik, and Spatareanu (2005) use data on international trademark registrations as an indicator of both product quality and the extent of brand differentiation in order to examine an extension of Linder's (1961) hypothesis.[5] Similarly, Mangani (2007) proposes the use of registered trademarks to estimate the variety and quality of goods and services in an economy and, thus, describes the patterns of production and exports of about 120 countries. Baroncelli, Fink, and Javorcik (2005) use trademark registration data as an information source on how reputational assets are distributed and how they are exploited in international commerce. Baroncelli, Krivonos, and Olarreaga (2007) explore the extent to which discrimination against foreign applicants in the trademark registration is used as a *behind-the-border* barrier to imports, i.e., a

[5] Linder's (1961) hypothesis suggests the quality of products as being the main determining factor of the closeness of exporter supply structures and importer preferences, which in turn explains why richer countries trade more among themselves than with poorer countries.

protectionism indicator. Mendonça (2012) employs trademarks as an indicator for assessing dynamic competition and international competitiveness in the telecommunications equipment and services sector. De Rassenfosse (2016) observes the validity of an intangible investment, such as *brand equity*, as a powerful predictor of trademark applications.[6] Finally, Herz and Mejer (2016) suggest that the increase in trademark applications experienced over the last 20 years in Europe is not a sign of increased innovative performance but rather the result of (i) national trademark filings simply being price-sensitive, and (ii) a decrease and convergence of trademark filing fees across countries in Europe.

Schumpeterian and Kirznerian entrepreneurs in brief

The Schumpeterian (1912, 1942) view of innovation is an industry phenomenon where new products or practices spread among competing firms or drive out those firms that are unable to adapt. The result is a change of industry practices. Hence, the *creativity* of Schumpeterian entrepreneurs *disrupts* what would otherwise have been a serene market. The creative genius of Schumpeterian entrepreneurs is thus scarce in nature.

In contrast, Kirzner's (1973) entrepreneurs are often viewed as merely speculative agents or arbitrageurs, i.e., individuals who are *alert* to price differentials which others had not yet noticed (Von Mises 1952). The discrepancies which the entrepreneur notices appear in the form of profit opportunities and, specifically, the prompt exploitation of such perceived opportunities by these entrepreneurs is what *drives the market towards the* (relevant new) *equilibrium* configurations.

Therefore, there is room for both views of the entrepreneurial process, and they are not at all mutually exclusive. Conversely, market dynamics can be seen as the outcome of two distinct kinds of entrepreneur-driven changes (Kirzner 2009). Furthermore, there are (at least) two arguments that support the existence of some overlapping (to a certain extent) between Schumpeterian and Kirznerian entrepreneurs. *First*, although the role of creator and innovator is commonly associated with Schumpeterian entrepreneurs, Kirzner's view is also linked to innovation in the sense that "his entrepreneur" discovers that there is indeed an opportunity to make a

[6] Brand equity investment series data were obtained from studies that have followed the Corrado-Hulten-Sichel (CHS) methodology (Corrado, Hulten and Sichel 2005).

profit by introducing an innovation to a market (Dahlqvist and Wiklund 2012). Thus, while Kirzner's (1973) earlier work might paint an image of the entrepreneur as an arbitrageur who *sees* the existing, but hitherto overlooked, opportunity, his more recent work (e.g., Kirzner 2009) suggests that the discovery of opportunity by what he refers to as *real-world entrepreneurs* takes creativity, imagination and even talent.[7] And *second*, as Kirzner (2009) argues, the bold, creative, innovative (Schumpeterian) entrepreneur is, at a higher level of abstraction, also engaged in arbitrage. In this regard, Prof. Kirzner claimed the following:

> *What [a Schumpeterian entrepreneur] 'sees' is that, by assembling available resources in an innovative, hitherto undreamt of fashion, and thus perhaps converting them into new, hitherto undreamt of products, he may be able (in the future) to sell output at prices which exceed the cost of that output to himself. In 'all' its manifestations, entrepreneurship identifies arbitrage opportunities (Kirzner 2009, p. 150).*

All in all, Schumpeterian entrepreneurs can be viewed as decisive drivers of economic development and, simultaneously, a (small) *subset* of Kirznerian entrepreneurs.

The relationship between entrepreneurship and IPR indicators

The existing controversy between Schumpeterian and Kirznerian entrepreneurs and their respective innovation types runs parallel to other innovation indicators, i.e., the tandem patents and trademarks. Both types of IPRs allow the holder to protect his or her market power and, hence, guarantee economic rents. However, while patents are typically related to original, non-trivial and productive inventions (i.e., technological aspects of a firm's business model), trademarks can conversely be used to capture the "softer" non-technological types of innovation (i.e., service, marketing and organizational innovation).

In industrial organization terms, those (presumably large) firms which are active in R&D-intensive and technology-oriented industries would be more likely to register patents, whereas firms that are active in advertising-intensive, consumer-related and service-related industries would be more likely to register trademarks (Amara, Landry, and Traoré 2008; Block et al. 2015a). These "softer" non-technological types of innovation, i.e., service, marketing and organizational innovation which can be better captured by trademarks, are, however, more probable within the SME

[7] See Dahlqvist and Wiklund (2012) for an interesting discussion of this issue.

framework (Flikkema, De Man, and Castaldi 2014). Hence, trademarks are also a useful resource to protect and appropriate the value of innovations in sectors or activities where patents are not a viable option (De Vries et al. 2017). As a result, start-ups are more likely to file trademarks than patents when entering the market (De Vries et al. 2017). In contrast, the likelihood to patent is rather low in SMEs (Blind et al. 2006; Leiponen and Byma 2007; Thomä and Bizer 2013; Flikkema, De Man, and Castaldi 2014) and, hence, trademarks are revealed as a more appropriate measure of innovation than patents in SMEs (Kleinknecht 2000). Therefore, since the share of individuals within the self-employment population running SMEs is broad (as argued in the introductory section), an important relationship between trademark filing behaviour and some innovative self-employed individuals is to be expected.

Stated under a microeconomic theoretical framework, two claims emerge from our previous discussion. *First*, the bold, disruptive, *Schumpeterian* entrepreneur would be more active in R&D exertion and patent registration activity in large firms, whereas the opportunity-alert *Kirznerian* entrepreneur would be more involved in trademark registration practices within the SME and self-employment framework. *Second*, patents and trademarks are related but distinct means of appropriating the benefits of innovation with a low degree of substitution. Indeed, both IPRs are only observed to successfully work as complementary assets in some highly innovative sectors (Srinivasan, Lilien and Rangaswamy 2008; Llenera and Millot 2013).[8]

However, the causality of these relationships among entrepreneurship and different innovation types and their associated IPRs may go in both directions (Wennekers et al. 2010). Thus, since entrepreneurs are responsible for registering both patents and trademarks, *Schumpeterian* and *Kirznerian* entrepreneurial activities can thus naturally explain the occurrence of intellectual protection. However, the inverse relationship can also occur, i.e., IPR measures can also help explain levels of entrepreneurial activity.

As regards patents, since registration makes others pay for using some particular technological knowledge, this form of IPR becomes an important incentive for entrepreneurial R&D commitment. In addition, the

[8] Srinivasan, Lilien and Rangaswamy (2008) find patents and trademarks to be complementary assets in the high-tech industry. Llenera and Millot (2013) find evidence of this complementarity in sectors such as pharmaceutical or chemical products.

patents a firm owns can also affect the prospects for follow-up funding (Audretsch, Bönte and Mahagaonkar 2012; Hsu and Ziedonis 2013; Haeussler, Harhoff and Mueller 2014), which can be used in later R&D investments. Furthermore, patents reveal that the firm was able to create an innovation and might do so again in the future (Farre-Mensa, Hegde and Ljungqvist 2017); i.e., patents can be a proxy for future R&D efforts. Finally, by publishing these rights, i.e., in the form of patents, technological knowledge becomes accessible in the form of "spillovers of R&D" which, in turn, raises business opportunities and new R&D efforts for the firms' neighbourhood (Jaffe 1986; Audretsch and Feldman 1996; Thumm 2004; Cassiman and Veugelers 2006).

When turning our attention to trademarks, analogous arguments can also be applied. Thus, filing trademarks demonstrates a start-up's degree of market and growth orientation and its willingness to protect its current and future marketing efforts from the impairment of others (Krasnikov, Mishra and Orozco 2009; Sandner and Block, 2011; Brahem, El Harbi and Grolleau 2013). Like patents, trademarks have been found to be positively related to firm survival (Srinivasan, Lilien, and Rangaswamy 2008; Helmers and Rogers 2010), firm valuations (Sandner and Block 2011; Greenhalgh and Rogers 2012) and access to external funds (Block et al. 2014). Moreover, particularly for nascent entrepreneurs (whose businesses are, by definition, small), the impact of trademark registration on both firm valuation and external investors is even higher than that by filed patents (Block et al. 2014). Finally, important knowledge spillovers can also occur as a result of registering trademarks. *First*, brand loyalty might spill over across products of the same firm (Parchomovsky and Siegelman 2002). *Second*, advertising of the trademarked product may spill over to its generic competitors, so that some of the benefit to the trademark 'leaks' away to its rivals (Llenera and Millot 2013). *Last*, product improvements (in the form of registered trademarks) can also generate knowledge spillovers which, in turn, may act as an important source of new business opportunities not only for imitative entrepreneurship but also innovative entrepreneurship that wishes to build further on the earlier innovations made in other firms (Acs et al. 2009; Burke and Fraser 2012).

Once the bidirectional relationship between entrepreneurship and IPRs has been argued, previous claims can be presented in a more straightforward manner: (i) *Schumpeterian* entrepreneurship is more likely linked with R&D efforts and patenting in large firms, and (ii) *Kirznerian* entrepreneurship is more likely associated with trademarking activity by SMEs and self-employed workers. Therefore, irrespective of the (rather

low) share of technologically innovative or Schumpeterian entrepreneurs in a given economy, an association is expected between trademark data and the relative weight of Kirznerian entrepreneurial activities over total self-employment in a given economy.

Previous discussion leads us to state our general hypothesis for this work as follows:

General Hypothesis. Trademarks present a stronger association with Kirznerian entrepreneurs' activity in a given economy than patents.

This work specifically aims to assess the appropriateness of using this trademark and patent information as a source of qualitative information on the self-employed workforce within a country. Given the exploratory nature of the current study, such relationships are expressed in terms of associations and, hence, a formal analysis of the presumably bidirectional causality between these variables is a topic for further research.

Operationalization of *Kirznerian* entrepreneurship

Due to data availability constraints, the production of statistical evidence in order to test our general hypothesis is, however, not straightforward. Hence, a proper selection of indicators for entrepreneurship from the pool of available empirical operationalizations is required. In particular, detailed information not only about the number of entrepreneurs in a particular geographical area but also about the way these entrepreneurs carry out their task is crucial.

In this sense, and based on the so-called 'revealed preference' principle, *economists* tend to classify entrepreneurs into different types from actual observed attributes and behaviours. Thus, self-employment is the more common labour economists' working definition for entrepreneurs (Parker 2018). Its wide implementation –both at the individual level within human population surveys and at the national level, via the *OECD Labour Force Statistics* database– is, undoubtedly, a practical advantage. In this sense, approximately 15.8 per cent of the workforces in the EU-28 are self-employed (OECD, 2019b).

The self-employed are formally considered as individuals working for themselves (instead of working for an employer that pays a salary or a wage) who derive their income by exercising their profession or business on their own account and at their own risk. However, there is plenty of

heterogeneity behind this indicator, as acknowledged by the OECD's own self-employment definition: "*self-employment may be seen either as a survival strategy for those who cannot find any other means of earning an income or as evidence of entrepreneurial spirit and a desire to be one's own boss*" (OECD 2019b).

Both the *number of employees* and the *number of clients* are immediate sources of self-employment heterogeneity based on their observed attributes. The *number of employees* leads to the distinction between *self-employed with employees* and *own-account workers*. The former type contributes to the job-generation process and, hence, works on a larger scale than own-account workers, which implies some degree of business success (Earle and Sakova 2000). Indeed, self-employed with employees are considered as more entrepreneurial forms of self-employment than own-account workers (Earle and Sakova 2000; Kuhn 2000; Román, Congregado, and J.M. Millán 2013; J.M. Millán, Congregado, and Román 2014a, 2014b). This larger scale, however, would probably still remain within the SME framework, as argued in preceding sections. As a consequence, both self-employed with and without employees would rarely participate in (Schumpeterian) R&D intensive and technology-oriented activities and, hence, would seldom be involved in patent registration. Conversely, their SME scale is more appropriate to performing those aforementioned "softer" non-technological types of innovation which can be registered in the form of trademarks (Flikkema, De Man, and Castaldi 2014). Thus, although trademark registration seems more likely for the outperforming group, i.e., self-employed with employees, there are no a priori reasons to assume that own-account workers will not register trademarks to a certain extent.

When turning our attention to the *number of clients*, an interesting distinction emerges within the group of own-account workers. Thus, as opposed to the *independent own-account self-employed* who work for different clients-firms, *dependent self-employed workers* work exclusively (or mainly) for a specific firm. Hence, they are economically dependent in the sense that they generate their whole (or a substantial part of their) income from this business relationship and, obviously, take an entrepreneurial risk (Muehlberger and Bertolini 2008). The OECD defines this particular group as "*own-account self-employed whose conditions of work are nonetheless similar to those of employees, in the sense that they work mainly or exclusively for a specific client-firm with limited autonomy and often closely integrated into its organizational structure*" (OECD 2014). Dependent self-employment can be regarded as a sub-phenomenon

of a general trend towards increasing labour market flexibility (Eichhorst et al. 2013), to which the growth of the *gig economy*, typified by online platforms and isolated independent workers, is seriously contributing (Stewart and Standord 2017). Unfortunately, these workers are usually beyond the scope of labour law (Muehlberger and Bertolini 2008; Román, Congregado, and Millán 2011; A. Millán and J.M. Millán 2017; A. Millán, J.M. Millán, and Román 2018), collective bargaining and trade union representation (Supiot 2001; ILO 2003). We will agree at any rate that there is nothing entrepreneurial about merely being a disguised employee and, therefore, trademark registration is expected to be anecdotal among this group.

All in all, based on the *economists*' view, three groups of self-employed workers emerge, from more to less entrepreneurial in a Kirznerian sense: (1) *self-employed with employees*; (2) *independent own-account self-employed*; and (3) *dependent self-employed workers*.

Business scholars propose an alternative classification for entrepreneurs where the source of heterogeneity concerns their *start-up motivation*. We refer here to the distinction between *opportunity* and *necessity* entrepreneurs, for which the more widely used operationalization is that based on the Global Entrepreneurship Monitor (GEM) definition proposed by Reynolds et al. (2002). In the GEM Adult Population Survey, respondents indicating that they run a business are asked whether they started their business because they saw a business opportunity they wanted to pursue, or whether they had no alternatives to obtain paid work.[9] This approach allows the contrast between those *opportunity-alert* (Kirznerian) entrepreneurs on the one hand, and those who can be considered self-employed as a *last resort* (Alba-Ramirez 1994; Hyytinen and Rouvinen 2008) on the other.

In this sense, these *opportunity entrepreneurs* can be interested in defending their market share, differentiating their products or services by means of trademarks as a way to guarantee their ability to compete

[9] GEM data suffers from severe drawbacks, such as the limited numbers of covariates or the impossibility of comparing its figures with data from official international statistics such as Eurostat or the OECD. Fortunately, other cross-country datasets for the European area also allow to obtain accurate proxies for opportunity and necessity entrepreneurs. We refer here to the *European Community Household Panel* (ECHP), the *European Union Statistics on Income and Living Conditions* (EU-SILC) or the *European Working Conditions Survey* (EWCS), the last being the one we use in the present study.

monopolistically and, thus, ensure a compensation for their marketing investments (Malmberg 2005). Their involvement, however, in (Schumpeterian) R&D-intensive projects or patent registration is hardly expected, due to the same scale arguments we previously used when presenting the *economists*' approach; i.e., the proportion of self-employed individuals running large firms, in which registering patents might occur, is minimal. When turning to the *necessity entrepreneurs*, these are more likely to run standard low-margin and low-added-value businesses mainly based on imitative strategies. Therefore, the absence of any particular attribute or a firm's brand to protect against competitors makes registering trademarks an unlikely practice among this group.

To sum up, both approaches, either that of economists or business scholars, allow us, on the basis of existing data sources, to identify useful proxies of *Kirznerian* entrepreneurs (i.e., *self-employed with employees* and *opportunity entrepreneurs*) and less (or none) entrepreneurial forms of self-employment (i.e., *dependent self-employed workers* and *necessity entrepreneurs*).

3.3. Data and variables

Dependent variables: trademarks and patents

The World Intellectual Property Organization (WIPO) offers global statistics on different intellectual property indicators: patents, trademarks, utility models and industrial designs. Our main dependent variables are based on registered trademarks and patents at the country level provided by the WIPO. To make fairer comparisons between countries, these figures are adjusted by GDP, as usual (see e.g., WIPO 2017). GDP data are derived from the World Bank national accounts data and OECD National Accounts data files.

In particular, our dependent variables are the registered trademarks and patents per constant 2010 US$ billion GDP for the periods 2010 and 2015. Both variables are generated for both periods at the country level for 33 European countries, which yields 66 observations. Table 1 below shows this information for the countries in our sample.[10]

[10] Detailed definitions of all our country-level and individual variables are presented, respectively, in Tables A1 and A2 in the Appendix.

Table 1: Patents, trademarks and Gross Domestic Expenditure on R&D (GERD) for 33 European countries

	Patents *per constant 2010 US$ billion GDP*				**Trademarks** *per constant 2010 US$ billion GDP*				**GERD** *PPS per inhabitant at constant 2005 prices*			
Country	**Rank#**	**10**	**Rank#**	**15**	**Rank#**	**10**	**Rank#**	**15**	**Rank#**	**06-10**	**Rank#**	**11-15**
Austria	9	11.7	7	17.2	8	217.4	10	203.4	6	793.4	3	942.7
Belgium	12	10.4	10	12.5	15	152.0	16	155.3	10	563.6	9	682.9
Bulgaria	21	4.2	29	1.9	4	275.4	5	360.9	31	48.9	30	79.9
Croatia	29	1.7	33	0.9	31	50.1	30	86.1	23	111.5	27	104.2
Cyprus	17	5.7	16	7.8	3	389.1	3	661.8	25	101.9	28	102.8
Czech Republic	26	2.8	21	4.9	24	126.0	23	142.7	17	263.7	15	385.3
Denmark	8	12.2	8	16.3	20	134.4	17	153.2	5	803.7	6	863.6
Estonia	20	4.3	20	5.2	6	245.7	4	411.2	19	193.1	17	291.0
Finland	2	26.0	2	28.2	22	132.0	18	152.6	3	1,006.7	4	906.0
France	7	12.6	9	15.8	27	97.7	29	92.1	11	558.9	11	596.1
Germany	4	20.7	5	23.4	13	182.1	14	163.2	7	744.3	5	890.6
Greece	28	2.1	28	2.0	32	47.6	31	76.6	21	137.3	25	142.7
Hungary	19	4.4	22	4.4	25	110.1	21	145.1	20	154.3	20	200.3
Ireland	15	7.5	17	7.6	19	139.6	27	100.7	12	478.1	12	530.8
Italy	10	11.7	13	9.1	14	168.9	20	149.7	16	295.9	16	306.5
Latvia	13	10.2	15	7.9	11	193.2	8	210.8	29	76.1	29	94.4
Lithuania	27	2.2	24	3.1	18	139.7	12	198.9	22	113.9	23	160.7
Luxembourg	5	17.4	3	25.9	1	586.8	2	695.3	4	989.8	7	802.0
Macedonia	32	1.3	32	1.1	16	147.8	32	52.5	33	40.0	33	40.0
Malta	14	8.8	12	9.5	2	431.0	1	1082.6	24	111.3	21	168.0
Netherlands	6	17.1	6	19.7	9	204.0	13	183.8	9	568.0	10	654.2
Norway	18	5.6	18	6.6	33	32.8	33	34.8	8	657.2	8	700.0
Poland	23	3.3	19	5.7	21	133.6	19	151.6	26	86.3	24	146.0
Portugal	31	1.3	30	1.6	10	197.8	7	212.3	18	262.6	19	254.1
Romania	25	2.8	26	2.1	29	96.3	25	108.4	32	48.6	32	48.0
Serbia	24	2.9	27	2.0	26	99.7	26	102.1	30	71.8	31	70.9
Slovakia	30	1.6	31	1.6	28	96.9	24	124.6	27	84.2	22	165.7
Slovenia	11	11.6	11	12.3	7	223.5	9	204.2	14	375.3	13	519.9
Spain	22	3.3	23	4.0	12	187.4	11	200.1	15	309.2	18	285.3
Sweden	3	21.7	4	23.6	17	145.1	15	160.6	1	1,018.8	2	1,007.4
Switzerland	1	28.3	1	35.0	5	266.2	6	270.4	2	1,013.8	1	1,089.7
Turkey	33	1.2	25	2.2	30	64.0	28	95.7	28	77.0	26	112.0
United Kingdom	16	6.8	14	7.9	23	127.3	22	145.1	13	455.9	14	463.5
33 European countries		***9.2***		***10.4***		***139.4***		***146.3***		***392.8***		***436.5***

Notes: Countries' population sizes are used as supranational weights to ensure that larger (smaller) countries weigh heavier (weaker) when calculating aggregated figures at the European level (i.e., for our 33 European countries). *Data sources*: WIPO IP Statistics Database, Eurostat, World Bank national accounts data, and OECD National Accounts data files.

Focal variables: occupational status, start-up motivation and expenditure on R&D

As argued in our background section, trademark-filing activities are expected to relate to some particular groups within self-employment, whereas patent registration practices seem to be associated with R&D efforts. Therefore, our focal variables must be defined accordingly.

However, due to data limitations, identifying the existing heterogeneity within the self-employed workforce is not straightforward. Precisely to overcome this issue, we use data from the Fifth and Sixth waves of the *European Working Conditions Survey* –EWCS 2010 and 2015– (Eurofound 2012, 2016, 2018), which are the first waves in the EWCS

series allowing the identification of certain categories. This survey is carried out every five years by the EU Agency *Eurofound* (*European Foundation for the Improvement of Living and Working Conditions*) and offers key work-related information on 44,000 workers (including both employees and self-employed individuals) covering 35 European countries.[11] To this end, these workers are interviewed about several working condition aspects, including physical environment, workplace design, working hours, work organization and social relationships in the workplace. Depending on country size and national arrangements, the sample ranges from 1,000 to 4,000 workers per country.

Conditional on self-classification, the EWCS 2010 and 2015 allow us to create 2 separate classifications of self-employed workers from more to less entrepreneurial forms. The *first classification of self-employed workers* combines the information collected by 2 different questions. *First*, the individuals in the survey are asked about their main activity status: self-employed with employees, self-employed without employees, employed or other. *Second*, an additional question is asked to those respondents who previously indicated being self-employed without employees, i.e., whether his/her firm generally has more than one client. Based on this information, we classify self-employed workers within our dataset from more to less entrepreneurial in (1) self-employed with employees; (2) independent own-account self-employed (i.e., self-employed without employees answering positively to the question about whether his/her firm generally has more than one client); and (3) dependent self-employed worker (i.e., self-employed without employees answering negatively to the question about whether his/her firm generally has more than one client). For the clarity of our exposition, we will refer hereafter to this classification as *occupational status within self-employment*. Our final sample includes men and women aged 18 to 65 who are classified as self-employed individuals. All individuals working part-time, i.e., working under 15 hours per week, are excluded. The final dataset, after removing cases with missing data for any of the relevant variables, yields 8,535 observations for 33 countries.[12]

The *second classification of self-employed workers* is created by means of a *third* question, which is asked to those respondents who previously

[11] This set includes the EU-28 together, 5 candidate countries (Albania, the Former Yugoslav Republic of Macedonia, Montenegro, Serbia and Turkey) and 2 EFTA countries (Norway and Switzerland).

[12] Albania and Montenegro are excluded during this process.

indicated being self-employed either with or without employees, i.e., whether he or she became self-employed mainly through personal preference, because he or she had no other alternatives for work, because of a combination of both reasons, or because of neither of these reasons. As this question was only used within the EWCS series in 2015, a subdataset is, hence, generated by excluding data from the EWCS 2010. Our subdataset, when using data from the EWCS 2015, yields 4,345 observations for 33 countries. Based on this information, we classify the observed set of self-employed workers within our dataset into (1) opportunity entrepreneur, (2) hybrid opportunity-necessity entrepreneur, (3) necessity entrepreneur, and (4) entrepreneur for other reasons. Categories 1, 2 and 3 are ordered from more to less entrepreneurial form of self-employment. Category 4, however, is assumed to have, by definition, a heterogeneous composition. For clarification purposes, we will refer henceforth to this classification as *start-up motivation*.

For the 33 European countries in our sample, this micro-level information is turned into macro-level data by estimating the share of self-employed workers belonging to the different categories included within both classifications presented above. In this sense, to ensure that these figures accurately reflect the population of self-employed workers in each country, post-stratification weights provided by the EWCS are used. This process yields only 64 observations, which is precisely the size of our final dataset.[13] Table 2 below shows the new data generated.

Table 2: Occupational status within self-employment and start-up motivation for 33 European countries

	Occupational status 2010			**Occupational status 2015**			**Start-up motivation [a] 2015**			
	1	**2**	**3**	**1**	**2**	**3**	**1**	**3**	**3**	**4**
Country	*SEwE*	*IOA*	*DSEW*	*SEwE*	*IOA*	*DSEW*	*Opp*	*Hyb*	*Nec*	*Oth*
Austria	42.9	51.1	6.0	37.4	51.5	11.1	40.7	15.2	30.1	14.1
Belgium	40.1	59.0	0.9	43.6	50.2	6.1	79.0	5.9	7.8	7.3
Bulgaria	38.8	48.6	12.6	37.7	58.1	4.2	67.4	10.9	21.7	0
Croatia	46.8	41.1	12.1	39.7	44.5	15.8	34.2	24.8	38.6	2.4
Cyprus	36.2	48.0	15.8	35.9	53.2	10.9	74.4	13.2	11.9	0.5
Czech Republic	32.8	57.2	10.1	32.6	62.3	5.0	51.3	30.3	17.2	1.3
Denmark	58.9	38.6	2.5	36.7	60.3	3.0	83.3	12.3	4.5	0
Estonia	36.5	57.8	5.7	62.4	30.1	7.5	56.7	15.7	20.6	7.0
Finland	25.3	66.1	8.6	36.8	50.5	12.7	80.0	12.4	6.1	1.5
France	28.1	68.7	3.2	43.9	51.9	4.3	68.8	17.4	10.2	3.6
Germany	43.1	52.5	4.4	58.8	37.8	3.5	61.9	21.5	12.9	3.8
Greece	23.8	65.2	11.0	37.1	51.9	11.0	50.4	24.7	23.1	1.8
Hungary	39.7	54.4	6.0	34.0	49.0	17.0	44.2	23.9	20.5	11.4
Ireland	30.7	60.0	9.3	37.8	50.5	11.7	67.5	10.5	21.0	1.0
Italy	31.3	62.4	6.3	32.1	61.1	6.8	63.4	18.5	16.3	1.8
Latvia	43.0	44.3	12.7	48.0	40.6	11.5	42.7	21.3	32.5	3.5
Lithuania	31.3	50.2	18.5	39.9	46.5	13.6	63.8	14.2	21.3	0.7

[13] The EWCS did not collect information for Serbia and Switzerland in 2010.

Luxembourg	45.7	49.8	4.5	31.7	58.3	10.1	72.8	14.0	9.3	3.9
Macedonia	31.2	53.9	15.0	33.6	49.6	16.8	28.1	19.1	50.3	2.5
Malta	39.7	54.3	6.0	27.8	61.9	10.3	67.1	15.9	14.2	2.8
Netherlands	25.9	66.2	8.0	27.8	67.9	4.3	76.4	12.1	8.0	3.5
Norway	29.4	66.0	4.6	34.5	55.6	9.9	69.8	14.6	14.0	1.7
Poland	15.1	71.4	13.5	36.6	50.2	13.1	47.7	23.0	20.3	9.1
Portugal	23.6	68.9	7.5	31.8	48.2	20.0	44.3	18.3	35.3	2.1
Romania	13.1	62.9	24.0	29.1	46.1	24.8	50.4	12.8	36.9	0
Serbia	*n.a.*	*n.a.*	*n.a.*	24.1	57.0	18.9	32.6	12.3	54.2	0.9
Slovakia	20.6	63.7	15.8	22.8	60.0	17.2	69.7	12.4	16.2	1.7
Slovenia	49.9	48.1	2.1	31.6	51.7	16.7	60.2	17.5	17.4	5.0
Spain	37.0	59.6	3.3	33.4	60.5	6.1	52.6	17.9	27.3	2.3
Sweden	26.8	72.7	0.5	30.5	62.6	6.9	87.6	7.3	5.1	0
Switzerland	*n.a.*	*n.a.*	*n.a.*	45.6	47.3	7.0	61.5	22.1	11.2	5.2
Turkey	25.9	62.4	11.7	23.0	42.0	34.9	53.6	6.9	38.5	1.0
United Kingdom	27.7	62.9	9.3	20.0	66.7	13.4	74.5	8.9	14.7	1.9
33 European countries	***30.8***	***61.4***	***7.9***	***35.5***	***52.3***	***12.1***	***60.8***	***20.4***	***15.7***	***3.1***

Notes: *SEwE* = self-employed with employees, *IOA* = independent own-account self-employed worker, *DSEW* = dependent self-employed worker, *Opp* = opportunity entrepreneur, *Hyb* = hybrid opportunity-necessity entrepreneur, *Nec* = necessity entrepreneur, *Oth* = entrepreneur for other reasons; To ensure that these figures accurately reflect the population of self-employed workers in each country, post-stratification weights provided by the EWCS are used. The design weights are calibrated by comparing the EWCS with Eurostat's Labour Force Survey with regard to respondents' gender, age, region, occupation and sector of economic activity. Countries' population sizes are used as supranational weights to ensure that larger (smaller) countries weigh heavier (weaker) when calculating aggregated figures at the European level (i.e., for our 33 European countries); [a] The information about entrepreneurship reasons is only available within the EWCS 2015.
Data source: EWCS 2010, 2015 and Eurostat.

To capture the presence and commitment to technological effort and innovation activities in each of the considered economies, our regressions also include the 5-year average Gross Domestic Expenditure on R&D (GERD) for periods 2006-10 and 2011-15. This indicator includes expenditures by business enterprises, higher education institutions, as well as government and private non-profit organizations.14 To make fairer comparisons between countries, Eurostat provides this information expressed as Purchasing Power Standards (PPS) per inhabitant at constant 2005 prices.15 Table 1 above also shows figures regarding this indicator for the 33 European countries in our sample.

Control variables

With the aim of controlling for the possible effects of different sector compositions of the economies under study, the empirical models control for the share of self-employed individuals working in high-technology industry and knowledge-intensive services for the 33 European countries

[14] GERD has been widely used within entrepreneurship literature as a measure of technological commitment in a particular economy (see e.g. Van Stel, J.M. Millán, and Román 2014).
[15] PPS is the technical term used by Eurostat for the common (artificial) currency in which national accounts aggregates are expressed when adjusted for price-level differences using PPPs. Thus, PPPs can be interpreted as the exchange rate of the PPS against the €.

in our sample. To this end, we use Eurostat aggregations of the manufacturing industry and services sector according to technological intensity based on NACE at the 2-digit level.16 Again, post-stratification weights provided by the EWCS are used to ensure that these figures accurately reflect each country's sector composition.

Finally, in order to control for the business cycle and some structural differences among countries, the empirical models also include the 5-year average unemployment rates for the periods 2006-10 and 2011-15, which we collect from Eurostat, and a period 2015 (vs. 2010) dummy.

3.4. Results

Descriptive analysis

We aim to explore the relationship between different statistics on IPR indicators and some particular groups within the self-employment workforce. Our hypotheses formulation is based on the assumption that these groups are good proxies for entrepreneurs in the Kirznerian sense and other less entrepreneurial forms of self-employment, respectively. In this sense, one important advantage of our country-level entrepreneurship dataset presented in Table 2 above is that we have access to the microdata information that was used for the macrodata generation process. Thus, we can use all the individual-based information within the EWCS to characterize those self-employed individuals belonging to each occupational status and start-up motivation we use in the analysis. Table 3 below compares these groups.

Table 3. Descriptive statistics for occupational status within self-employment and start-up motivation in the EWCS

	Occupational status		
	1	**2**	**3**
	Self-employed with employees 2010, 2015	*Independent own-account self-employed worker 2010, 2015*	*Dependent self-employed worker 2010, 2015*
# observations	N = 2,780	N = 4,881	N = 874
% observations	32.6%	57.2%	10.2%

[16] Eurostat aggregations based on 'Statistics on high-tech industry and knowledge-intensive services' (sometimes referred to as simply 'high-tech statistics') can be found at https://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an3.pdf.

Variables	Mean	SD	Mean	SD	Mean	SD
Educational attainment						
Basic education [a]	0.059		0.114		0.222	
Secondary education [a]	0.598		0.613		0.638	
Tertiary education [a]	0.343		0.272		0.140	
Job characteristics						
Years of tenure in present job (*1 – 53*)	13.53	9.85	12.54	10.37	14.70	12.48
Working hours (*15 – 98*)	49.5	13.3	46.0	15.3	44.2	16.3
Net monthly earnings - PPP $ of 2015 (*1 – 55,210*)	2,884	2,454	1,950	1,733	1,471	1,509
Sector composition						
High-tech industry and knowledge-intensive	0.035		0.038		0.035	
Demographic characteristics						
Female [a]	0.293		0.372		0.368	
Immigrant [a]	0.107		0.101		0.097	
Age (*18-65*)	44.46	10.50	44.24	11.10	46.24	11.54
Cohabiting [a]	0.773		0.709		0.722	
Children under 14 [a]	0.341		0.308		0.251	
Health (1-5)	4.05	0.73	3.98	0.78	3.80	0.79
Ends meet (1-6)	4.24	1.16	3.70	1.31	3.35	1.34

	Start-up motivation [b]							
	1		**2**		**3**		**4**	
	Opportunity Entrepreneur 2015		*Hybrid opportunity-necessity entrepreneur 2015*		*Necessity Entrepreneur 2015*		*Entrepreneur for other reasons 2015*	
# observations	N = 2,670		N = 652		N = 909		N = 114	
% observations	61.5%		15%		20.9%		2.6%	
Variables	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Educational attainment								
Basic education [a]	0.058		0.060		0.188		0.052	
Secondary education [a]	0.598		0.635		0.632		0.681	
Tertiary education [a]	0.344		0.305		0.180		0.267	
Job characteristics								
Years of tenure in present job (*1 –*	14.09	10.56	12.18	10.49	12.70	11.36	15.13	11.97
Working hours (*15 – 98*)	46.2	13.4	45.0	13.7	44.5	15.5	42.6	16.0
Net monthly earnings - PPP $ of 2015 (*1 – 55,210*)	2,545	2,578	1,984	1,422	1,440	1,115	2,021	1,380
Sector composition								
High-tech industry and knowledge-	0.048		0.041		0.017		0.026	
Demographic characteristics								
Female [a]	0.332		0.351		0.399		0.422	
Immigrant [a]	0.111		0.113		0.115		0.121	
Age (*18-65*)	45.67	10.77	44.83	10.97	46.02	11.18	46.35	10.85
Cohabiting [a]	0.725		0.710		0.698		0.733	
Children under 14 [a]	0.299		0.299		0.275		0.241	
Health (1-5)	4.08	0.73	3.96	0.75	3.77	0.79	3.97	0.80
Ends meet (1-6)	4.16	1.17	3.71	1.22	3.18	1.34	4.05	1.32

Notes: N = 8,535; [a] Dummy variable; [b] The information about entrepreneurship reasons is only available within the EWCS 2015.
Data source: EWCS 2010, 2015.

We first explore occupational status within self-employment. Approximately 32.6%, 57.2% and 10.2% of our sample are, respectively, self-employed with employees, independent own-account self-employed and dependent self-employed workers. In this sense, the self-employed with employees are, in our sample, most often male and most often with a partner and with children. Moreover, they have the highest educational attainment, earnings and ability to make ends meet. Finally, they also work the longest hours and feel the healthiest. These figures suggest the appropriateness of this self-employment category in order to capture Kirznerian entrepreneurs. When comparing independent own-account self-employed and dependent self-employed workers, the latter group is lower-educated, older and more likely to have worse health perception. Furthermore, they work longer hours and, conversely, have lower earnings and are less able to make ends meet. Finally, they are also less likely to work in high-tech industry and knowledge-intensive services. These figures suggest the appropriateness of using dependent self-employed workers as a proxy for the least entrepreneurial form of self-employment. As expected, independent own-account workers show up as an intermediate category where many (but not all) can be examples of Kirznerian entrepreneurs.

When concentrating on start-up motivation (only available for the EWCS 2015), a similar characterization of our relevant groups is revealed. However, the proportions of belonging to these groups varies substantially with respect those obtained for our occupational statuses. In particular, 61.5% of our sample report being opportunity entrepreneurs. We observe, inter alia, that this group is in our sample most often male, higher-educated, and most often with a better health perception. Moreover, they have the highest earnings and ability to make ends meet. Finally, they are also the most likely to work in high-tech industry and knowledge-intensive services. These attributes suggest the appropriateness of this category in order to capture Kirznerian entrepreneurs. Regarding their necessity entrepreneurs' counterparts, this group accounts for 20.9% of our sample. These self-employed workers present the lowest educational attainment levels and least often work in high-tech industry and knowledge-intensive services. Furthermore, they have the lowest earnings and are the least able to make ends meet. Hence, this category seems to be confirmed as a good proxy for the least entrepreneurial form of self-employment. Finally, the groups of hybrid entrepreneurs and entrepreneurs for other reasons account for 15%

and 2.6% of our sample. Their intermediate positions in terms of education levels, earnings, ability to make ends meet and likelihood to work for high-tech industry and knowledge-intensive services suggest these categories may also collect a certain proportion of Kirznerian entrepreneurs.

Multivariate analysis

The estimation results are presented in Tables 4 and 5. Table 4 in subsection 4.2.1 shows the results from 4 specifications as regards patents and their covariates. Similarly, Table 5 in subsection 4.2.2 shows the results from 4 specifications aimed to present trademarks and their covariates. As regards estimation methods, we opted for estimating by means of OLS models and adjusted the standard errors for intra-countries correlation by clustering in those models where more than one EWCS wave was involved. The following structure is used to present our results. First, average predicted values of our dependent variables are indicated at the top of each specification. Below, each model is presented in a three-column format, where marginal effects and t-statistics are reported. Thus, within each specification, the first column shows the absolute marginal effects associated with all covariates. The second column also refers to marginal effects but is expressed in relative terms (with respect to average predicted values of our dependent variables). The third column presents t-statistics associated with marginal effects. Finally, the following information is reported at the bottom of each specification: (i) use of post-stratification weights, (ii) R-squared, (iii) sample size, and (iv) periods involved.

Results for patents

Table 4 below shows the estimation results from 4 specifications.

Table 4. Results for patents –linear regression models (OLS)–

# Model	1A			1B		
Average predicted patents per constant 2010 US$ billion GDP (*y*)	9.14			9.11		
Independent variables (*x*)	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$ %	t-statistic
Focal variables						
Occupational status within self-employment						
1 Share of self-employed with employees (*13.1 –*	0.076	0.83	1.64	0.047	0.52	1.05
2 Share of independent own-account self-	0.015	0.17	0.39	0.020	0.21	0.45
3 Share of dependent self-employed workers						
R&D effort						
GERD PPS per inhabitant at constant 2005 prices (*40.0 – 1,089.7*)	0.021	0.22	7.16***	0.021	0.23	7.60***

Control variables						
Sector composition						
Share of high-tech industry and knowledge-	-0.293	-3.21	-1.08	-0.195	-2.14	-0.83
Business cycle						
Unemployment rate (*3.0 – 33.8*)	-0.115	-1.26	-1.15	-0.100	-1.10	-0.92
Period						
2015 [a]	0.968	10.59	1.23	0.958	10.51	1.20
Post-stratification weights for entrepreneurship		No			Yes	
R-squared		0.90			0.89	
# observations		64				
Periods		2010, 2015				

# Model	2B			2C		
Average predicted patents per constant 2010 US$ billion GDP (*y*)	10.04			10.03		
Independent variables (*x*)	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$%	t-statistic	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$%	t-statistic
Focal variables						
Start-up motivation						
1 Share of opportunity entrepreneurs (*28.1 – 87.6*)	0.052	0.52	1.16	0.053	0.53	1.17
2 Share of hybrid opportunity-necessity entrepreneurs (*5.9 – 30.3*)	0.141	1.41	1.06	0.148	1.47	1.04
3 Share of necessity entrepreneurs (*ref.*) (*4.5 – 54.2*)						
4 Share of entrepreneurs for other reasons (*0 – 14.1*)	-0.069	-0.69	-0.26	0.044	0.44	0.18
R&D effort						
GERD PPS per inhabitant at constant 2005 prices (*40.0 – 1,089.7*)	0.024	0.24	6.64***	0.023	0.23	7.02***
Control variables						
Sector composition						
Share of high-tech industry and knowledge-	-0.621	-6.18	-1.31	-0.601	-6.00	-1.61
Business cycle						
Unemployment rate (*3.0 – 33.8*)	-0.137	-1.36	-1.11	-0.144	-1.44	-1.14
Period						
2015 [a]						
Post-stratification weights for		No			Yes	
R-squared		0.92			0.92	
# observations		33				
Periods		2015				

Notes: [a] Dummy variable. For continuous variables, *dy/dx* captures absolute marginal effects whereas [(*dy/dx*)/*y*]% refers to marginal effects, but expressed in relative terms with respect to predicted probabilities. In the context of dummy variables, these reflects the impact for a discrete change of the dummy variable from 0 to 1; * $0.1 > p \geq 0.05$; ** $0.05 > p \geq 0.01$; *** $p < 0.01$; For models 1A-1B, the maximum correlation is -0.495 (between GERD and Unemployment rate), and the VIFs values (from model 1B) range from 1.07 to 1.49. For models 2A-2B, the maximum correlation is -0.564 (between Share of opportunity entrepreneurs and Unemployment rate), and the VIFs values (from model 2B) range from 1.32 to 1.78. Thus, multicollinearity does not pose a concern.

Data source: WIPO IP Statistics Database, Eurostat, World Bank national accounts data, OECD National Accounts data files, and EWCS 2010, 2015.

Models 1A-1B explore the relationship between patents and occupational status within self-employment, whereas models 2A-2B investigate the association between patents and start-up motivation. All models incorporate our measure of R&D effort, our control for sector composition and our control for business cycle. Models 1B and 2B correct for the possible presence of representation issues using post-stratification weights in our measures for occupational status, start-up motivation and sector composition. Finally, models 1A-1B also include a period dummy given that 2 different periods, i.e., 2010 and 2015, are involved.

In line with what was predicted by our general hypothesis, our results show how none of our measures for occupational status and start-up motivation seem to be statistically associated with patent registration activities at the country level. We associate this absence of relationship with the existing rather low propensity to patent within the SME and self-employment framework (Blind et al. 2006; Leiponen and Byma 2007; Thomä and Bizer 2013; Flikkema, De Man, and Castaldi 2014), discussed above in our background section. As an illustration, only 7% of the total self-employed in our sample have 10 or more employees and only 2% have 50 or more employees. Hence, these self-employed are hardly engaged in patent-related activities and, as a result, patents do not seem to be revealed as a convenient measure of innovation for self-employed workers (as happens for SMEs; Kleinknecht 2000).

In contrast, our results consistently show a robust association at the country level between expenditures on R&D and patent registration, as predicted in preceding sections. In particular, average predicted patents per constant 2010 US$ billion GDP are observed to increase by 0.21% (model 1B) with each PPS per inhabitant unit of increase in GERD. In light of this relationship, an important association is revealed between patents and (Schumpeterian) R&D-intensive and technology-oriented industrial activities.

Finally, as for our control variables, none of our controls for sector composition, business cycle and period show any statistically significant association with patent registration.

Results for trademarks

Table 5 below shows the estimation results from 4 specifications.

Table 5. Results for trademarks –linear regression models (OLS)–

# Model	3A			3B		
Average predicted trademarks per constant 2010 US$ billion GDP (*y*)	201.4			200.4		
Independent variables (*x*)	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$%	t-statistic	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$%	t-statistic
Focal variables						
Occupational status within self-employment						
1 Share of self-employed with employees (*13.1 – 62.4*)	5.79	2.87	3.08***	5.23	2.61	3.84***
2 Share of independent own-account self-employed workers (*30.1 – 62.7*)	3.01	1.50	2.25**	3.93	1.96	2.23**
3 Share of dependent self-employed workers (*ref.*) (*0.5 – 34.9*)						
R&D effort						
GERD PPS per inhabitant at constant 2005 prices (*40.0 – 1,089.7*)	-0.11	-0.06	-0.76	-0.10	-0.05	-0.72
Control variables						
Sector composition						
Share of high-tech industry and knowledge-intensive services (*2.3 – 11.7*)	-9.43	-4.68	-0.62	-13.80	-6.89	-1.01
Business cycle						
Unemployment rate (3.0 – 33.8)	-10.01	-4.97	-1.85*	-10.59	-5.29	-1.82*
Period						
2015 [a]	73.94	36.71	1.62	73.16	36.50	1.55
Post-stratification weights for entrepreneurship variables used	No			Yes		
R-squared	0.64			0.63		
# observations	64					
Periods	2010, 2015					

# Model	4A			4B		
Average predicted trademarks per constant 2010 US$ billion GDP (*y*)	221.8			221.8		
Independent variables (*x*)	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$%	t-statistic	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$%	t-statistic
Focal variables						
Start-up motivation						
1 Share of opportunity entrepreneurs (*28.1 – 87.6*)	6.07	2.74	2.58***	6.40	2.89	2.63***
2 Share of hybrid opportunity-necessity entrepreneurs (*5.9 – 30.3*)	0.49	0.22	0.12	3.16	1.42	0.84
3 Share of necessity entrepreneurs (*ref.*) (*4.5 – 54.2*)						
4 Share of entrepreneurs for other reasons (*0 – 14.1*)	11.82	5.33	1.39	11.59	5.23	1.36
R&D effort						
GERD PPS per inhabitant at constant 2005 prices (*40.0 – 1,089.7*)	-0.32	-0.14	-1.36	-0.29	-0.13	-1.41

Control variables						
Sector composition						
Share of high-tech industry and knowledge-intensive services (*2.3 – 11.7*)	5.99	2.70	0.22	-4.62	-2.08	-0.25
Business cycle						
Unemployment rate (3.0 – 33.8)	-8.34	-3.76	-1.45	-8.87	-4.00	-1.35
Period						
2015 [a]						
Post-stratification weights for entrepreneurship variables used	No			Yes		
R-squared	0.63			0.62		
# observations	33					
Periods	2015					

Notes: [a] Dummy variable. For continuous variables, *dy/dx* captures absolute marginal effects whereas [(*dy/dx*)/*y*]% refers to marginal effects, but expressed in relative terms with respect to predicted probabilities. In the context of dummy variables, these reflects the impact for a discrete change of the dummy variable from 0 to 1; * $0.1 > p \geq 0.05$; ** $0.05 > p \geq 0.01$; *** $p < 0.01$; For models 3A-3B, the maximum correlation is -0.495 (between GERD and Unemployment rate), and the VIFs values (from model 3B) range from 1.07 to 1.49. For models 4A-4B, the maximum correlation is -0.564 (between Share of opportunity entrepreneurs and Unemployment rate), and the VIFs values (from model 4B) range from 1.32 to 1.78. Thus, multicollinearity does not pose a concern.
Data source: WIPO IP Statistics Database, Eurostat, World Bank national accounts data, OECD National Accounts data files, and EWCS 2010, 2015.

The relationship between trademarks and occupational status within self-employment is investigated in Models 3A-3B, whereas models 4A-4B explore the association between trademarks and start-up motivation.

In line with what was stated by our general hypothesis, our results show how both categories of self-employed workers which better capture Kirznerian entrepreneurs, i.e., self-employed with employees and opportunity entrepreneurs, are positively and statistically associated with trademark registration at the country level. Similarly, independent own-account self-employed workers, which can also capture a certain amount of Kirznerian entrepreneurs, are also found to be positively and statistically associated with trademark registration. Specifically, average predicted trademarks per constant 2010 US$ billion GDP are observed to increase by 2.6% (model 3B), 2% (model 3B) and 2.9% (model 4B) with each unitary increase in the share of self-employed with employees, independent own-account self-employed workers, and opportunity entrepreneurs, respectively.[17]

[17] The reference categories for occupational status and start-up motivation are, respectively, dependent self-employed workers and necessity entrepreneurs. Therefore, each unitary increase in the share of self-employed with employees and opportunity entrepreneurs lead, respectively, to a unitary decrease in the share of dependent self-employed workers and necessity entrepreneurs.

We associate this result with the better ability of trademark indicators to capture the "softer" non-technological types of innovation, i.e., service, marketing and organizational innovation, which are more probable within the SME framework and self-employment framework (Flikkema, De Man, and Castaldi 2014), as discussed previously. Therefore, an important association is revealed between trademarks and the relative weight of Kirznerian entrepreneurs in a given economy.

Conversely, we find no relevant association at the country level between expenditures on R&D and trademark registration. This absence of a link between both indicators can be explained by the existing relationship between R&D efforts and technology-oriented firms, for which the propensity to register trademarks (patents) is low (high) (Amara, Landry, and Traoré 2008; Block et al. 2015a).

Regarding our control variables, we only find a negative relationship between unemployment rate and trademark registration, i.e., those economies with lower unemployment seem to register trademarks with higher likelihood (models 3A-3B). In contrast, neither our control for sector composition nor our period dummy shows any association with trademark registration.

Robustness checks

We perform several robustness checks. First, although we present only a few models in Tables 4–5, a complete stepwise regression approach (in which models incorporate covariates one by one) was followed, which serves as a robustness check for the results obtained in previous models. Second, as noted in subsection 4.2, we adjusted the standard errors for intra-countries correlation by clustering in those models where more than one EWCS wave was involved (models 1A-1B and 3A-3B). These approaches indicate no major changes relative to simple pooled regressions. Third, the robustness of our t-statistics was verified by re-estimating them from variance–covariance matrices of the coefficients obtained by bootstrapping. Fourth, the results are not sensitive to the use of dependent variables adjusted by population (instead, GDP). Fifth, the results are also robust to the use of two alternative proxies for Kirznerian entrepreneurs, i.e., self-employed with employees and opportunity entrepreneurs. Sixth, our results remain stable when using measures for occupational status and start-up motivation which are corrected for representation issues using post-stratification weights (models B). Seventh, the results are also not

sensitive to the use of GERD adjusted for GDP (instead, population and PPP) and a more restrictive definition of high-tech manufacturing industries.[18] Finally, the results are also robust to the restriction of our geographical framework to the EU-28 area. All results regarding these robustness checks are available upon request.

3.5. Conclusions

This work assesses the appropriateness of trademark data as a source of qualitative information on the self-employed workforce within a particular country or region. More specifically, this paper investigates the possible existence of an association between trademark data and relative weight of Kirznerian entrepreneurial activities over total self-employment in a given economy. To this end, we use country-level information for 33 European countries during the periods of 2010 and 2015. Our empirical results suggest that trademarks present a stronger association with Kirznerian entrepreneurs' activity in a given economy than patents.

This evidence has important implications for scholars, practitioners and policy makers. From an academic perspective, this paper lies at the intersection of entrepreneurship, innovation and industrial organization. For entrepreneurship literature, our results *first* confirm the need to consider self-employment as a heterogeneous or multifaceted group (Carrasco 1999; Burchell, Deakin, and Honey 1999; Reynolds et al. 2002; Grilo and Thurik 2008; Van der Zwan, Thurik, and Grilo 2010) and, *second*, suggest a strong association between trademark data and the presence of Kirznerian entrepreneurs in a given economy. Finally, from an innovation and industrial organization perspective, there is an emerging body of literature supporting the links between trademarks and innovation (Mendonça, Pereira, and Godinho 2004, Flikkema, De Man, and Castaldi 2014; Block et al. 2015b), to which the present paper contributes. In this regard, trademarks are revealed as a unique (and still under-exploited) source of information for the analysis of innovation behaviour and industrial dynamics. For practitioners, this study stresses the importance of

[18] This more restrictive definition excludes those industries classified by 'Eurostat high-tech statistics' as only medium-high (and not strictly high) technology manufacturing industries. We refer here to the following NACE rev. 2 codes: 20 = Manufacture of chemicals and chemical products; 27 = Manufacture of electrical equipment; 28 = Manufacture of machinery and equipment not elsewhere classified; 29 = Manufacture of motor vehicles, trailers and semi-trailers; and 30 = Manufacture of other transport equipment.

trademarks for opportunity-driven business development. Finally, from a public policy perspective, our results underline the risk of using a unique recipe when defining instruments for self-employment promotion. By ignoring the existing heterogeneity, prescriptions might be beneficial for certain forms of self-employment and harmless—or even harmful—for other types.

Our paper has some limitations, the more serious one being, perhaps, data availability and, in particular, our rather low number of observations. In addition, this work is exploratory in scope and, hence, its results can only be presented in an associative manner. Therefore, it remains unclear what the exact mechanisms behind our findings are. Undoubtedly, for finer-grained evidence and a better-tailored policy approach, better data availability is simply essential. In this sense, there are reasons to be optimistic, as the production and availability of reliable and internationally comparable statistics able to capture the existing heterogeneity within self-employment are expected to grow in the short term. Thus, the European Union Labour Force Survey *ad hoc* module 2017 (EU-LFS AHM 2017) on self-employment, which is expected to be ready for scientific purposes in 2019, incorporates particular sub-modules specifically designed to identify dependent self-employed workers (sub-module 1) and opportunity vs. necessity entrepreneurs (sub-module 2). Moreover, the former sub-module is planned to be permanently incorporated into the survey from 2019 onwards, which means a forthcoming availability of information extracted from some 1.8 million interviews throughout participating countries[19] each quarter. Future research will benefit from these new data.

3.6. References

Acs, Z. J., P. Braunerhjelm, D. B. Audretsch, and B. Carlsson. 2009. "The Knowledge Spillover Theory of Entrepreneurship." *Small Business Economics* 32 (1): 15–30. https://doi.org/10.1007/s11187-008-9157-3.

Acs, Z. J., and M. Sanders. 2012. "Patents, Knowledge Spillovers, and Entrepreneurship." *Small Business Economics* 39 (4): 801–817. https://doi.org/10.1007/s11187-011-9322-y.

[19] The EU-28, 2 candidate countries (the Former Yugoslav Republic of Macedonia and Turkey) and 3 EFTA countries (Iceland, Norway and Switzerland).

Alba-Ramirez, A. 1994. "Self-employment in the Midst of Unemployment: The Case of Spain and the United States.". *Applied Economics* 26 (3): 189–204. https://doi.org/10.1080/00036849400000001.

Allred, B., and W. Park. 2007. "The Influence of Patent Protection on Firm Innovation Investment in Manufacturing Industries." *Journal of International Management* 13 (2): 91–109. https://doi.org/10.1016/j.intman.2007.02.001.

Amara, N., R. Landry, and N. Traoré. 2008. "Managing the Protection of Innovations in Knowledge-Intensive Business Services." *Research Policy* 37 (9): 1530–1547. https://doi.org/10.1016/j.respol.2008.07.001.

Aparicio, S., D. Urbano, and D. B. Audretsch. 2016. "Institutional Factors, Opportunity Entrepreneurship and Economic Growth: Panel Data Evidence." *Technological Forecasting and Social Change* 102: 45–61. https://doi.org/10.1016/j.techfore.2015.04.006.

Audretsch, D. B., and M. P. Feldman. 1996. "R&D Spillovers and the Geography of Innovation and Production." *American Economic Review* 86 (3): 630–640. https://www.jstor.org/stable/2118216.

Audretsch, D. B., W. Bönte, and P. Mahagaonkar. 2012. "Financial signaling by Innovative Nascent Ventures: The Relevance of Patents and Prototypes." *Research Policy* 41 (8): 1407–1421. https://doi.org/10.1016/j.respol.2012.02.003.

Baroncelli, E., C. Fink, and B. S. Javorcik. 2005. "The Global Distribution of Trademarks: Some Stylized Facts." *The World Economy* 28 (6): 765–782. https://doi.org/10.1111/j.1467-9701.2005.00706.x.

Baroncelli, E., E. Krivonos, and M. Olarreaga. 2007. "Trademark Protection or Protectionism?" *Review of International Economics* 15 (1): 126–145. https://doi.org/10.1111/j.1467-9396.2006.00639.x.

Blind, K., E. Edler, R. Frietsch, and U. Schmoch. 2006. "Motives to Patent." *Research Policy*, 35 (5): 655–672. https://doi.org/10.1016/j.respol.2006.03.002.

Block, J. H., G. De Vries, J. H. Schumann, and P. G. Sandner. 2014. "Trademarks and Venture Capital Valuation." *Journal of Business Venturing*, 29 (4): 525–542. https://doi.org/10.1016/j.jbusvent.2013.07.006.

Block, J. H., C. O. Fisch, A. Hahn, and P. G. Sandner. 2015a. "Why do SMEs File Trademarks? Insights from Firms in Innovative Industries." *Research Policy* 44 (10): 1915–1930. https://doi.org/10.1016/j.respol.2015.06.007.

Block J. H, K. Kohn, D. Miller, and K. Ullrich. 2015b. "Necessity entrepreneurship and Competitive Strategy." *Small Business Economics* 44 (1), 37–54. https://doi.org/10.1007/s11187-014-9589-x.

Brahem, M., S. El Harbi, and G. Grolleau. 2013. "What Drives Trademarks Registration among Tunisian Clothing Firms? An Econometric Investigation." *International Journal of Intellectual Property Management* 6 (1–2): 1–14. https://doi.org/10.1504/IJIPM.2013.053447.

Branstetter, L., R. Fishman, and F. Foley. 2006. "Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence from US Firm-level Panel Data." *The Quarterly Journal of Economics* 121(1): 321–349. https://doi.org/10.1093/qje/121.1.321

Burchell, B., S. Deakin, and S. Honey. 1999. "The Employment Status of Individuals in Non-standard Employment." Employment Relations Research Series No. 6. London: Department of Trade and Industry. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.594.173&rep=rep1&type=pdf.

Burke, A., and S. Fraser. 2012. "Self-employment: The Role of Intellectual Property Right Laws." *Small Business Economics* 39 (4), 819–833. https://doi.org/10.1007/s11187-011-9336-5.

Carrasco R. 1999. "Transitions to and from Self-employment in Spain: An Empirical Analysis." *Oxford Bulletin of Economics and Statistics* 61 (3): 315–341. https://doi.org/10.1111/1468-0084.00132.

Cassiman, B., and R. Veugelers. 2006. "In Search of Complementarity in Innovation Strategy: Internal R&D and External Knowledge Acquisition." *Management Science* 52 (1): 68–82. https://doi.org/10.1287/mnsc.1050.0470.

Corrado, C., C. Hulten, and D. Sichel. 2005. "Measuring Capital and Technology: An Expanded Framework." In *Measuring Capital in the New Economy*, edited by Carol Corrado, John Haltiwanger and Dan Sichel, 11–46. Chicago, IL: University of Chicago Press. https://www.nber.org/chapters/c0202.pdf.

Dahlqvist, J., and J. Wiklund. 2012. "Measuring the Market Newness of New Ventures." *Journal of Business Venturing* 27 (2): 185–196. https://doi.org/10.1016/j.jbusvent.2010.12.001.

De Rassenfosse, G. 2016. "An Assessment of How Well We Account for Intangibles." *Industrial and Corporate Change* 26 (3): 517–534. https://doi.org/10.1093/icc/dtw034.

De Vries, G., E. Pennings, J. H. Block, and C. O. Fisch. 2017. "Trademark or patent? The effects of Market Concentration, Customer Type and Venture Capital Financing on Start-ups' Initial IP Applications." *Industry and Innovation* 24(4): 325–345. https://doi.org/10.1080/13662716.2016.1231607.

Earle, J. S., and Z. Sakova. 2000. "Business Start-ups or Disguised Unemployment? Evidence on the Character of Self-employment from Transition Economies", *Labour Economics* 7 (5): 575–601. https://doi.org/10.1016/S0927-5371(00)00014-2.

Eichhorst, W., M. Braga, U. Mühlberger, M. Gerard, T. Horvath, M. Kahanec, M. Kahancová, M. Kendzia, M. Martišková, P. Monti, J. L. Pedersen, J. Stanley, B. Vandeweghe, C. Wehner, and C. White. 2013. "Social Protection Rights of Economically Dependent Self-Employed Workers." Policy Department A - Economic and Scientific Policy, European Parliament, Brussels: European Parliament. http://www.europarl.europa.eu/RegData/etudes/etudes/join/2013/507449/IPOL-EMPL_ET%282013%29507449_EN.pdf.

Eurofound. 2012. "Fifth European Working Conditions Survey – Overview report." Luxembourg: Publications Office of the European Union. https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1182en.pdf.

Eurofound. 2016. "Sixth European Working Conditions Survey – Overview report." Luxembourg: Publications Office of the European Union. https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1634en.pdf.

Eurofound. 2018. "European Working Conditions Survey Integrated Data File, 1991-2015. [data collection]." 6th Edition. UK Data Service. SN: 7363, http://doi.org/10.5255/UKDA-SN-7363-6.

Farre-Mensa, J., D. Hegde, and A. Ljungqvist. 2017. "What is a Patent Worth? Evidence from the US Patent 'Lottery'." NBER Working Paper Series No. 23268. Cambridge, MA: National Bureau of Economic Research. https://doi.org/10.3386/w23268.

Ferreira, J. J., A. Fayolle, C. Fernandes, and C. Raposo. 2017. "Effects of Schumpeterian and Kirznerian Entrepreneurship on Economic Growth: Panel Data Evidence." *Entrepreneurship & Regional Development* 29 (1-2): 27–50. https://doi.org/10.1080/08985626.2016.1255431.

Fink, C., B. S. Javorcik, and M. Spatareanu. 2005. "Income-Related Biases in International Trade: What Do Trademark Registration Data Tell Us?" *Review of World Economics* 14 (1): 79–103. http://dx.doi.org/10.1007/s10290-005-0016-x.

Flikkema, M., A-P. De Man, and C. Castaldi. 2014. "Are Trademark Counts a Valid Indicator of Innovation? Results of an In-depth Study of New Benelux Trademarks Filed by SMEs." *Industry and Innovation* 21 (4): 310–331. http://dx.doi.org/10.1080/13662716.2014.934547.

Greenhalgh, C., and M. Rogers. 2012. "Trade Marks and Performance in Services and Manufacturing Firms: Evidence of Schumpeterian Competition through Innovation." *Australian Economic Review* 45 (1): 50-76. https://doi.org/10.1111/j.1467-8462.2011.00665.x

Grilo, I., and R. Thurik. 2008. "Determinants of Entrepreneurial Engagement Levels in Europe and the US." *Industrial and Corporate Change* 17 (6): 1113–1145. https://doi.org/10.1093/icc/dtn044.

Haeussler, C., D. Harhoff, and E. Mueller. 2014. "How Patenting Informs VC investors: The Case of Biotechnology." *Research Policy* 43(8): 1286–1298. https://doi.org/10.1016/j.respol.2014.03.012.

Helmers, C., and M. Rogers. 2010. Innovation and the Survival of New Firms in the UK. *Review of Industrial Organization* 36 (3): 227–248. https://doi.org/10.1007/s11151-010-9247-7.

Herz, B., and M. Mejer. 2016. "On the Fee Elasticity of the Demand for Trademarks in Europe." *Oxford Economic Papers* 68 (4): 1039–1061. https://doi.org/10.1093/oep/gpw035.

Hsu, D. H., and R. H. Ziedonis. 2013. "Resources as dual sources of advantage: Implications for Valuing Entrepreneurial-firm Patents." *Strategic Management Journal* 34: 761–781. https://doi.org/10.1002/smj.2037.

Hyytinen, A., and P. Rouvinen. 2008. "The Labour Market Consequences of Self-employment Spells: European Evidence." *Labour Economics* 15 (2): 246–271. https://doi.org/10.1016/j.labeco.2007.02.001.

ILO. 2003. “The Scope of the Employment Relationship. Report V.” Paper presented at the International Labour Conference, 91st Session, Geneva. http://www.ilo.org/public/english/standards/relm/ilc/ilc91/pdf/rep-v.pdf.

Jaffe, A. B. 1986. Technological Opportunity and Spillovers of R&D: Evidence from Firms’ Patents, Profits and Market Value. *American Economic Review* 76 (5): 984–999.

Kanwar, S. 2006. “Innovation and Intellectual Property Rights.” Centre for Development Economics Working Paper. No. 142. Department of Economics, Delhi School of Economics. http://cdedse.org/pdf/work142.pdf.

Kirzner, I. M. 1973. *Competition and Entrepreneurship*. Chicago, IL: University of Chicago Press.

Kirzner, I. M. 2009. The Alert and Creative Entrepreneur: A Clarification. *Small Business Economics* 32 (2): 145–152. https://doi.org/10.1007/s11187-008-9153-7.

Kleinknecht, A. H. 2000. “Indicators of Manufacturing and Service Innovation: Their Strengths and Weaknesses.” In *Innovation Systems in the Service Economy. Measurement and Case Study Analysis*, edited by J. Stanley Metcalfe and Ian Miles, 169–186. Dordrecht: Kluwer Academic Publishers.

Krasnikov, A., S. Mishra, and D. Orozco. 2009. “Evaluating the Financial Impact of Branding Using Trademarks: A Framework and Empirical Evidence.” *Journal of Marketing* 73 (6): 154–166. https://doi.org/10.1509/jmkg.73.6.154.

Kuhn, P. 2000, “Editor’s Note”, *Labour Economics* 7 (5): 463–469. https://doi.org/10.1016/S0927-5371(00)00010-5.

Leiponen, A., and J. Byma. 2007. “If You Cannot Block, You Better Run: Small Firms, Cooperative Innovation and Appropriation Strategies.” *Research Policy* 38(9), 1478–1488. https://doi.org/10.1016/j.respol.2009.06.003.

Linder, S. B. 1961. *An Essay on Trade and Transformation*. Uppsala: Almqvist & Wiksell. https://ex.hhs.se/dissertations/221624-FULLTEXT01.pdf (accessed 3 February 2019).

Llerena, P., and V. Millot. 2013. “Are Trade Marks and Patents Complementary or Substitute Protections for Innovation.” Bureau d’économie théorique et appliquée (BETA). Document de Travail n° 2013 – 01. Strasbourg: Université de Strasbourg. http://www.beta-umr7522.fr/productions/publications/2013/2013-01.pdf.

Malmberg, C. 2005. “Trademark Statistics as Innovation Indicators? A Micro Study.” CIRCLE Electronic Working Paper Series 2005/17. CIRCLE - Center for Innovation, Research and Competences in the Learning Economy, Lund University. http://portal.research.lu.se/portal/files/4643553/4407256.pdf (accessed 3 February 2019).

Mangani, A. 2007. “Measuring Variety and Quality of Products with Trademarks.” *International Economic Journal* 21 (4): 613–631. https://doi.org/10.1080/10168730701699109.

Mendonça, S., T. S. Pereira, and M. M. Godinho. 2004. “Trademarks as an Indicator of Innovation and Industrial Change.” *Research Policy* 33 (9): 1385–1404. https://doi.org/10.1016/j.respol.2004.09.005.

Mendonça, S. 2012. "Trademarks as a Telecommunications Indicator for Industrial Analysis and Policy." In *Telecommunication Economics*, edited by Antonis M. Hadjiantonis and Burkhard Stiller, 33–41. Heidelberg: Springer. https://doi.org/10.1007/978-3-642-30382-1_6.

Millán, A., and J. M. Millán. 2017. "Disclosing 'Masked Employees' in Europe: Job Control, Job Demands and Job Outcomes of 'Dependent Self-Employed Workers'". Paper presented at XII Jornadas de Economía Laboral. University of Valladolid, Spain, July 5–7.

Millán, A., J. M. Millán, and C. Román. 2018. "Are False Own-account Workers Less Job Satisfied than True Ones?" *Applied Economics Letters* 25 (13): 945–950. https://doi.org/10.1080/13504851.2017.1388902.

Millán, J. M., E. Congregado, and C. Román. 2014a. "Persistence in Entrepreneurship and its Implications for the European Entrepreneurial Promotion Policy." *Journal of Policy Modeling* 36 (1): 83–106. https://doi.org/10.1016/j.jpolmod.2013.10.001.

Millán, J. M., E. Congregado, and C. Román 2014b. "Entrepreneurship Persistence With and Without Personnel: The Role of Human Capital and Previous Unemployment." *International Entrepreneurship and Management Journal* 10 (1): 187–206. https://doi.org/10.1007/s11365-011-0184-1.

Muehlberger, U., and S. Bertolini. 2008. "The Organizational Governance of Work Relationships Between Employment and Self-employment." *Socio-Economic Review* 6 (3), 449–472. https://doi.org/10.1093/ser/mwm026.

OECD. 2014. "The Employment Outlook", chapter 4. Paris: OECD. http://dx.doi.org/10.1787/empl_outlook-2014-en.

OECD. 2019a. "OECD Structural and Demographic Business Statistics (database)." https://doi.org/10.1787/sdbs-data-en.

OECD. 2019b. "Self-employment rate (indicator)." https://doi.org/10.1787/fb58715e-en.

Parchomovsky, G., and P. Siegelman. 2002. "Towards an Integrated Theory of Intellectual Property." *Virginia Law Review*, 88 (7): 1455–1528. https://doi.org/10.2307/1073990.

Parker, S. C. 2018. *The Economics of Entrepreneurship*. Cambridge University Press. https://doi.org/10.1017/9781316756706.

Reynolds, P., S. M. Camp, W. D. Bygrave, E. Autio, and M. Hay. 2002. "Global Entrepreneurship Monitor 2001 Executive Report." Babson Park/London: Babson College and London Business School. http://unpan1.un.org/intradoc/groups/public/documents/un/unpan002481.pdf.

Román, C., E. Congregado, and J. M. Millán. 2011. "Dependent Self-employment as a Way to Evade Employment Protection Legislation." *Small Business Economics* 37 (3): 363–392. https://doi.org/10.1007/s11187-009-9241-3.

Román, C., E. Congregado, and J. M. Millán. 2013. "Start-up Incentives: Entrepreneurship Policy or Active Labour Market Programme?" *Journal of Business Venturing* 28 (1): 151–175. https://doi.org/10.1016/j.jbusvent.2012.01.004.

Sandner, P. G., and J. H. Block. 2011. The Market Value of R&D, Patents and Trademarks. *Research Policy* 40 (7): 969–985. https://doi.org/10.1016/j.respol.2011.04.004.

Schautschick, P., and C. Greenhalgh. 2016. "Empirical Studies of Trade Marks – The Existing Economic Literature." *Economics of Innovation and New Technology* 25 (4): 358–390. https://doi.org/10.1080/10438599.2015.1064598.

Schumpeter, J. A. 1912. *Theorie der Wirtschaftlichen Entwicklung* [The Theory of Economic Development]. Leipzig: Dunker & Humblot. Translated by Dedvers Opie. Cambridge, MA: Harvard University Press, 1934.

Schumpeter, J. A. 1942. *Capitalism, Socialism and Democracy*. New York: Harper & Row.

Shane, S. 2009. "Why Encouraging More People to Become Entrepreneurs is Bad Public Policy." *Small Business Economics* 33 (2): 141–149. https://www.jstor.org/stable/259271.

Srinivasan, R., G. L. Lilien, and A. Rangaswamy. 2008. "Survival of High Tech Firms: The Effects of Diversity of Product–market Portfolios, Patents, and Trademarks." *International Journal of Research in Marketing* 25 (2): 119–128. https://doi.org/10.1016/j.ijresmar.2007.12.005.

Stewart, A., and J. Stanford. 2017. "Regulating Work in the Gig Economy: What are the Options?" *The Economic and Labour Relations Review* 28 (3): 420–437. https://doi.org/10.1177/1035304617722461.

Sundqvist, S. K., K. Kylheiko, O. Kuivalainen, and J. W. Cadogan 2012. "Kirznerian and Schumpeterian Entrepreneurial-Oriented Behavior in Turbulent Export Markets." *International Marketing Review* 29 (2): 203–219. https://doi.org/10.1108/02651331211216989.

Supiot, A. 2001. *Beyond Employment. Changes in Work and the Future of Labour Law in Europe*. Oxford: Oxford University Press.

Thomä, J. and K. Bizer. 2013. "To Protect or Not to Protect? Modes of Appropriability in the Small Enterprises Sector." *Research Policy* 42 (1): 35–49. https://doi.org/10.1016/j.respol.2012.04.019.

Thumm, N. 2004. "Strategic Patenting in Biotechnology." *Technology Analysis & Strategic Management* 16 (4): 529–538. https://doi.org/doi/10.1080/0953732042000295829.

Van der Zwan, P., R. Thurik, and I. Grilo 2010. "The Entrepreneurial Ladder and Its Determinants." *Applied Economics* 42 (17), 2183–2191. https://doi.org/10.1080/00036840701765437.

Van Stel, A., J. M. Millán, and C. Román 2014. "Investigating the Impact of the Technological Environment on Survival Chances of Employer Entrepreneurs." *Small Business Economics* 43 (4): 839–855. https://doi.org/10.1007/s11187-014-9565-5.

Varsakelis, N. 2001. "The Impact of Patent Protection, Economy Openness and National Culture on R&D Investment: A Cross-country Empirical Investigation." *Research Policy* 30 (7): 1059–1068. https://doi.org/10.1016/S0048-7333(00)00130-X.

Von Mises, L. 1952. "Profit and Loss." In *Planning for Freedom and Other Essays and Addresses* (3rd ed.), edited by Ludwig von Mises, 108–149. South Holland: Libertarian Press.

Wennekers, S., A. van Stel, M. Carree, and R. Thurik. 2010. "The Relationship Between Entrepreneurship and Economic Development: Is it U-shaped?" *Foundations and Trends in Entrepreneurship* 6 (3), 167–237. https://doi.org/doi/10.1561/0300000023.

WIPO. 2017. *World Intellectual Property Indicators 2017*. Geneva: World Intellectual Property Organization. http://www.wipo.int/edocs/pubdocs/en/wipo_pub_941_2017.pdf.

Appendix. Variable definitions

Table A1. Country level variables

Variable	Description
Dependent variables	
Trademarks per constant 2010 US$ billion GDP	Registered trademarks per constant 2010 US$ billion GDP. Data correspond to total trademark registrations, direct and via the *Madrid system*, expressed in equivalent class counts. This variable is generated for the periods 2010 and 2015 (*Data sources*: WIPO IP Statistics Database & World Bank national accounts data, and OECD National Accounts data files).
Patents per constant 2010 US$ billion GDP	Patent grants per constant 2010 US$ billion GDP. Data correspond to total patent grants registrations, direct and *Patent Cooperation Treaty* national phase entries, expressed in equivalent class counts. This variable is generated for the periods 2010 and 2015 (*Data sources*: WIPO IP Statistics Database & World Bank national accounts data, and OECD National Accounts data files).
Focal variables	
Occupational status within self-employment [a]	
1 Share of self-employed with employees	% of self-employed workforce who declare being self-employed with employees. This variable is generated for the years 2010 and 2015 (*Data source*: EWCS).
2 Share of independent own-account self-employed workers	% of self-employed workforce who declare being self-employed without employees and answer positively to the question on whether he/she generally has more than one client or customer. This variable is generated for the years 2010 and 2015 (*Data source*: EWCS).
3 Share of dependent self-employed workers	% of self-employed workforce who declare being self-employed without employees and answer negatively to the question on whether he/she generally has more than one client or customer. This variable is generated for the years 2010 and 2015 (*Data source*: EWCS).
Start-up motivation [a]	
1 Share of opportunity entrepreneurs	% of self-employed workforce who declare having become self-employed mainly through own personal preferences. This variable is generated for the year 2015 (*Data source*: EWCS).
2 Share of hybrid opportunity-necessity entrepreneurs	% of self-employed workforce who declare having become self-employed due to a combination of both reasons: own personal preferences and no other alternatives for work. This variable is generated for the year 2015 (*Data source*: EWCS).
3 Share of necessity entrepreneurs	% of self-employed workforce who declare having become self-employed because had no other alternatives for work. This variable is generated for the year 2015 (*Data source*: EWCS).
4 Share of entrepreneurs for other reasons	% of self-employed workforce who declare having become self-employed due to neither of these previous reasons. This variable is generated for the year 2015 (*Data source*: EWCS).
R&D effort	
GERD PPS per inhabitant at constant 2005 prices	5 years average Gross Domestic Expenditure on R&D expressed as Purchasing Power Standards –PPS– per inhabitant at constant 2005 prices. This variable includes expenditure on research and development by business enterprises, higher education institutions, as well as government and private non-profit organisations. This variable is generated for the periods 2006-10 and 2011-15 (*Data source*: Eurostat).
Control variables	
Sector composition [a]	

Share of high-tech industry and knowledge-intensive services [a]	% of self-employed workforce who declare working in high-technology industry and knowledge-intensive services, as defined by Eurostat aggregations based on 'Statistics on high-tech industry and knowledge-intensive services'. It includes all workers whose codes of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) at 2-digit level, are 20 = Manufacture of chemicals and chemical products; 21 = Manufacture of basic pharmaceutical products and pharmaceutical preparations; 26 = Manufacture of computer, electronic and optical products; 27 = Manufacture of electrical equipment; 28 = Manufacture of machinery and equipment not elsewhere classified; 29 = Manufacture of motor vehicles, trailers and semi-trailers; 30 = Manufacture of other transport equipment; 59 = Motion picture, video and television programme production, sound recording and music publishing activities; 60 = Programming and broadcasting activities; 61 = Telecommunications; 62 = Computer programming, consultancy and related activities; 63 = Information service activities; and 72 = Scientific research and development (*Data source*: EWCS).
Business cycle	
Unemployment rate	5 years average unemployment rates. This variable is generated for the periods 2006-10 and 2011-15 (*Data sources*: Eurostat, ILO).
Period	
2015	Dummy equals 1 for observations corresponding to the period 2015 and 0 for observations corresponding to the period 2010 (*Data source*: EWCS).

Notes: [a] Two variants of these variables are used in our regressions: (i) uncorrected for the possible presence of over or underrepresentation of certain groups; and (ii) corrected for the possible presence of representation issues using post-stratification weights.

Table A2. Individual level variables

Variable	Description
Occupational status within self-employment	
1 Self-employed with employees	Dummy equals 1 for workers who declare being self-employed with employees.
2 Independent own-account self-employed worker	Dummy equals 1 for individuals who declare being self-employed without employees and answer positively to the question on whether he/she generally has more than one client or customer.
3 Dependent self-employed worker	Dummy equals 1 for individuals who declare being self-employed without employees and answer negatively to the question on whether he/she generally has more than one client or customer.
Start-up motivation	
1 Opportunity entrepreneur	Dummy equals 1 for workers who declare having become self-employed mainly through own personal preferences. This variable is only available for wave 2015.
2 Hybrid opportunity-necessity entrepreneur	Dummy equals 1 for workers who declare having become self-employed due to a combination of both reasons: own personal preferences and no other alternatives for work. This variable is only available for wave 2015.
3 Necessity entrepreneur	Dummy equals 1 for workers who declare having become self-employed because had no other alternatives for work. This variable is only available for wave 2015.
4 Entrepreneur for other reasons	Dummy equals 1 for workers who declare having become self-employed due to neither of these reasons. This variable is only available for wave 2015.
Educational attainment	
Basic education	Dummy equals 1 for workers with less than lower secondary education (ISCED-1997, 0-1).

Secondary education	Dummy equals 1 for workers with, at least, lower secondary education but non-tertiary education (ISCED-1997, 2-4).
Tertiary education	Dummy equals 1 for workers with tertiary education (ISCED-1997, 5-6).
Job characteristics	
Years of tenure in present job	Number of years of experience in the company or organization.
Working hours	Working hours per week.
Net monthly earnings – PPP $ of 2015	Average net earnings in recent months. The variable is defined in PPP $ of 2015.
Sector composition	
High-tech industry and knowledge-intensive services	Dummy equals 1 for individuals who declare working in high-technology industry and knowledge-intensive services, as defined by Eurostat aggregations based on 'Statistics on high-tech industry and knowledge-intensive services'. It includes all workers whose codes of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) at 2-digit level, are 20 = Manufacture of chemicals and chemical products; 21 = Manufacture of basic pharmaceutical products and pharmaceutical preparations; 26 = Manufacture of computer, electronic and optical products; 27 = Manufacture of electrical equipment; 28 = Manufacture of machinery and equipment not elsewhere classified; 29 = Manufacture of motor vehicles, trailers and semi-trailers; 30 = Manufacture of other transport equipment; 59 = Motion picture, video and television programme production, sound recording and music publishing activities; 60 = Programming and broadcasting activities; 61 = Telecommunications; 62 = Computer programming, consultancy and related activities; 63 = Information service activities; and 72 = Scientific research and development.
Demographic characteristics	
Female	Dummy equals 1 for females.
Immigrant	Dummy equals 1 for citizens of a different country of that of residence.
Age	Age reported by the worker.
Cohabiting	Dummy equals 1 for individuals cohabiting with spouse/partner.
Children under 14	Dummy equals 1 for individuals cohabiting with any son or daughter aged under 14.
Health	Variable ranging from 1 to 5. The scale refers to the level of health declared by the worker. It equals 1 for individuals whose health is very bad and 5 for individuals whose health is very good.
Ends meet	Variable ranging from 1 to 6. The scale refers to the household ability to make ends meet. It equals 1 for households which make ends meet very easily and 6 for households which make ends meet with great difficulty.

Data source: EWCS.

Part IV: R&D, IPR and Self-employment

Universidad Internacional de Andalucía, 2022

Chapter 4: How does country R&D change the allocation of self-employment across different types

We investigate the impact of country R&D on the allocation of self-employment across different types, where types are identified based on occupational status and start-up motive. We first conduct a literature review based on which we consider the self-employed with employees to be of higher 'quality' (in terms of their overall contribution to the economy) compared to independent own-account workers, who in turn may be considered of higher 'quality' than dependent self-employed workers. Similarly, we also consider opportunity self-employed to be of higher 'quality' than necessity self-employed. Our empirical analysis then shows that the level of a country's R&D expenditures increases the share of self-employed with employees and that of opportunity self-employed (i.e. the self-employment types associated with higher 'quality') at the cost of the shares of dependent self-employed and necessity self-employed. Higher R&D expenditures at the country level thus increase the quality of self-employment in the country.

4.1. Introduction

Emanating from the pioneering theoretical work on self-employment by Kihlstrom and Laffont (1979) and the subsequent empirical analyses of Evans and Jovanovic (1989) and Evans and Leighton (1989), a significant trajectory of research on the determinants of the supply of entrepreneurs has emerged over the last three decades (for an overview, see Parker 2018). However, although by now it is widely acknowledged that entrepreneurs differ greatly in their contribution to economy and society (Kuhn 2000; Blanchflower 2004; Cowling et al. 2004; Carree et al. 2007; Shane 2009; A. Millán et al. 2015; Wennekers and Van Stel 2017), this heterogeneity is not as acknowledged in empirical studies as it could and should be. This is unfortunate since encouraging entrepreneurship is often seen by

policy makers as a route to combat unemployment and stimulating economic development (Meager 1992; Earle and Sakova 2000; Santarelli and Vivarelli 2007; Román et al. 2013; Dvouletý and Lukeš 2016). However, if the wrong 'types' of entrepreneurs are being stimulated, this may lead to adverse effects on the economy (Santarelli and Vivarelli 2007; Mueller et al. 2008; Román et al. 2011, 2013). Hence, new studies are needed that do not so much look into the determinants of the absolute number of entrepreneurs in a given country, but rather investigate the determinants of the allocation of entrepreneurship across different types. Moreover, we also need knowledge on which types generate bigger contributions to the economy. Only then we can evaluate whether a shift of the entrepreneurship distribution in a certain direction (e.g. more innovative and less imitative entrepreneurs, or vice versa) can be considered an improvement of the 'quality' of a population of entrepreneurs.

Entrepreneurship research should thus deepen the identification of the existing heterogeneity within the population of entrepreneurs. Indeed, several approaches attempted to capture different groups within entrepreneurship or self-employment. [1] The present study focuses on the heterogeneity of the self-employed along two dimensions: occupational status (self-employed with employees versus independent own-account worker versus dependent self-employed) and start-up motive (opportunity versus necessity). Based on literature review, we will consider for each dimension which types generally show higher firm performance and may thus be considered of higher 'quality' in terms of their expected overall contribution to the economy. Next, we investigate if and how country-level R&D influences the allocation of self-employment in terms of these two dimensions. R&D is an important determinant of entrepreneurship because it creates many entrepreneurial opportunities (Acs and Audretsch 2003; Venkataraman 1997), and a lot of potential for knowledge spillovers that benefit the economy (Audretsch 2007). However, to our knowledge the impact of R&D on the allocation of self-employment across different types has not been studied yet.

[1] The more relevant traditional and recent approaches are: (i) *innovative* against *imitative* entrepreneurs (Schumpeter 1912); (ii) *productive*, *unproductive* and *destructive* entrepreneurs (Baumol 1990); (iii) self-employed *with* or *without employees* (Carrasco 1999); (iv) *dependent* against *independent* self-employment (Burchell et al. 1999); (v) *opportunity* against *necessity* entrepreneurs (Reynolds et al. 2002); (vi) *providing* versus *enabling* entrepreneurship (Burke 2012) and (vii) the distinction between several engagement levels in the entrepreneurial process (Van der Zwan et al. 2010).

So, the aim of this paper is to examine whether the innovative nature of an economy as expressed by its level of R&D undertaken as a percentage of GDP, affects the composition of the self-employed workforce and, in particular, the relative weights of (i) self-employed workers with employees; (ii) independent own-account self-employed workers; and (iii) dependent self-employed workers, over total self-employment in a given country. Moreover, we investigate whether country R&D affects the allocation between opportunity and necessity self-employed. To this end, we use (a) homogeneous proxies for dependent self-employed workers and opportunity self-employed; (b) a geographical coverage as wide as the EU-28 countries; and (c) the most recent international microdata available (5th and 6th waves of the European Working Conditions Survey for 2010 and 2015).

The present paper contributes to the general literature on the determinants of entrepreneurship. Although this literature is extensive, research to date typically focuses on explaining the propensity of being an entrepreneur (Simoes et al. 2016), or at the macro-level, on explaining the rate or number of entrepreneurs in a region or country (Parker 2018). However, studies focusing on the allocation of entrepreneurs among certain types (i.e. studies focusing on the quality rather than the quantity of entrepreneurship) are scarce.

We also contribute more specifically to the literature on R&D and entrepreneurship. The knowledge spillover theory of entrepreneurship (Acs et al. 2013) argues that firms tend to locate closely to sources of knowledge spillovers (e.g. universities or corporate research laboratories) as this facilitates exploitation of such spillovers, and hence a positive link has been found between R&D and entrepreneurship at the regional level (Audretsch and Lehmann 2005). Moreover, country-level R&D expenditures have been found to increase firm performance of individual entrepreneurs (Van Stel et al. 2014). However, the impact of R&D on the qualitative composition of a country's population of entrepreneurs (i.e. the allocation of entrepreneurs over different types) has not been studied yet.

Finally, our paper also contributes to the emerging field within entrepreneurship literature that distinguishes between different types of entrepreneurs. In this regard, several studies focus on the subgroup of high-growth or high-potential entrepreneurs (Henrekson and Johansson 2010). However, more general approaches to identify types of entrepreneurs along different dimensions are scarce and typically conceptual in nature (e.g. Baumol 1990; Terjesen et al. 2016; Wennekers and Van Stel 2017). In this

regard, our aim to identify 'high-quality' self-employment is closely related to the concept of 'productive' entrepreneurship in the Baumol (1990) sense. Belitski and Korosteleva (2010) explain that certain segments of self-employment may be considered productive whereas other segments of self-employment are more likely to be unproductive. In this sense, our quest for identifying (the determinants of) 'high-quality' self-employed can be seen as an attempt to identify those segments of self-employment that can be considered productive in the Baumol sense (Belitski and Korosteleva 2010). Apart from the literature on high-growth firms, the literature on types of entrepreneurship is mainly conceptual in nature, and empirical studies are scarce (Henrekson and Sanandaji 2018 is an exception). We contribute by empirically operationalising types of entrepreneurship along two dimensions and focusing on the determinants of the relative shares of these different types in total self-employment.

In Section 2 we conduct a brief literature review to establish which types of entrepreneurs may be considered to be of higher 'quality' (in terms of their overall contribution to the economy). We also derive hypotheses regarding the impact of R&D on the allocation of self-employment across the different types. We then test these hypotheses making use of the 2010 and 2015 waves of the European Working Conditions Survey. This data base, the variables that we employ from it and our methods of analysis are discussed in Section 3. Section 4 describes the empirical results and, finally, Section 5 concludes.

4.2. Literature review & hypotheses

We first discuss some matters related to operationalizing the types of self-employment we use in this paper into statistical indicators. Next, we conduct a short literature review to establish the relative 'quality' (in terms of direct performance and expected contribution to the economy) of the various self-employment types that we focus on. Finally, we derive hypotheses regarding the impact of country-level R&D on the allocation of self-employment across different types.

Operationalizing types of self-employment

Economists tend to classify entrepreneurs and their motives from actual observed behavior. This is the so-called 'revealed preference' principle. In particular, labour economists are often content to utilise self-employment

as a working definition (Parker 2018). A practical advantage of using self-employment as a measure of entrepreneurship is that it is widely implemented – both at the individual level within human population surveys and at the national level, via the OECD Labour Force Statistics database, allowing international comparisons to be performed. In this sense, around 15.8 per cent of the workforce in the EU-28 are self-employed (OECD 2018).

The self-employed are usually classified formally as individuals who earn no regular wage or salary but who derive their income by exercising their profession or business on their own account and at their own risk. In this sense, OECD's own self-employment definition stresses how self-employment may be seen either as a survival strategy for those who cannot find any other means of earning an income or as evidence of entrepreneurial spirit and a desire to be one's own boss (OECD 2018). Stated otherwise, the OECD acknowledges the existing heterogeneity behind this indicator.

A first source of heterogeneity is related with the number of employees. Thus, some individuals operate as self-employed with employees –or employers– (and, hence, contribute directly to the job-generation process) and many more as own-account workers –or sole proprietorships–, i.e., the simplest form of business organisation. Both groups are often considered as proxies for true entrepreneurs and less entrepreneurial forms of self-employment, respectively (Earle and Sakova 2000; Kuhn 2000; Román et al. 2013; J.M. Millán et al. 2014a, 2014b). Furthermore, as will be explained in the next subsection, to account for the existing heterogeneity within the group of self-employed workers without employees, identification of dependent self-employed workers is also of relevance.

Business scholars propose alternative approaches to entrepreneurship. Thus, equating entrepreneurship with opportunity recognition is now standard practice in the business studies approach to entrepreneurship (Shane and Venkataraman 2000). Opportunity and necessity entrepreneurship is typically measured on the basis of the Global Entrepreneurship Monitor (GEM) definition proposed by Reynolds et al. (2002). Respondents of the GEM Adult Population Survey indicating that they run a business are asked whether they started their business because they saw a business opportunity they wanted to pursue or whether they had no alternatives to obtain paid work.

The 'quality' of different types of self-employed workers

The self-employed can be considered a heterogeneous group in terms of their own direct performance, wherein only a minority of entrepreneurs generate jobs (i.e. the self-employed with employees), innovation and wealth leading to a conclusion in the literature that 'less is more' or more self-employment is not necessarily better (Burke et al. 2000; Blanchflower 2004; Shane 2009; Van Praag and Van Stel 2013). In particular, policies to stimulate self-employment, e.g. in the form of start-up subsidies, may lead to more but not necessarily 'better' entrepreneurship. Indeed, these incentives can generate an adverse selection problem by encouraging mostly unskilled individuals to enter (solo) self-employment and, therefore, deteriorating entrepreneurship quality (Román et al. 2011, 2013; Dvouletý and Lukeš 2016). In terms of the distinction self-employed with or without employees, Belitski and Korosteleva (2010) explain that self-employed with employees are often seen as 'productive' in the Baumol sense whereas own-account workers are often considered unproductive.

It is also clear that among the solo self-employed a great diversity exists with some occupational groups of solo self-employed (freelancers) earning more than equivalent employees (e.g. IPSE Freelancer Confidence index reports 2014-2018; CRSE 2017; Burke and Vigne 2018) and playing an 'entrepreneurial enabling role' for business customers comprising SMEs and large corporations engaged in innovation and growth (Burke, 2011, 2012; Burke and Cowling 2015). So, although in direct terms, solo self-employed are less productive than those with employees, there are segments of solo self-employed who indirectly enable entrepreneurship in other firms by providing a flexible and diverse pool of freelance expertise that enables firms to grow faster and undertake more innovation than would be possible if they were only to rely on their own employees (Burke 2011, 2012). In this manner, the solo self-employed can indirectly generate significant value added in other firms.

So, one useful means of accounting for the existing heterogeneity within the solo self-employed workers without employees is undertaken by OECD (2014), who define 'dependent self-employed workers' as "own-account self-employed whose conditions of work are nonetheless similar to those of employees, in the sense that they work mainly or exclusively for a specific client-firm with limited autonomy and often closely integrated into its organizational structure". By contrast, independent own-account self-employed workers have multiple clients and relate more to the project-

based freelance workers described by Burke and Cowling (2015) who enable entrepreneurship in other firms and are able to share in the gains in the value added that they generate in these companies thereby earning more than equivalent employees – and indeed more than dependent solo self-employed. The situation faced by dependent solo self-employed is that they often find themselves in an economically weak situation and this is being widely discussed in international (OECD 2000, 2014; ILO 2003) and European political and legal forums (Supiot 2001; EIRO 2002; Perulli 2003; Sciarra 2005; European Commission 2006; Eichhorst et al. 2013). Nevertheless, the number of empirical studies that explore the frequency and working conditions of dependent self-employed workers has been rather low to date, despite this topic being a potentially pressing political issue. [2] The heterogeneous nature of the situations involved, the lack of a definition or statistical tool and, ultimately, the lack of reliable data are seen as more than probable causes of this research gap (Eichhorst et al. 2013; ILO 2006).

A second source of heterogeneity among the self-employed concerns their start-up motive. Van Stel et al. (2018) show that entrepreneurs who started a business because they spotted a business opportunity (opportunity entrepreneurs) perform better than those who had no other options for work (necessity entrepreneurs). This may be the case because opportunity entrepreneurs were able to take more time to carefully prepare their start-up effort, influencing both the nature and execution of the business opportunity (Block and Sandner 2009). In particular, start-up conditions of the new firm are likely to be better for opportunity entrepreneurs, due to their better preparations. These start-up conditions, in turn, may have lasting effects on business performance (Martin 2002).

Summarising, based on the short review above, in terms of the occupational status dimension we consider the self-employed with employees to be of higher 'quality' (in terms of direct performance and overall contribution to the economy) compared to independent own-account workers, who in turn may be considered of higher 'quality' than dependent self-employed workers. Similarly, we also consider opportunity self-employed to be of higher 'quality' than necessity self-employed.

[2] Thus, most previous studies focus on a single country (e.g. CRSE 2017). The only conditional analysis that characterizes dependent self-employed workers, compared with self-employed and paid employed in a cross-country comparable setting is the work by A. Millán and J.M. Millán (2017). Another related conditional analysis is that by A. Millán et al. (2018), which which compares job satisfaction of independent own-account works and dependent self-employed workers.

Hypotheses derivation

Having established that different forms of self-employment differ in quality, it is essential to identify the key attributes of the institutional framework that can lead to different forms of an Entrepreneurial Society (Audretsch 2007), i.e., that can alter the relative weight of different forms of self-employment in the labour market. The existing evidence on this issue is not just scarce but also mixed (e.g. McMullen et al. 2008; Román et al. 2011, 2013; Valdez and Richardson 2013; Congregado et al. 2014; Van Stel et al. 2014; Fuentelsaz et al. 2015). As an explanation of the absence of clear-cut results as regards the role of institutions, Freeman (2008) stresses that the effectiveness of a specific institutional set-up depends on contextual contingencies and complementarities arising from its several elements.

Freeman (2008) also suggests that there is not a single recipe for creating the aforementioned Entrepreneurial Society. In this sense, it is expected that the innovative environment of an economy plays an important role in the qualitative composition of entrepreneurship. Expenditures on R&D activities should positively affect knowledge spillovers, increasing the stock of technological capital and, thus, the number of entrepreneurial opportunities (Audretsch 1995; Kirzner 1997; Venkataraman 1997). Moreover, an advanced technological environment might create a self-selection effect where only the best and most qualified individuals dare to become entrepreneurs increasing the quality of entrepreneurship and its potential to generate employment (Acs and Audretsch 2003; Acemoglu et al. 2006; Crifo and Sami 2008).

A key tenet of industrial organisation research is the identification of R&D as a sunk fixed cost which thereby raises minimum efficient scale (MES) in industry (Martin 2002). Consequently, a higher MES provides a scale advantage to larger firms which among the self-employed disproportionately favours self-employed with employees over those who operate at the smallest possible scale on their own account. This gives rise to hypothesis 1.

Hypothesis 1: Greater R&D investment will promote self-employment with employees over solo self-employment.

Of course, R&D is ‘a means to an end’ in terms of enabling firms to be innovative and to be more entrepreneurial. In modern economies more

innovative and entrepreneurial firms involve freelancer solo self-employed workers in projects requiring more diverse and specialist expertise than they have available among their employees. Firms that make use of freelancers can also operate with more flexibility and agility than they could do if required to hire on an employee only basis. In fact, the innovation–driven economy has been associated with the rise in independent contractors with multiple clients who are paid very well and work as complements to employees (Burke 2012; Burke and Cowling 2015). Therefore, greater investments in R&D which gives rise to more innovation is likely to create more work opportunities for independent solo self-employed as opposed to the dependent solo self-employed which are less complements and more substitutes for employees (Burke and Cowling 2015). This gives rise to hypothesis 2:

Hypothesis 2: Greater investment in R&D facilitates independence for solo self-employment over dependent solo self-employment.

In economics, the main business raison d'être to invest in R&D is to generate new knowledge which in turn creates new profit opportunities that would not otherwise be available for exploitation (see for example, Martin, 2002). So correspondingly in the field of entrepreneurship Acs and Varga (2005) suggest that R&D process in society entails the creation of extra opportunities for the self-employed. But there is diversity in terms of how R&D filters through to affect different forms of self-employment. For example, higher levels of R&D generating new knowledge can specifically enable knowledge-based entrepreneurship (Audretsch and Keilbach 2007; Acs et al. 2013). By contrast, Dvoulety (2017) finds no statistical relation between R&D expenditures and entrepreneurship in the Nordic regions which supports Schmitz's (1989) contention that imitative self-employment can draw on knowledge generated by foreign R&D. In addition, Holcombe (2003) argues that opportunities from R&D often manifest themselves in the development of an environment that promotes a general increase in profit opportunities. As a result, the exploitation of opportunities does not necessarily have to be carried out by the innovator who is undertaking the R&D but could be developed by other agents through imitation (Schmitz, 1989) and knowledge spillovers (Audretsch and Lehmann 2005; Acs and Varga 2005; Holcombe 2003). So, in terms of the demarcation between necessity and opportunity-driven self-employment, since greater levels of investment in R&D create more opportunities, then for any given level of necessity/push forces into self-employment, one might logically expect that a greater proportion of the the

self-employed workforce will be opportunity-driven. This leads to hypothesis 3:

Hypothesis 3: Greater investment in R&D promotes opportunity-driven self-employment over necessity-driven self-employment.

4.3. Data and methods

Data and sample

Identifying the existing heterogeneity within the self-employed workforce is not straightforward due to data limitations. To overcome this issue, we use data from the Fifth and Sixth waves of the European Working Conditions Survey –EWCS 2010 and 2015– (Eurofound 2012, 2016, 2018), which are the first waves in the EWCS series allowing identification of certain categories within self-employment. This survey is carried out every five years by the EU Agency Eurofound (European Foundation for the Improvement of Living and Working Conditions) and offers key work-related information on 44,000 workers (including both employees and self-employed individuals) covering 35 European countries. [3] These workers are interviewed about several working condition aspects, including physical environment, workplace design, working hours, work organization and social relationships in the workplace. Depending on country size and national arrangements, the sample ranges from 1,000 to 4,000 workers per country.

Conditional on self-classification, the EWCS 2010 and 2015 allow creating 2 separate classifications of self-employed workers. The first classification of self-employed workers combines the information collected by 2 different questions. First, the individuals in the survey are asked about their main activity status: self-employed with employees, self-employed without employees, employed or other. Second, an additional question is asked to those respondents who previously indicated being self-employed without employees, i.e., whether his/her firm generally has more than one client. Based on this information, we classify self-employed workers within our dataset as (1) self-employed with employees; (2) independent own-

[3] This set includes the EU-28 together, 5 candidate countries (Albania, the Former Yugoslav Republic of Macedonia, Montenegro, Serbia and Turkey) and 2 EFTA countries (Norway and Switzerland).

account self-employed (i.e. self-employed without employees answering positively to the question on whether his/her firm generally has more than one client); and (3) dependent self-employed worker (i.e. self-employed without employees answering negatively to the question on whether his/her firm generally has more than one client). For the clarity of our exposition, we will refer, hereinafter, to this classification as occupational status within self-employment. Our final sample includes men and women aged 18 to 65 who are classified as self-employed individuals within the EU-28 territory. All individuals working part-time, i.e., working under 15 hours per week, are excluded. The final dataset, after removing cases with missing data for any of the relevant variables, yields 5,141 observations.

The second classification of self-employed workers is created by means of a third question which is asked to those respondents who previously indicated being self-employed either with or without employees, i.e., whether he or she became self-employed mainly through own personal preference, because they had no other alternatives for work, due to a combination of both reasons, or due to neither of these reasons. Given this question was only used within the EWCS series in 2015, a subdataset is, hence, generated by excluding data from the EWCS 2010. Our subdataset when using data from the EWCS 2015 yields 2,961 observations. Based on this information, we classify the observed set of self-employed workers within our dataset as (1) opportunity entrepreneur; (2) hybrid opportunity-necessity entrepreneur; (3) necessity entrepreneur; and (4) entrepreneur for other reasons. For clarification purposes, we will refer, henceforth, to this classification as start-up motive.

Table 1 below shows the distribution of observations for both classifications across the EU-28 countries.

Table 1: Occupational status within self-employment and start-up motive across the EU-28

	Occupational status within self-employment 2010			**Occupational status within self-employment 2015**			**Start-up motive [a] 2015**			
Country	**1** ***SEwE***	**2** ***IOA***	**3** ***DSEW***	**1** ***SEwE***	**2** ***IOA***	**3** ***DSEW***	**1** ***Opp***	**3** ***Hyb***	**3** ***Nec***	**4** ***Oth***
Austria	33.3	62.5	4.2	33.7	56.6	9.6	39.1	29.9	16.1	14.9
Belgium	35.3	64.7	0.0	38.5	53.6	7.8	77.4	10.8	5.1	6.7
Bulgaria	31.8	56.1	12.1	32.2	63.3	4.4	66.7	21.1	12.2	0
Croatia	41.5	49.1	9.4	30.2	52.8	17.0	39.7	37.9	22.4	0
Cyprus	41.8	42.5	15.7	35.4	56.7	7.9	77.3	9.9	12.8	0
Czech Republic	27.2	63.1	9.7	29.5	63.9	6.6	50.8	18.5	29.2	1.5
Denmark	56.4	41.0	2.6	34.3	62.9	2.9	81.0	7.1	11.9	0
Estonia	38.3	55.3	6.4	51.8	37.5	10.7	59.4	21.9	12.5	6.3
Finland	30.4	60.7	8.9	39.6	49.3	11.2	80.3	6.3	11.3	2.1
France	26.5	70.4	3.1	37.4	57.1	5.5	65.3	12.2	18.4	4.1

Germany [b]	---	---	---	49.6	45.3	5.0	56.5	19.0	22.4	2.0
Greece	20.6	66.4	13.0	35.2	50.8	13.9	45.9	24.9	26.8	2.4
Hungary	34.8	57.6	7.6	31.3	53.1	15.6	25.7	31.4	31.4	11.4
Ireland	25.9	62.4	11.8	38.9	47.6	13.5	69.1	17.6	11.8	1.5
Italy	28.5	65.4	6.2	32.2	58.2	9.6	55.8	19.5	22.1	2.6
Latvia	35.7	57.1	7.1	40.0	45.0	15.0	37.5	34.4	26.6	1.6
Lithuania	12.8	63.8	23.4	30.9	54.4	14.7	56.4	25.6	17.9	0
Luxembourg	36.4	59.1	4.5	45.5	49.1	5.5	76.2	6.3	12.7	4.8
Malta	38.3	53.3	8.3	20.8	73.6	5.6	68.8	17.5	12.5	1.3
Netherlands	25.9	65.4	8.6	28.2	67.1	4.7	73.1	7.7	14.4	4.8
Poland	19.2	63.8	16.9	31.0	53.4	15.5	49.2	23.1	20.0	7.7
Portugal	23.8	68.8	7.5	25.5	51.1	23.4	40.6	37.6	17.8	4.0
Romania	21.3	59.6	19.1	27.1	41.7	31.3	54.2	35.6	10.2	0
Slovakia	21.0	61.9	17.1	20.0	60.0	20.0	66.7	20.8	11.1	1.4
Slovenia	36.2	60.6	3.2	28.2	50.9	20.9	64.2	15.0	15.0	5.8
Spain	30.6	66.1	3.2	30.1	63.1	6.8	47.9	31.2	19.5	1.4
Sweden	35.2	64.8	0.0	32.7	61.2	6.1	86.5	5.8	7.7	0.0
United Kingdom	24.6	66.2	9.2	25.0	62.1	12.9	71.1	16.4	10.5	2.0
EU-28 (unweighted)	***30.9***	***60.3***	***8.9***	***33.4***	***55.1***	***11.6***	***60.1***	***20.2***	***16.5***	***3.2***

Notes: N = 5,141; *SEwE* = self-employed with employees, *IOA* = independent own-account self-employed worker, *DSEW* = dependent self-employed worker, *Opp* = opportunity entrepreneur, *Hyb* = hybrid opportunity-necessity entrepreneur, *Nec* = necessity entrepreneur, *Oth* = entrepreneur for other reasons; [a] The information about start-up motive is only available within the EWCS 2015. [b] Germany has to be excluded from our sample for 2010 due to missing data in relevant variables.
Data source: EWCS 2010, 2015.

Dependent variables

We aim to study whether the R&D effort in a given economy affects the qualitative composition of self-employment and, in particular, the relative weights of our different entrepreneurship types in total entrepreneurship. To this end, we generate the following discrete non-ordered variables from the information on occupational status within self-employment and start-up motive described above:

(i) a discrete non-ordered variable equaling 1 for self-employed with employees, 2 for independent own-account self-employed workers, and 3 for dependent self-employed workers

(ii) a discrete non-ordered variable equaling 1 for opportunity entrepreneurs; 2 for hybrid opportunity-necessity entrepreneurs, 3 for necessity entrepreneurs; and 4 for entrepreneur for other reasons.

Main independent variables

The fundamental role of technological activities, as drivers of entrepreneurial success and hence of economic development, urges countries to promote innovation in their economies (Van Stel et al. 2014). Therefore, in order to capture the presence and commitment to technological effort and innovation activities in each of the considered economies, our regressions

on the relative weight of different entrepreneurship types and reasons include the 5 years average Gross Domestic Expenditure on R&D (GERD) for periods 2006-10 and 2011-15. This indicator includes expenditures by business enterprises, higher education institutions, as well as government and private non-profit organisations. In order to make fairer comparisons between countries, Eurostat provides this information expressed (i) as Purchasing Power Standards –PPS– per inhabitant at constant 2005 prices[4]; and (ii) as percentage of GDP. The periods 2006-10 and 2011-15 are used to generate focal variables values for 2010 and 2015 respectively. Table 2 below shows figures as regards this indicator for the EU-28.

Table 2: GERD and GDP for the EU-28

	GERD as % of GDP				GERD PPS per inhabitant at constant 2005 prices			
Country	**Rank#**	**2006-10**	**Rank#**	**2011-15**	**Rank#**	**2006-10**	**Rank#**	**2011-15**
Austria	5	2.54	4	2.93	5	793.4	2	942.7
Belgium	7	1.92	7	2.32	8	563.6	7	682.9
Bulgaria	27	0.48	25	0.70	27	48.9	27	79.9
Croatia	20	0.80	23	0.79	21	111.5	24	104.2
Cyprus	28	0.41	27	0.47	23	101.9	25	102.8
Czech Republic	16	1.28	10	1.83	15	263.7	13	385.3
Denmark	3	2.73	3	2.95	4	803.7	5	863.6
Estonia	14	1.29	11	1.82	17	193.1	15	291
Finland	1	3.54	1	3.28	2	1,006.70	3	906
France	6	2.10	8	2.22	9	558.9	9	596.1
Germany	4	2.59	5	2.86	6	744.3	4	890.6
Greece	22	0.61	22	0.80	19	137.3	23	142.7
Hungary	18	1.04	16	1.31	18	154.3	18	200.3
Ireland	12	1.40	13	1.47	10	478.1	10	530.8
Italy	17	1.16	17	1.29	14	295.9	14	306.5
Latvia	23	0.57	26	0.66	26	76.1	26	94.4
Lithuania	19	0.80	19	0.96	20	113.9	21	160.7
Luxembourg	11	1.61	15	1.31	3	989.8	6	802
Malta	24	0.56	24	0.75	22	111.3	19	168
Netherlands	8	1.70	9	1.96	7	568	8	654.2
Poland	21	0.62	20	0.89	24	86.3	22	146
Portugal	13	1.33	14	1.34	16	262.6	17	254.1
Romania	26	0.49	28	0.45	28	48.6	28	48
Slovakia	25	0.50	21	0.87	25	84.2	20	165.7
Slovenia	9	1.69	6	2.43	12	375.3	11	519.9
Spain	15	1.28	18	1.27	13	309.2	16	285.3
Sweden	2	3.39	2	3.25	1	1,018.80	1	1,007.40
United Kingdom	10	1.64	12	1.65	11	455.9	12	463.5
EU-28 (unweighted)		***1.43***		***1.60***		***384.1***		***421.2***

[4] PPS is the technical term used by Eurostat for the common (artificial) currency in which national accounts aggregates are expressed when adjusted for price level differences using PPPs. Thus, PPPs can be interpreted as the exchange rate of the PPS against the €.

	GDP growth rate				GDP PPS per inhabitant			
Country	**Rank#**	**2010**	**Rank#**	**2015**	**Rank#**	**2010**	**Rank#**	**2015**
Austria	15	1.8	24-25	1.1	5	126	3	130
Belgium	8	2.7	23	1.4	7-8	120	8	118
Bulgaria	19-21	1.3	8	3.6	28	44	28	47
Croatia	25	-1.5	13	2.4	25	59	26	59
Cyprus	19-21	1.3	16-18	2	13	100	16-17	82
Czech Republic	9-10	2.3	3	5.3	17-18	83	15	87
Denmark	11-14	1.9	22	1.6	4	129	5	127
Estonia	9-10	2.3	20-21	1.7	21-22	65	20-21	75
Finland	7	3	27	0.1	9	116	9	109
France	11-14	1.9	24-25	1.1	10-11	108	11	105
Germany	4	4.1	20-21	1.7	7-8	120	7	124
Greece	28	-5.5	28	-0.3	15	85	22	69
Hungary	23	0.7	9-10	3.4	21-22	65	23-24	68
Ireland	11-14	1.9	1	25.1	3	130	2	181
Italy	16-17	1.7	26	1	12	104	12	95
Latvia	27	-3.9	11	3	26	53	25	64
Lithuania	18	1.6	16-18	2	24	60	20-21	75
Luxembourg	3	4.9	12	2.9	1	257	1	267
Malta	6	3.5	2	9.6	16	84	13	93
Netherlands	19-21	1.3	16-18	2	2	134	4	129
Poland	5	3.6	7	3.8	23	62	23-24	68
Portugal	11-14	1.9	19	1.8	19	82	18-19	77
Romania	26	-2.8	5-6	3.9	27	51	27	56
Slovakia	2	5	5-6	3.9	20	74	18-19	77
Slovenia	22	1.2	14-15	2.3	17-18	83	16-17	82
Spain	24	0	9-10	3.4	14	96	14	91
Sweden	1	6	4	4.5	6	125	6	125
United Kingdom	16-17	1.7	14-15	2.3	10-11	108	10	108
EU-28 (unweighted)		***1.6***		***3.45***		***97.3***		***99.6***

Notes: Countries are ranked from higher to lower GERD and GDP; *Data source*: Eurostat.

Commitment to R&D varies from industry to industry, from country to country and from year to year. However, we observe that Nordic countries (Denmark, Finland and Sweden), together with Continental countries (Austria, Belgium, France, Germany, Luxembourg and The Netherlands) consistently rank high on the scale of R&D spenders across the EU-28 area. In contrast, some Mediterranean countries (Cyprus, Greece and Malta), Baltic States (Lithuania and Latvia) and East-European countries (Bulgaria, Croatia, Poland, Romania and Slovakia) normally rank low in the same scale. Although imperfect, the direct relationship between these investments and some macroeconomic indicators based on GDP is revealed.

Control variables

In order to isolate the effect of our hypotheses-related variables, the empirical models also include a set of explanatory variables that are known to influence self-employment participation (see e.g. Evans and Leighton 1989; Blanchflower and Oswald 1998; Carrasco 1999; Román et al. 2011, 2013; Congregado et al. 2014; Parker 2018): educational attainment, job-related aspects (tenure, working hours, business sector) and some demographic indicators (gender, immigrant, age, cohabitation status, children, health status).

In order to control for the business cycle and some structural differences between countries, the empirical models also include GDP growth rates and GDP per inhabitant for periods 2010 and 2015, which we collect from Eurostat, and a period 2015 (vs. 2010) dummy. Table 2 above also presents country-level information concerning GDP growth rates and GDP per inhabitant for the countries in our sample.

Definitions of all model variables are provided in the Appendix.

Methodology

To explore whether R&D effort in an economy affects the qualitative composition of entrepreneurship, we use non-ordered discrete choice models (multinomial logit). Standard errors are adjusted for intra-countries correlation by clustering.

4.4. Results

Descriptive analysis

We aim to explore how our different self-employment types and reasons affect their earnings and whether R&D effort affects their relative weight in a given economy. Table 3 below compares these groups.

Table 3. Descriptive statistics for occupational status within self-employment and start-up motive

	Occupational status within self-employment					
	1		**2**		**3**	
	Self-employed with employees 2010, 2015		*Independent own-account self-employed worker 2010, 2015*		*Dependent self-employed worker 2010, 2015*	
# observations	N = 1,630		N = 3,003		N = 508	
% observations	31.7%		58.4%		9.9%	
Variables	Mean	SD	Mean	SD	Mean	SD
Educational attainment						
Basic education [c]	0.036		0.072		0.130	
Secondary education [c]	0.603		0.620		0.687	
Tertiary education [c]	0.361		0.308		0.183	
Job aspects						
Tenure (*1 – 53*)	13.70	10.03	12.01	10.20	13.73	12.18
Working hours (*15 – 98*)	48.66	12.78	44.59	14.64	44.12	16.06
Net monthly earnings - PPP $ of 2015 (*1 – 55,211*)	2954	2555	2011	1795	1590	1457
Business sector dummies						
Agriculture [c]	0.091		0.114		0.386	
Industry [c]	0.110		0.094		0.098	
Construction [c]	0.133		0.120		0.087	
Commerce and hospitality [c]	0.330		0.250		0.100	
Transport [c]	0.036		0.040		0.065	
Financial services [c]	0.029		0.034		0.026	
Public administration and defence [c]	0.004		0.002		0.004	
Education [c]	0.012		0.020		0.018	
Health [c]	0.048		0.059		0.043	
Other services [c]	0.206		0.267		0.173	
Demographic characteristics						
Female [c]	0.309		0.402		0.382	
Immigrant [c]	0.123		0.119		0.126	
Age (*18-65*)	45.20	10.36	44.82	10.90	46.57	11.46
Cohabiting [c]	0.790		0.699		0.693	
Children under 14 [c]	0.345		0.306		0.230	
Health (1-5)	4.05	0.76	3.99	0.77	3.81	0.81

	Start-up motive [a]							
	1		**2**		**3**		**4**	
	Opportunity Entrepreneur 2015		*Hybrid opportunity-necessity entrepreneur 2015*		*Necessity Entrepreneur 2015*		*Entrepreneur for other reasons 2015*	
# observations	N = 1,796		N = 485		N = 590		N = 90	
% observations	60.7%		16.4%		19.9%		3%	
Variables	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Educational attainment								
Basic education [c]	0.031		0.056		0.110		0.056	
Secondary education [c]	0.587		0.625		0.663		0.589	
Tertiary education [c]	0.382		0.320		0.227		0.356	
Job aspects								
Tenure (*1 – 53*)	13.83	10.59	12.14	10.15	11.63	11.08	14.76	12.41
Working hours (*15 – 98*)	45.05	13.19	44.04	13.67	43.28	15.29	42.13	16.45
Net monthly earnings - PPP $ of	2617	2615	1956	1320	1618	1182	1897	1289
Business sector dummies								
Agriculture [c]	0.107		0.130		0.197		0.178	
Industry [c]	0.102		0.095		0.078		0.111	
Construction [c]	0.119		0.118		0.119		0.078	
Commerce and hospitality [c]	0.234		0.264		0.222		0.178	
Transport [c]	0.037		0.047		0.056		0.033	
Financial services [c]	0.028		0.029		0.025		0.044	
Public administration and defence [c]	0.001		0.002		0.002		0.011	
Education [c]	0.020		0.025		0.031		0.033	
Health [c]	0.061		0.035		0.046		0.078	
Other services [c]	0.290		0.256		0.225		0.256	
Demographic characteristics								
Female [c]	0.354		0.375		0.415		0.522	
Immigrant [c]	0.137		0.126		0.134		0.133	
Age (*18-65*)	45.96	10.62	45.14	10.82	46.34	11.00	46.31	11.57
Cohabiting [c]	0.724		0.705		0.659		0.744	
Children under 14 [c]	0.307		0.320		0.271		0.222	
Health (1-5)	4.11	0.73	3.93	0.79	3.74	0.81	4.00	0.76

Notes: Notes: N = 5,141 for occupational status within self-employment; N = 2,961 for start-up motive; [a] The information about start-up motive is only available within the EWCS 2015; [c] Dummy variable; *Data source*: EWCS 2010, 2015.

We first explore occupational status within self-employment. About 31.7% of our sample are self-employed with employees. We observe in our sample that, compared to the other types, self-employed with employees are more often male, better educated, more often to work in industry, construction and commerce and hospitality sectors, more often with partner and with children, they work the longest hours, feel the healthiest and also have the highest earnings. These figures suggest the appropriateness of the category of self-employed with employees in order to capture those more entrepreneurial forms of self-employment. About 58.4% and 9.9% of the workers in our sample are, respectively, independent own-account self-

employed and dependent self-employed workers. When comparing both groups, dependent self-employed workers are lower educated, older, more likely to have worse health perception, and far more likely to work in the agricultural sector than independent own-account self-employed. Furthermore, they have lower earnings.

When concentrating on start-up motive (only available for the EWCS 2015), a similar characterization of our relevant groups is revealed. However, the shares of belonging to these groups varies substantially with respect to those obtained for our entrepreneurship types. In particular, 60.7% of our sample report to be opportunity entrepreneurs. We observe, inter alia, they are in our sample more often male, better educated, they have better health perception, and they work the longest hours. Moreover, they have the highest earnings. As regards their necessity entrepreneurs counterparts, this group accounts for 19.9% of our sample. These self-employed workers present the lowest educational attainment levels and more often work in the agricultural sector. Furthermore, they have the lowest earnings. Finally, the groups of hybrid entrepreneurs and entrepreneurs for other reasons account for 16.4% and 3% of our sample. Both categories present intermediate positions in terms of education levels and earnings.

Multivariate analysis

The estimation results are presented in Tables 4 and 5. Table 4 in subsection 4.2.1 shows the results from 2 specifications aimed to explore the role of expenditures on R&D over different occupational statuses. Similarly, Table 5 in subsection 4.2.2 shows the results from 2 specifications devoted to investigate the role of expenditures on R&D over different start-up motives. The following structure is used to present these results in Tables 4 and 5. First, average predicted probabilities of belonging to different categories (in terms of occupational status or start-up motive) are indicated at the top of each specification. These predicted probabilities are useful to understand the relative importance of our marginal effects, presented below. Specifically, each model is presented in a three-column format, where marginal effects and t-statistics are reported. Thus, within each specification, the first column shows the absolute marginal effects associated with all covariates. The second column also refers to marginal effects, but is expressed in relative terms (with respect to average predicted values of our dependent variables). The third column presents t-statistics associated with marginal effects.

Finally, section 4.4.2.3 presents some robustness checks which are part of the analysis.

Relationship between R&D and occupational status within self-employment types

Table 4 below presents models 1A–1B aimed to test our hypotheses on the relationship between GERD over different self-employment types. GERD is expressed as PPS per inhabitant at constant 2005 prices in model 1A whereas GERD as percentage of GDP is used in model 1B. To explore whether R&D effort affects the qualitative composition of entrepreneurship, we use non-ordered discrete choice models (multinomial logit). Standard errors are adjusted for intra-countries correlation in models 1A–1B by clustering.

Table 4. Determinants of different occupational statuses within self-employment –Discrete choice non-ordered models (multinomial models)–

# Specification	**1A**								
Occupational status within self-employment	**1** *Self-employed with employees*			**2** *Independent own-account self-employed worker*			**3** *Dependent self-employed worker*		
Average predicted probability	0.32			0.58			0.10		
Independent variables (*x*)	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$%	t-statistic	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$%	t-statistic	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$%	t-statistic
Expenditure on R&D: GERD									
- PPS per inhabitant at constant 2005 prices (*48 – 1,019*)	9.7E-05	0.03	3.01***	-6.3E-06	-1.1E-03	-0.17	-9.1E-05	-0.09	-3.78***
- as % of GDP (*0.41 – 3.54*)									
Educational attainment									
Basic education [c] (*ref.*)									
Secondary education [c]	0.11	34.7	4.73***	-0.08	-14.5	-3.10***	-0.03	-25.4	-1.39
Tertiary education [c]	0.20	63.2	7.71***	-0.13	-23.0	-4.50***	-0.07	-66.5	-3.40***
Job aspects									
Tenure (*1 – 60*)	0.01	3.96	5.94***	-0.01	-1.31	-3.42***	-4.9E-	-4.95	-4.02***
Tenure (squared)	-2.2E-	-0.07	-3.92***	1.3E-	0.02	2.15**	9.5E-	0.10	3.20***
Working hours (*15 – 98*)	0.02	5.36	7.38***	-0.01	-2.34	-5.85***	-3.3E-	-3.35	-2.93***
Working hours (squared)	-1.3E-	-0.04	-5.90***	1.1E-	0.02	4.70***	2.4E-	0.02	2.07**
Business sector dummies									
Agriculture [c]	-0.11	-35.5	-4.50***	-0.09	-15.1	-3.07***	0.20	203.1	9.45***
Industry [c]	0.01	3.29	0.38	-0.04	-6.62	-1.33	0.03	28.6	1.75*
Construction [c] (*ref.*)									
Commerce and hospitality [c]	0.07	21.5	2.99***	-0.04	-6.62	-1.62	-0.03	-29.9	-2.61***
Transport [c]	-0.06	-18.7	-1.72*	-0.02	-3.34	-0.51	0.08	79.8	3.14***
Financial services [c]	-0.05	-17.2	-1.40	0.03	5.12	0.70	0.02	25.0	0.95
Public administration and	0.10	31.8	0.78	-0.17	-29.7	-1.33	0.07	73.7	0.79
Education [c]	-0.10	-31.9	-2.03**	0.06	10.4	1.09	0.04	40.8	1.13
Health [c]	-0.07	-20.8	-1.95*	0.03	4.39	0.68	0.04	40.8	1.63
Other services [c]	-0.06	-17.5	-2.36**	0.05	8.17	1.91*	7.7E-	7.81	0.59

Demographic characteristics									
Female [c]	-0.04	-14.0	-3.19***	0.04	7.59	2.93***	1.8E-	0.18	0.02
Immigrant [c]	-0.01	-2.72	-0.44	-0.03	-5.21	-1.39	0.04	39.5	2.57**
Age (*18 – 65*)	-3.0E-	-0.94	-0.59	4.4E-	0.76	0.83	-1.5E-	-1.49	-0.50
Age (squared)	1.1E-	3.6E-03	0.20	-3.2E-	-0.01	-0.53	2.0E-	0.02	0.61
Cohabiting [c]	0.07	22.9	4.79***	-0.07	-11.8	-4.15***	-4.0E-	-4.09	-0.42
Children under 14 [c]	0.02	5.46	1.09	0.01	1.23	0.42	-0.02	-24.8	-2.48**
Health (*1 – 5*)	0.01	4.58	1.70*	-4.1E-	-0.71	-0.45	-0.01	-10.5	-1.93*
Macroeconomics indicators									
GDP growth rate (*-5.5 – 25.1*)	6.1E-	0.19	0.37	-6.5E-	-0.11	-0.36	4.6E-	0.05	0.04
GDP PPS per inhabitant (*44 –*	3.6E-	0.01	0.13	-6.4E-	-0.01	-0.20	2.8E-	0.03	0.14
Wave									
2015 [c]	0.04	11.2	2.69***	-0.06	-10.57	-4.28***	0.03	26.4	3.02***
Log likelihood	-4,266.2								

# Specification	**1B**								
Occupational status within self-employment	**1** *Self-employed with employees*			**2** *Independent own-account self-employed worker*			**3** *Dependent self-employed worker*		
Average predicted probability	0.32			0.58			0.10		
Independent variables (*x*)	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$%	t-statistic	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$%	t-statistic	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$%	t-statistic
Expenditure on R&D: GERD									
- PPS per inhabitant at constant 2005 prices (*48 – 1,019*)									
- as % of GDP (*0.41 – 3.54*)	0.03	8.63	3.14***	-3.7E-03	-0.64	-0.38	-0.02	-23.9	-3.73***
Educational attainment									
Basic education [c] (*ref.*)									
Secondary education [c]	0.11	34.9	4.79***	-0.08	-14.3	-3.07***	-0.03	-27.4	-1.49
Tertiary education [c]	0.20	63.4	7.76***	-0.13	-22.9	-4.46***	-0.07	-68.2	-3.46***
Job aspects									
Tenure (*1 – 60*)	0.01	3.96	5.94***	-0.01	-1.32	-3.43***	-4.9E-03	-4.94	-4.01***
Tenure (squared)	-2.2E-04	-0.07	-3.93***	1.3E-04	0.02	2.15**	9.5E-05	0.10	3.21***
Working hours (*15 – 98*)	0.02	5.35	7.37***	-0.01	-2.34	-5.85***	-3.3E-03	-3.35	-2.92***
Working hours (squared)	-1.3E-04	-0.04	-5.88***	1.1E-04	0.02	4.70***	2.4E-05	0.02	2.05**
Business sector dummies									
Agriculture [c]	-0.11	-35.3	-4.48***	-0.09	-15.0	-3.06***	0.20	202.1	9.42***
Industry [c]	0.01	3.10	0.36	-0.04	-6.60	-1.33	0.03	29.0	1.78*
Construction [c] (*ref.*)									
Commerce and hospitality [c]	0.07	21.5	2.98***	-0.04	-6.61	-1.62	-0.03	-29.8	-2.60***
Transport [c]	-0.06	-18.7	-1.72*	-0.02	-3.27	-0.50	0.08	79.4	3.13***
Financial services [c]	-0.06	-17.4	-1.42	0.03	5.11	0.70	0.03	25.7	0.97
Public administration and defence	0.10	31.1	0.76	-0.17	-29.6	-1.32	0.07	75.3	0.80
Education [c]	-0.10	-31.8	-2.03**	0.06	10.4	1.09	0.04	40.5	1.12
Health [c]	-0.07	-20.7	-1.94*	0.03	4.51	0.70	0.04	39.8	1.60
Other services [c]	-0.06	-17.5	-2.37**	0.05	8.20	1.92*	0.01	7.81	0.59
Demographic characteristics									
Female [c]	-0.04	-14.0	-3.18***	0.04	7.56	2.92***	2.4E-04	0.24	0.03
Immigrant [c]	-0.01	-2.68	-0.43	-0.03	-5.27	-1.41	0.04	39.7	2.59***
Age (*18 – 65*)	-3.0E-03	-0.95	-0.59	4.5E-03	0.77	0.84	-1.5E-03	-1.50	-0.50
Age (squared)	1.2E-05	3.8E-03	0.21	-3.2E-05	-0.01	-0.54	2.0E-05	0.02	0.61
Cohabiting [c]	0.07	22.9	4.79***	-0.07	-11.7	-4.15***	-4.2E-03	-4.21	-0.43
Children under 14 [c]	0.02	5.36	1.07	0.01	1.27	0.43	-0.02	-24.7	-2.47**
Health (*1 – 5*)	0.01	4.62	1.71*	-4.1E-03	-0.71	-0.45	-0.01	-10.7	-1.96**

Macroeconomics indicators								
GDP growth rate (*-5.5 – 25.1*)	2.8E-04	0.09	0.17	-6.6E-04	-0.11-0.37	3.8E-04	0.38	0.37
GDP PPS per inhabitant (*44 – 267*)	3.1E-04	0.10	1.39	-7.3E-05	-0.01-0.29	-2.4E-04	-0.24	-1.50
Wave								
2015 [c]	0.04	11.0	2.64***	-0.06	-10.5-4.25***	0.03	26.7	3.05***
Log likelihood	-4,266.1							

Notes: N = 5,141; [c] Dummy variable. For continuous variables, *dy/dx* captures absolute marginal effects whereas [(*dy/dx*)/*y*]% refers to marginal effects, but expressed in relative terms with respect to predicted probabilities. In the context of dummy variables, these reflects the impact for a discrete change of the dummy variable from 0 to 1; * $0.1 > p \geq 0.05$; ** $0.05 > p \geq 0.01$; *** $p < 0.01$; The maximum correlation is 0.54 (between age and tenure), and the VIFs values (from model 3B) range from 1.05 to 1.78. Thus, multicollinearity does not pose a concern, especially in consideration of the large size of our sample; Data source: EWCS 2010, 2015.

In coherence with Hypotheses 1 and 2, we observe that the qualitative composition of European self-employment is positively influenced by GERD in terms of a higher relative weight of self-employed with employees and a lower relative weight of dependent self-employed workers. In particular, model 1A shows that each additional PPS per inhabitant in R&D effort increases the likelihood of being self-employed with employees by about 0.03% and decreases the likelihood of being dependent self-employed worker by about 0.09%. Similarly, model 1B demonstrates how each additional 1% of GDP devoted to expenditures on R&D increases the chances of being self-employed with employees by about 9% and decreases the likelihood of being dependent self-employed worker by about 24%.

Turning to the results for our control variables, we observe how education, tenure and the number of working hours increase the chances of being self-employed with employees and decrease the likelihood of being both independent own-account worker and dependent self-employed worker. As regards tenure, we find a non-linear, inverted U-shaped impact on self-employed with employees likelihood where the turning point is reached after 28 years of experience in the company or organization. Conversely, we find a U-shaped effect on chances of being both independent own-account worker and dependent self-employed worker, where the turning points are reached with 30 and 26 years of tenure, respectively. A similar pattern is observed for working hours. Thus, there is also a positive (non-linear) association between working hours and the likelihood of being self-employed with employees, where the quadratic term begins to dominate the linear term at 64 working hours per week. Conversely, there is a negative (non-linear) relation between hours of work and the likelihood of being an independent own-account worker or a dependent self-employed worker, where the turning points are reached at 63 and 69 working hours per week, respectively. Since self-employed

individuals are distinguished by the effort (e.g. working more hours is associated with being more job satisfied among the self-employed; Millán et al. 2013), the positive (negative) association between working hours and the more (less) entrepreneurial forms of self-employment cannot be a surprising result. We also find that females are less likely to be self-employed with employees and more likely to be independent own-account workers. Regarding place of birth, being an immigrant increases the chances to be dependent self-employed. Cohabitation is also positively associated with the chances of being self-employed with employees and negatively associated with the likelihood of being independent own-account worker. We also find a negative effect of dependent children on the options to be dependent self-employed worker. Reporting good health also seems to be positively associated with the chances to be self-employed with employees and negatively linked with the likelihood of being dependent self-employed worker. Thus, our findings lend support to the view that an entrepreneurial career may have some health benefits (e.g. Stephan and Roesler 2010). Finally, being both self-employed with employees and dependent self-employed worker was more probable in 2015 whereas being independent own-account worker was more likely in 2010.

Start-up motive

Table 5 below presents models 2A–2B aimed to test our hypothesis on the relationship between GERD over different entrepreneurship reasons. GERD expressed as PPS per inhabitant at constant 2005 prices is used in model 2A whereas GERD is expressed as percentage of GDP in model 2B. Non-ordered discrete choice models (multinomial logit) are also used in these models, in which standard errors are also adjusted for intra-countries correlation by clustering.

Table 5. Determinants of different start-up motives –Discrete choice non-ordered models (multinomial models)–

# Specification	2A											
	1			2			3			4		
Start-up motive	*Opportunity entrepreneur*			*Hybrid opportunity-necessity entrepreneur*			*Necessity entrepreneur*			*Entrepreneur for other reasons*		
Average predicted	0.61			0.16			0.20			0.03		
Independent variables (x)	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$ %	t-statistic
Expenditure on R&D: GERD												
- PPS per inhabitant at constant 2005 prices (*48 – 1,007*)	1.2E-04	0.02	2.61***	-6.2E-05	-0.04	-1.62	-9.5E-05	-0.05	-2.21**	3.3E-05	0.11	2.25**
- as % of GDP (*0.45 – 3.28*)												
Educational												
Basic education [b]												
Secondary education	0.18	30.5	4.32***	-0.02	-9.30	-0.44	-0.17	-85.6	-4.09***	9.0E-	2.95	0.06
Tertiary education [b]	0.26	43.1	5.76***	-0.02	-10.9	-0.49	-0.25	-123.2	-5.66***	2.0E-	6.56	0.13
Job aspects												
Tenure (*1 – 60*)	0.01	2.20	4.88***	-1.0E-	-0.63	-0.47	-0.01	-6.12	-5.70***	-9.4E-	-0.31	-0.10
Tenure (squared)	-1.9E-	-0.03	-2.62***	-1.3E-	-0.01	-0.21	1.8E-	0.09	3.29***	1.9E-	0.06	0.82
Working hours (*15 – 98*)	0.01	1.42	3.05***	-7.3E-05	-0.04	-0.03	-0.01	-3.17	-2.97***	-2.2E-03	-7.32	-2.62***
Working hours (squared)	-8.4E-05	-0.01	-2.75***	-3.9E-06	-2.4E-03	-0.16	6.7E-05	0.03	2.89***	2.1E-05	0.07	2.35**
Business sector												
Agriculture [b]	-0.09	-14.3	-2.32**	0.01	8.25	0.46	0.06	30.2	1.94*	0.01	42.9	0.89
Industry [b]	0.03	4.63	0.75	-1.5E-	-0.94	-0.05	-0.04	-19.4	-1.32	0.01	39.8	0.79
Construction [b] (*ref.*)												
Commerce and	-4.1E-	-0.67	-0.13	0.02	12.8	0.84	-0.02	-8.16	-0.64	-7.0E-	-2.29	-0.06
Transport [b]	-0.09	-14.2	-1.76*	0.02	12.4	0.52	0.06	30.7	1.46	4.8E-	15.7	0.24
Financial services [b]	-0.05	-8.24	-0.84	0.01	9.08	0.32	0.02	8.77	0.34	0.02	57.9	0.74
Public	-0.24	-38.9	-0.90	0.08	47.9	0.37	-0.03	-16.9	-0.22	0.19	629.4	0.96
Education [b]	-0.12	-19.8	-1.84*	3.4E-	2.09	0.07	0.11	55.9	1.82*	0.01	16.5	0.24
Health [b]	0.01	2.33	0.29	-0.04	-27.4	-1.28	0.02	12.3	0.56	0.01	20.5	0.37
Other services [b]	0.03	4.64	0.88	-0.01	-3.07	-0.20	-0.02	-11.5	-0.89	-1.9E-	-0.62	-0.02
Demographic												
Female [b]	-0.04	-6.36	-1.97**	-2.6E-	-1.60	-0.17	0.02	12.2	1.51	0.02	55.8	2.22**
Immigrant [b]	-0.01	-1.96	-0.45	-0.01	-6.00	-0.48	0.02	11.5	1.02	-1.2E-	-3.90	-0.12
Age (*18 – 65*)	-2.8E-	-0.47	-0.42	-8.4E-	-0.51	-0.16	0.01	2.60	0.96	-1.5E-	-4.96	-0.63
Age (squared)	2.1E-	3.5E-03	0.28	6.9E-	4.2E-03	0.11	-3.8E-	-0.02	-0.63	9.9E-	0.03	0.37
Cohabiting [c]	0.04	6.49	1.88*	-0.01	-4.71	-0.46	-0.04	-21.5	-2.46**	0.01	36.9	1.66*
Children under 14 [c]	-0.01	-1.68	-0.45	0.02	11.0	0.99	0.01	4.11	0.43	-0.02	-52.6	-2.27**
Health (*1 – 5*)	0.09	14.8	7.86***	-0.02	-14.9	-2.70***	-0.07	-33.2	-7.28***	9.0E-	2.97	0.22
Macroeconomics												
GDP growth rate (-*0.3 – 25.1*)	5.0E-04	0.08	0.22	-2.5E-03	-1.54	-1.32	3.5E-03	1.74	1.79*	-1.5E-03	-4.78	-1.51
GDP PPS per inhabitant (*47 – 267*)	7.2E-04	0.12	1.69*	-1.6E-05	-0.01	-0.05	-7.7E-04	-0.39	-1.92*	6.7E-05	0.22	0.57
Log likelihood	-2,828.4											

# Specification	2B											
	1			2			3			4		
Start-up motive	*Opportunity entrepreneur*			*Hybrid opportunity-necessity entrepreneur*			*Necessity entrepreneur*			*Entrepreneur for other reasons*		
Average predicted	0.61			0.16			0.20			0.03		
Independent variables (x)	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy}{dx}$	$\frac{dy/dx}{y}$ %	t-statistic
Expenditure on R&D: GERD												
- PPS per inhabitant at constant 2005 prices (*48 – 1,007*)												
- as % of GDP (*0.45 – 3.28*)	0.03	5.22	2.47**	-0.02	-9.39	-1.51	-0.03	-13.2	-2.30**	0.01	32.8	2.43**
Educational												
Basic education [b]												
Secondary education	0.19	30.9	4.39***	-0.02	-9.82	-0.47	-0.17	-86.4	-4.12***	8.9E-	2.94	0.06
Tertiary education [b]	0.26	43.4	5.82***	-0.02	-11.3	-0.51	-0.25	-123.7	-5.68***	1.7E-	5.72	0.11
Job aspects												
Tenure (*1 – 60*)	0.01	2.20	4.87***	-1.0E-	-0.63	-0.47	-0.01	-6.13	-5.70***	-8.1E-	-0.27	-0.09
Tenure (squared)	-1.9E-	-0.03	-2.63***	-1.2E-	-0.01	-0.21	1.9E-	0.09	3.30***	1.8E-	0.06	0.80
Working hours (*15 – 98*)	0.01	1.42	3.04***	-6.5E-05	-0.04	-0.03	-0.01	-3.17	-2.97***	-2.2E-03	-7.26	-2.60***
Working hours (squared)	-8.4E-05	-0.01	-2.74***	-4.1E-06	-2.5E-03	-0.16	6.7E-05	0.03	2.89***	2.1E-05	0.07	2.33**
Business sector												
Agriculture [b]	-0.09	-14.3	-2.32**	0.01	8.33	0.46	0.06	30.2	1.94*	0.01	42.1	0.88
Industry [b]	0.03	4.51	0.73	-1.1E-	-0.68	-0.04	-0.04	-19.2	-1.30	0.01	39.4	0.78
Construction [b] (*ref.*)												
Commerce and	-4.3E-	-0.71	-0.14	0.02	12.9	0.85	-0.02	-8.22	-0.65	-5.2E-	-1.70	-0.04
Transport [b]	-0.09	-14.2	-1.76*	0.02	12.5	0.52	0.06	30.6	1.46	4.8E-	15.8	0.24
Financial services [b]	-0.05	-8.35	-0.85	0.02	9.40	0.33	0.02	8.89	0.35	0.02	57.8	0.74
Public	-0.24	-38.8	-0.89	0.08	50.2	0.38	-0.03	-16.5	-0.21	0.19	612.1	0.94
Education [b]	-0.12	-19.6	-1.83*	3.3E-	2.03	0.07	0.11	55.0	1.79*	0.01	20.0	0.28
Health [b]	0.02	2.54	0.31	-0.05	-27.6	-1.30	0.02	11.7	0.54	0.01	21.2	0.38
Other services [b]	0.03	4.61	0.87	-4.9E-	-3.00	-0.20	-0.02	-11.5	-0.88	-1.6E-	-0.53	-0.01
Demographic												
Female [b]	-0.04	-6.43	-1.99**	-2.5E-	-1.51	-0.16	0.02	12.3	1.53	0.02	55.6	2.22**
Immigrant [b]	-0.01	-2.07	-0.47	-0.01	-5.77	-0.46	0.02	11.6	1.03	-1.0E-	-3.35	-0.10
Age (*18 – 65*)	-2.9E-	-0.48	-0.43	-8.1E-	-0.50	-0.15	0.01	2.62	0.97	-1.5E-	-5.00	-0.63
Age (squared)	2.2E-	3.7E-03	0.29	6.3E-	3.9E-03	0.11	-3.9E-	-0.02	-0.64	1.0E-	0.03	0.37
Cohabiting [c]	0.04	6.47	1.87*	-0.01	-4.62	-0.45	-0.04	-21.5	-2.46**	0.01	36.8	1.66*
Children under 14 [c]	-0.01	-1.74	-0.47	0.02	11.0	0.99	0.01	4.31	0.46	-0.02	-53.0	-2.29**
Health (*1 – 5*)	0.09	14.9	7.90***	-0.02	-15.1	-2.73***	-0.07	-33.4	-7.33***	1.0E-	3.45	0.25
Macroeconomics												
GDP growth rate (*-0.3 – 25.1*)	-1.1E-04	-0.02	-0.05	-2.2E-03	-1.33	-1.18	3.8E-03	1.91	2.05**	-1.5E-03	-4.98	-1.61
GDP PPS per inhabitant (*47 – 267*)	1.1E-03	0.18	3.28***	-2.2E-04	-0.13	-0.82	-1.0E-03	-0.52	-3.33***	1.6E-04	0.51	1.61
Log likelihood	-2,828.1											

Notes: N = 2,961; b Dummy variable. For continuous variables, dy/dx captures absolute marginal effects whereas [(dy/dx)/y]% refers to marginal effects, but expressed in relative terms with respect to predicted probabilities. In the context of dummy variables, these reflects the impact for a discrete change of the dummy variable from 0 to 1; * $0.1 > p \geq 0.05$; ** $0.05 > p \geq 0.01$; *** $p < 0.01$; The maximum correlation is 0.54 (between age and tenure), and the VIFs values (from model 4B) range from 1.07 to 1.82. Thus, multicollinearity does not pose a concern, especially in consideration of the large size of our sample; Data source: EWCS 2015.

In concordance with Hypothesis 3, we observe that the qualitative composition of the European self-employed workforce is positively influenced by GERD in terms of a higher relative weight of opportunity entrepreneurs and a lower relative weight of necessity entrepreneurs. In particular, model 2A shows as each additional PPS per inhabitant in R&D effort increases the likelihood of being an opportunity-driven entrepreneur by about 0.02% and decreases the likelihood of being a necessity-driven entrepreneur by about 0.05%. Similarly, from model 2B we also observe as each additional 1% of GDP devoted to expenditures on R&D increases the chances of being opportunity entrepreneur by about 5% and decreases the likelihood of being necessity entrepreneur by about 13%.

Other covariates are also analysed. Thus, we observe how education, tenure and the number of working hours increase the chances of being opportunity entrepreneur and decrease the likelihood of being necessity entrepreneur. As regards tenure, we find a non-linear, inverted U-shaped impact on the probability of being an opportunity entrepreneur where the quadratic term begins to dominate the linear term after 35 years of experience. In contrast, we observe a U-shaped effect on the probability of being a necessity entrepreneur where the quadratic term begins to dominate the linear term after 33 years of tenure. A similar pattern occurs for working hours. Thus, a positive (inverted U-shaped) impact on opportunity entrepreneurship probabilities is also observed for working hours, where the turning point is reached at 51 working hours per week. Conversely, the effect of working hours on the probability of being a necessity entrepreneur is observed to be negative (U-shaped), where the turning point is reached at 47 working hours per week. Stated otherwise, we observe again a positive association between working hours and the more entrepreneurial forms of self-employment. We also find that females are less likely to be opportunity entrepreneurs. Cohabitation is also positively associated with the probability of being opportunity entrepreneur and negatively associated with the likelihood of being necessity entrepreneur. The same result is observed for those reporting good health which also supports the view that an entrepreneurial career may have some health benefits. Finally, GDP per inhabitant also seems to be positively associated with the chances to be opportunity entrepreneur and negatively linked with the likelihood of being necessity entrepreneur.

Robustness checks

We performed several robustness checks. First, although we present only a few models in Tables 4–5, a complete stepwise regression approach (in which models incorporate covariates one-by-one) was followed, which serves as a robustness check for the results obtained in previous models. Second, as noted in subsections 4.2.1 and 4.2.2, all models incorporated controls for intra-countries correlation. These approaches indicate no major changes relative to simple pooled regressions (not presented for brevity). Third, the robustness of our t-statistics was verified by re-estimating them from variance–covariance matrices of the coefficients obtained by bootstrapping. And fourth, we have obtained similar results by considering national unemployment rates (Eurostat) as alternative measure of macroeconomic conditions. All results as regards these robustness checks are available upon request.

4.5. Conclusions

We investigated the impact of country R&D on the allocation of self-employment across different types, where types are identified based on two dimensions: occupational status and start-up motive. We first conducted a literature review to establish which of our identified 'types' of self-employment may be considered to be of higher 'quality' in terms of direct firm performance. This is important since the high-performing types are expected to provide a relatively bigger contribution to economy and society so policy makers may want to target especially these high-quality types. We found in our review that particularly the self-employed with employees and the opportunity self-employed can be regarded as higher performers. In addition, the descriptive statistics of our data set also revealed that, compared to their counterparts, these types of entrepreneurs were on average higher educated, worked longer hours and felt more healthy.

However, the main contribution of our paper concerns an empirical analysis which finds that the level of a country's R&D expenditures increases the shares of self-employed with employees and opportunity self-employed at the cost of the shares of dependent self-employed and necessity self-employed. Since the former types were found to be the high-performing types in our literature review, our results imply that higher R&D expenditures increase the quality of a country's self-employment population. This is an important finding as it confirms the existence of

substantial knowledge spillovers from R&D, stimulating particularly more promising forms of entrepreneurship at the cost of less promising forms.

Our paper has implications for R&D policy. Evaluation of R&D policies, either in the form of tax credits or R&D subsidies, typically focuses on the amount of additional R&D spending by private firms as a result of receiving tax credits or subsidies (Busom et al. 2014). An important measure in this regard is the 'bang for the buck', which measures the extra R&D spending per euro or dollar of subsidy or tax credit received. Evaluation studies typically find that this 'bang for the buck' is substantial and often lies between 1 and 2 (Hall and Van Reenen 2000; Mohnen and Lokshin 2010). The present study shows that R&D policy may have wider implications than stimulating private R&D investments. In particular, if successful, it may also increase the quality of self-employment in a country. Still, policy makers are advised not just to stimulate R&D levels but also to carefully consider the strictness of their Intellectual Property Rights (IPR). A fine balance is required between protecting the rights of innovators (who benefit from strict IPR) and facilitating knowledge spillovers to occur (by means of less strict IPR) (Burke and Fraser 2012).

A limitation of our study is that our data is cross-sectional in nature so that we are not able to investigate the dynamics behind the occupational choices that the respondents have made. For instance, a proportion of independent own-account workers will expand their business at a later stage to become self-employed with employees. In this regard, some own-account workers deliberately start out small using a lean start-up strategy so that they are more flexible and agile when they want to to expand later on (Burke et al. 2018). Arguably these self-employed belong to the 'high-quality' types but because our data base is a snapshot in time, we are not able to identify them as such. Another limitation concerns the aggregate nature of country R&D expenditures. Possibly, different sources of R&D expenditures (e.g. business enterprises, higher education institutions, government) may have different effects on the allocation of self-employment types.

Nevertheless, we suggest that our results are not only a good starting point for an analysis of the effect of R&D on the qualitative composition of a country's population of entrepreneurs, but they also suggest a promising avenue for further research. Thus, given that strict IPR may be favourable for innovative entrepreneurs but unfavourable for imitative entrepreneurs (Burke and Fraser 2012), it would be interesting to explore how country-level R&D, the strictness of IPR, and their interaction relate to the

'quality' and performance (i.e., earnings, survival, or employment growth) of a population of entrepreneurs. In addition, the horizons of the present enquiry could be broadened by extending the analysis to other countries and periods. Finally, future research may also focus on other country-level determinants of the allocation of entrepreneurship across different types, and on exploring different categorisations to capture the heterogeneity of self-employment.

4.6. References

Acs, Z.J., & Audretsch, D.B. (2003). Innovation and technological change. In Acs, Z.J., & Audretsch, D.B. (Eds.), *Handbook of Entrepreneurship Research* (pp. 55–79). Boston, MA: Kluwer Academic Publishers.

Acs, Z.J., & Varga, A. (2005). Entrepreneurship, agglomeration and technological change. *Small Business Economics*, 24(3), 323–334. https://doi.org/10.1007/s11187-005-1998-4.

Acs, Z.J., Audretsch, D.B., & Lehmann, E.E. (2013). The knowledge spillover theory of entrepreneurship. *Small Business Economics*, 41(4), 757–774. https://doi.org/10.1007/s11187-013-9505-9.

Acemoglu, D., Aghion, P., & Zilibotti, F. (2006). Distance to frontier, selection, and economic growth. *Journal of the European Economic Association*, 4(1), 37–74. https://doi.org/10.1162/jeea.2006.4.1.37.

Audretsch, D.B. (1995). *Innovation and Industry Evolution*. Cambridge, MA: MIT Press.

Audretsch, D.B. (2007). *The Entrepreneurial Society*. New York: Oxford University Press.

Audretsch, D.B., & Keilbach, M. (2007). The localisation of entrepreneurship capital: evidence from Germany. *Papers in Regional Science*, 86(3), 351–365. https://doi.org/10.1111/j.1435-5957.2007.00131.x.

Audretsch, D.B., & Lehmann, E.E. (2005). Does the knowledge spillover theory of entrepreneurship hold for regions?. *Research Policy*, 34(8), 1191–1202. https://doi.org/10.1016/j.respol.2005.03.012.

Baumol, W. (1990). Entrepreneurship: productive, unproductive and destructive. *Journal of Political Economy* 98(5), 893–921. Reprinted in *Journal of Business Venturing*, 11(1), 1996, 3–22. http://www.jstor.org/stable/2937617.

Belitski, M., & Korosteleva, J. (2010). Entrepreneurial activity across European cities, 50th Congress of the European Regional Science Association (ERSA), 19-23 August 2010, Jönköping, Sweden.

Blanchflower, D.G. (2004). Self-employment: more may not be better. *Swedish Economic Policy Review*, 11(2), 15–74.

Blanchflower, D.G., & Oswald, A.J. (1998). What makes an entrepreneur?. *Journal of Labor Economics,* 16(1), 26-60. https://doi.org/10.1086/209881.

Block J.H., & Sandner, P. (2009). Necessity and opportunity entrepreneurs and their duration in self-employment: evidence from German micro data. *Journal of Industry, Competition and Trade*, 9(2), 117–137. https://doi.org/10.1007/s10842-007-0029-3.

Burchell, B., Deakin, S. & Honey, S. (1999). The employment status of individuals in non-standard employment. Report for the British Department of Trade and Industry, Employment relations Research Series 6.

Burke, A.E. (2011). The Entrepreneurship Enabling Role of Freelancers: Theory with Evidence from the Construction Industry, *International Review of Entrepreneurship,* 9(3), 131–158.

Burke, A.E. (2012), The Role of Freelancers in the 21st Century British Economy, London: Centre for Research on Self-Employment (CRSE). London: CRSE. http://www.crse.co.uk/research/role-freelancers-21st-century-british-economy.

Burke, A.E, & Cowling, M. (2015). The use and value of freelancers: the perspective of managers. In Burke, A. (Ed.), *The Handbook of Research on Freelancing and Self-Employment*, chapter 1 (pp. 1–14). Dublin: Senate Hall Academic Publishers.

Burke, A.E., FitzRoy, F., & Nolan, M.A. (2000). When less is more: Distinguishing between entrepreneurial choice and performance, *Oxford Bulletin of Economics & Statistics*, 62(5), 565–587. https://doi.org/10.1111/1468-0084.00190.

Burke, A., S. Fraser (2012). Self-employment: the role of intellectual property right laws. *Small Business Economics*, 39(4), 819–833. https://doi.org/10.1007/s11187-011-9336-5.

Burke, A.E., & Vigne, S. (2018). An Economic Analysis of Freelance Workers in the Construction Industry. Centre for Research on Self-Employment (CRSE). London: CRSE. http://www.crse.co.uk/research/economic-role-freelance-workers-construction-industry.

Burke, A., Millán, J.M., Román, C., & Van Stel, A. (2018). Exploring the impact of different types of prior entrepreneurial experience on employer firm performance. *Journal of Business Research*, 90, 107-122. https://doi.org/10.1016/j.jbusres.2018.05.004.

Busom, I., Corchuelo, B., & Martínez-Ros, E. (2014). Tax incentives… or subsidies for business R&D?. *Small Business Economics*, 43(3), 571–596. https://doi.org/10.1007/s11187-014-9569-1.

Carrasco, R. (1999). Transitions to and from self-employment in Spain: an empirical analysis. *Oxford Bulletin of Economics and Statistics*, 61(3), 315–341. https://doi.org/10.1111/1468-0084.00132.

Carree, M., Thurik, R., Van Stel, A., & Wennekers, S. (2007). The relationship between economic development and business ownership Revisited. *Entrepreneurship and Regional Development*, 19(3), 281–291. https://doi.org/10.1080/08985620701296318.

Congregado, E., Millán, J.M., & Román, C. (2014). The emergence of new entrepreneurs in Europe. *International Economics* 138, 28–48. https://doi.org/10.1016/j.inteco.2014.01.002.

Cowling, M., Mitchell, P., & Taylor, M. (2004). Job creators. *The Manchester School*, 72(5), 601–617. https://doi.org/10.1111/j.1467-9957.2004.00411.x.

Crifo, P., & Sami, H. (2008). Entrepreneurship turnover and endogenous returns to ability. *Economic Modelling*, 25(4), 585–604. https://doi.org/10.1016/j.econmod.2007.10.005.

CRSE (2017). *The True Diversity of Self-Employment*. Centre for Research on Self-Employment (CRSE). London: CRSE. http://www.crse.co.uk/research/true-diversity-self-employment.

Dvouletý, O. (2017). Determinants of Nordic entrepreneurship. *Journal of Small Business and Enterprise Development*, 24(1), 12–33. https://doi.org/10.1108/JSBED-07-2016-0104.

Dvouletý, O., & Lukeš, M. (2016). Review of empirical studies on self-employment out of unemployment: do self-employment policies make a positive impact? *International Review of Entrepreneurship*, 14(3), 361–376.

Earle, J.S., & Sakova, Z. (2000). Business start-ups or disguised unemployment? Evidence on the character of self-employment from transition economies. *Labour Economics*, 7(5), 575–601. https://doi.org/10.1016/S0927-5371(00)00014-2.

Eichhorst, W., Braga, M., Famira-Mühlberger, U., Gerard, M., Horvath, T., Kahanec, M., Kahancová, M., Kendzia, M., Martišková, M., Monti, P., Pedersen, J.L., Stanley, J., Vandeweghe, B., Wehner, C., & White, C. (2013). Social protection rights of economically dependent self-employed workers. Policy Department A - Economic and Scientific Policy, European Parliament, Brussels. http://www.europarl.europa.eu/RegData/etudes/etudes/join/2013/507449/IPOL-EMPL_ET%282013%29507449_EN.pdf.

EIRO (2002). EIRO comparative study on economically dependent workers: The case of Germany. European Industrial Relations Observatory, Eurofound.

European Commission (2006). Green Paper. Modernising labour law to meet the challenges of the 21st century. Brussels. http://www.europarl.europa.eu/meetdocs/2004_2009/documents/com/com_com(2006)0708_/com_com(2006)0708_en.pdf.

Eurofound (2012). Fifth European Working Conditions Survey – Overview report, Publications Office of the European Union, Luxembourg. https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1182en.pdf. (accessed 13 October 2018).

Eurofound (2016). Sixth European Working Conditions Survey – Overview report, Publications Office of the European Union, Luxembourg. https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1634en.pdf (accessed 13 October 2018).

Eurofound (2018). European Working Conditions Survey Integrated Data File, 1991-2015. [data collection]. 6th Edition. UK Data Service. SN: 7363, http://doi.org/10.5255/UKDA-SN-7363-6.

Evans, D., & Jovanovic, B. (1989). An estimated model of entrepreneurial choice under liquidity constraints. *Journal of Political Economy*, 97(4), 519–535. https://doi.org/10.1086/261629.

Evans D.S., & Leighton L.S. (1989). Some empirical aspects of entrepreneurship. *American Economic Review*, 79(3), 519–535. http://www.jstor.org/stable/1806861.

Fuentelsaz, L., González, C., Maícas, J.P. & Montero, J. (2015). How different formal institutions affect opportunity and necessity entrepreneurship. *BRQ Business Research Quarterly*, 18(4), 246–258. https://doi.org/10.1016/j.brq.2015.02.001.

Freeman, C. (2008). *Systems of Innovation*. Cheltenham: Edward Elgar.

Hall, B., & Van Reenen, J. (2000). How effective are fiscal incentives for R&D? A review of the evidence. *Research Policy*, 29(4-5), 449–469. https://doi.org/10.1016/S0048-7333(99)00085-2.

Henrekson, M., & Johansson, D. (2010). Gazelles as job creators: a survey and interpretation of the evidence. *Small Business Economics*, 35(2), 227–244. https://doi.org/10.1007/s11187-009-9172-z.

Henrekson, M. & Sanandaji, T. (2018). Schumpeterian entrepreneurship in Europe compared to other industrialized regions. *International Review of Entrepreneurship*, 16(2), 157–182.

Holcombe, R.G. (2003). The origins of entrepreneurial opportunities. *The Review of Austrian Economics*, 16(1), 25-43. https://doi.org/10.1023/A:1022953123111.

ILO (2003). The scope of the employment relationship. Report V. International Labour Conference. 91st Session. Geneva. http://www.ilo.org/public/english/standards/relm/ilc/ilc91/pdf/rep-v.pdf.

ILO (2006). The employment relationship. Report V(1). International Labour Conference. 95th Session. Geneva. http://www.ilo.org/public/english/standards/relm/ilc/ilc95/pdf/rep-v-1.pdf.

IPSE (2014-2018). IPSE Freelancer Confidence Index Report, Quarterly reports, London: Association of Independent Professionals and Self-Employed (IPSE). London: IPSE. https://www.ipse.co.uk/resource/freelancer-confidence-index-q4-2017-pdf.html.

Kihlstrom, R., & Laffont, J.J. (1979). A general equilibrium entrepreneurial theory of the firm formation based on risk aversion. *Journal of Political Economy*, 87(4), 719–748. https://doi.org/10.1086/260790.

Kirzner, I.M. (1997). Entrepreneurial discovery and the competitive market process: an Austrian approach. *Journal of Economic Literature*, 35(1), 60–85. https://www.jstor.org/stable/2729693.

Kuhn, P. (2000). Editor's Note, *Labour Economics*, 7(5), 463–469. https://doi.org/10.1016/S0927-5371(00)00010-5.

Martin, S. (2002). *Advanced Industrial Economics. 2nd Edition*. Oxford, UK: Blackwell Publishers.

McMullen, J.S., Bagby, D.R., & Palich, L.E. (2008). Economic freedom and the motivation to engage in entrepreneurial action. *Entrepreneurship Theory and Practice* 32(5), 875–895. https://doi.org/10.1111/j.1540-6520.2008.00260.x.

Meager, N. (1992). Does unemployment lead to self-employment? *Small Business Economics*, 4(2), 87–103. https://doi.org/10.1007/BF00389850.

Millán, A., & Millán, J.M. (2017). Disclosing 'masked employees' in Europe: job control, job demands and job outcomes of 'dependent self-employed workers'. Paper presented at XII Jornadas de Economía Laboral. University of Valladolid, Spain.

Millán, A., Millán, J.M., & Román, C. (2018). Are false own-account workers less job satisfied than true ones? *Applied Economics Letters*, 25(13), 945–950. https://doi.org/10.1080/13504851.2017.1388902.

Millán, A., Millán, J.M., Román, C., & Van Stel, A. (2015). Determinants of the own-account worker's decision to hire employees: a review. *International Review of Entrepreneurship*, 13(2), 129–142. Also published in Burke, A. (Ed.), *The Handbook of Research on Freelancing and Self-Employment*, chapter 13 (pp. 147–160). Senate Hall Academic Publishing.

Millán, J.M., Congregado, E., & Román, C. (2014a). Persistence in entrepreneurship and its implications for the European entrepreneurial promotion policy. *Journal of Policy Modeling*, 36(1), 83–106. https://doi.org/10.1016/j.jpolmod.2013.10.001.

Millán, J.M., Congregado, E., & Román, C. (2014b). Entrepreneurship persistence with and without personnel: The role of human capital and previous unemployment. *International Entrepreneurship and Management Journal*, 10(1), 187–206. https://doi.org/10.1007/s11365-011-0184-1.

Millán, J.M., Hessels, J., Thurik, R., & Aguado, R. (2013). Determinants of job satisfaction: A European comparison of self-employed and paid employees. *Small Business Economics*, 40(3), 651–670. https://doi.org/10.1007/s11187-011-9380-1.

Mohnen, P., & Lokshin, B. (2010). What does it take for an R&D tax incentive policy to be effective?. In: Ghosal, V. (Ed.), *Reforming Rules and Regulations*, Cambridge, MA: MIT Press, pp. 33–58.

Mueller, P., Van Stel, A., & Storey, D.J. (2008). The effects of new firm formation on regional development over time: the case of Great Britain. *Small Business Economics*, 30(1), 59–71. https://doi.org/10.1007/s11187-007-9056-z.

OECD (2000). The Employment Outlook. OECD, Paris, chapter 5. http://www.oecd.org/els/emp/2079593.pdf.

OECD (2014). The Employment Outlook. OECD, Paris, chapter 4. http://dx.doi.org/10.1787/empl_outlook-2014-en.

OECD (2018). Self-employment rate (indicator). https://doi.org/10.1787/fb58715e-en (accessed 13 October 2018).

Parker, S.C. (2018). *The Economics of Entrepreneurship*. Cambridge University Press. https://doi.org/10.1017/9781316756706.

Perulli, A. (2003). Economically dependent / quasi-subordinate (parasubordinate) employment: legal, social and economic aspects. Study for the European Commission, Brussels. http://ec.europa.eu/social/BlobServlet?docId=2510&langId=en.

Reynolds, P., Camp, S.M., Bygrave, W.D., Autio, E., & Hay, M. (2002). Global Entrepreneurship Monitor 2001 Executive Report. Babson Park/London: Babson College and London Business School. http://unpan1.un.org/intradoc/groups/public/documents/un/unpan002481.pdf.

Román, C., Congregado, E., & Millán, J.M. (2011). Dependent self-employment as a way to evade employment protection legislation. *Small Business Economics*, 37(3), 363–392. https://doi.org/10.1007/s11187-009-9241-3.

Román, C., Congregado, E., & Millán, J.M. (2013). Start-up incentives: entrepreneurship policy or active labour market programme? *Journal of Business Venturing*, 28(1), 151–175. https://doi.org/10.1016/j.jbusvent.2012.01.004.

Santarelli, E., Vivarelli, M. (2007). Entrepreneurship and the process of firm's entry, survival and growth. *Industrial and Corporate Change*, 16(3), 455–488. https://doi.org/10.1093/icc/dtm010.

Schmitz, J. (1989). Imitation, entrepreneurship, and long-run growth, *Journal of Political Economy*, 97(3), 721–739. https://doi.org/10.1086/261624.

Schumpeter, J.A. (1912). *Theorie der Wirtschaftlichen Entwicklung* (The Theory of Economic Development). Leipzig: Dunker & Humblot; translated by Dedvers Opie. Cambridge, MA: Harvard University Press, 1934.

Sciarra, S. (2005). The evolution of labour law (1992-2003). National reports (Vol. 2). Office for Official Publications of the European Communities. https://publications.europa.eu/en/publication-detail/-/publication/6c453451-a58e-45ad-93e4-4ce438b4dd45/language-en.

Shane, S. (2009). Why encouraging more people to become entrepreneurs is bad public policy. *Small Business Economics* 33(2), 141–149. https://doi.org/10.1007/s11187-009-9215-5.

Shane, S., & Venkataraman, S. (2000). The promise of entrepreneurship as a field of research. *Academy of Management Review*, 25(1), 217–226. https://www.jstor.org/stable/259271.

Simoes, N., Crespo, N., & Moreira, S.B. (2016). Individual determinants of self-employment entry: What do we really know?. *Journal of Economic Surveys*, 30(4), 783–806. https://doi.org/10.1111/joes.12111.

Stephan, U., & Roesler, U. (2010). Health of entrepreneurs versus employees in a national representative sample. *Journal of Occupational and Organizational Psychology*, 83(3), 717–738. https://doi.org/10.1348/096317909X472067.

Supiot, A. (2001). *Beyond Employment. Changes in Work and the Future of Labour Law in Europe*. Oxford: Oxford University Press.

Terjesen, S., Bosma, N., & Stam, E. (2016). Advancing public policy for high-growth, female, and social entrepreneurs. *Public Administration Review*, 76(2), 230–239. https://doi.org/10.1111/puar.12472.

Valdez, M.E., & Richardson, J. (2013). Institutional determinants of macro-level entrepreneurship. *Entrepreneurship Theory and Practice*, 37(5), 1149–1175. https://doi.org/10.1111/etap.12000.

Van Praag, M., & Van Stel, A. (2013). The more business owners, the merrier? The role of tertiary education. *Small Business Economics*, 41(2), 335–357. https://doi.org/10.1007/s11187-012-9436-x.

Van Stel, A., Millán, A., Millán, J.M., & Román, C. (2018). The relationship between start-up motive and earnings over the course of the entrepreneur's business tenure. *Journal of Evolutionary Economics*, 28(1), 103–123. https://doi.org/10.1007/s00191-017-0499-3.

Van Stel, A., Millán, J.M., & Román, C. (2014). Investigating the impact of the technological environment on survival chances of employer entrepreneurs. *Small Business Economics*, 43(4), 839–855. https://doi.org/10.1007/s11187-014-9565-5.

Van der Zwan, P., Thurik, R., & Grilo, I. (2010). The entrepreneurial ladder and its determinants. *Applied Economics*, 42(17), 2183–2191. https://doi.org/10.1080/00036840701765437.

Venkataraman, S. (1997). The distinctive domain of entrepreneurship research. In Katz, J., & Brockhaus, R. (Eds.), *Advances in Entrepreneurship, Firm Emergence, and Growth*, vol. 3 (pp. 119–138). Greenwich, CT: JAI Press.

Wennekers, S., & Van Stel, A. (2017). Types and roles of productive entrepreneurship: a conceptual study. In Ahmetoglu, G., Chamorro-Premuzic, T., Klinger, B., & Karcisky, T. (Eds.), *The Wiley Handbook of Entrepreneurship* (pp. 37–69). Chichester, UK: John Wiley & Sons Ltd.

Appendix. Variable definitions

Variable	Description
	Dependent variables
Relative weight of different occupational statuses and start-up motives	
Occupational status	Variable equals 1 for workers who declare being self-employed with employees; 2 for workers who declare being independent own-account self-employed worker (i.e. those who declare being self-employed without employees and answer positively to the question on whether he/she generally has more than one client or customer); and 3 for workers who declare being dependent self-employed worker worker (i.e. those who declare being self-employed without employees and answer negatively to the question on whether he/she generally has more than one client or customer).
Start-up motive	Variable equals 1 for workers who declare being opportunity entrepreneur (i.e. those who declare having become self-employed mainly through own personal preferences); 2 for workers who declare being hybrid opportunity-necessity entrepreneur (i.e. those who declare having become self-employed due to a combination of both reasons: own personal preferences and no other alternatives for work); 3 for workers who declare being necessity entrepreneur (i.e. those who declare having become self-employed because had no other alternatives for work); and 4 for workers who declare being entrepreneur for other reasons (i.e. those who declare having become self-employed due to neither of these reasons). This variable is only available for wave 2015.
	Main independent variables
Expenditure on R&D	These variables include expenditure on research and development by business enterprises, higher education institutions, as well as government and private non-profit organisations. Both variables are generated for the periods 2006-10 and 2011-15 (Data source: Eurostat).
GERD PPS per inhabitant at constant 2005 prices	5 years average Gross Domestic Expenditure on R&D expressed as Purchasing Power Standards –PPS– per inhabitant at constant 2005 prices.
GERD as % of GDP	5 years average Gross Domestic Expenditure on R&D expressed as % of GDP.
	Control variables
Educational attainment	
Basic education	Dummy equals 1 for workers with less than lower secondary education (ISCED-1997, 0-1).
Secondary education	Dummy equals 1 for workers with, at least, lower secondary education but non-tertiary education (ISCED-1997, 2-4).
Tertiary education	Dummy equals 1 for workers with tertiary education (ISCED-1997, 5-6).
Job aspects	
Tenure	Years of experience in the company or organization.
Working hours	Working hours per week.
Business sector dummies	
Agriculture	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is A = Agriculture, forestry and fishing.
Industry	Dummy equals 1 for workers whose codes of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) are B = Mining and quarrying, C = Manufacturing, D = Electricity, gas, steam and air conditioning supply, and E = Water supply; sewerage, waste management and remediation activities.
Construction	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is F = Construction.
Commerce and hospitality	Dummy equals 1 for workers whose codes of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) are

	G = Wholesale and retail trade; repair of motor vehicles and motorcycles, and I = Accommodation and food service activities.
Transport	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is H = Transportation and storage.
Financial services	ımmy equals 1 for workers whose codes of main activity of the local unit of the business, means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) are K = ıancial and insurance activities, and L = Real estate activities.
Public administration and defence	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is O = Public administration and defence; compulsory social security.
Education	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is P = Education.
Health	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is Q = Human health and social work activities.
Other services	Dummy equals 1 for workers whose codes of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) are J = Information and communication, M = Professional, scientific and technical activities, N = Administrative and support service activities, R = Arts, entertainment and recreation, S = Other service activities, T = Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U = Activities of extraterritorial organisations and bodies.
Demographic characteristics	
Female	Dummy equals 1 for females.
Immigrant	Dummy equals 1 for citizens of a different country of that of residence.
Age	Age reported by the workers.
Cohabiting	Dummy equals 1 for individuals cohabiting with spouse/partner.
Children under 14	Dummy equals 1 for individuals cohabiting with any son or daughter aged under 14.
Health	Variable ranging from 1 to 5. The scale refers to the level of health declared by the worker. It equals 1 for individuals whose health is very bad and 5 for individuals whose health is very good.
Ends meet	Variable ranging from 1 to 6. The scale refers to the household ability to make ends meet. It equals 1 for households which make ends meet very easily and 6 for households which make ends meet with great difficulty.
Macroeconomic indicators	
GDP growth rate	Annual growth rate of GDP volume. Its calculation is intended to allow comparisons of the dynamics of economic development both over time and between economies of different sizes. For measuring the growth rate of GDP in terms of volumes, the GDP at current prices are valued in the prices of the previous year and the thus computed volume changes are imposed on the level of a reference year; this is called a chain-linked series. Accordingly, price movements will not inflate the growth rate (source: Eurostat).
GDP PPS per inhabitant	The volume index of GDP per inhabitant in PPS is expressed in relation to the EU28 average set to equal 100. If the index of a country is higher than 100, this country's level of GDP per head is higher than the EU average and vice versa.
Wave	
2015	Dummy equals 1 for observations corresponding to the EWCS 2015 and 0 for observations corresponding to the EWCS 2010.
Country dummies	28 dummies equaling 1 for individuals living in the named country: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom.

Chapter 5: The moderating role of IPR on the relationship between country-level R&D and individual-level entrepreneurial performance

Using recent data drawn from the European Working Conditions Survey for 32 European countries, we explore the relationship between country-level expenditures on R&D, Intellectual Property Rights (IPR), and individual-level entrepreneurial performance as measured by earnings. Our results show that both R&D expenditures and IPR are positively associated with earnings (and hence the quality) of individual entrepreneurs. However, we also find an intriguing moderation effect in the sense that IPR reduces the positive relationship between country R&D and entrepreneurial earnings. This suggests that too strict IPR legislation may hamper the diffusion of knowledge created by R&D. Hence, governments need to carefully consider the level of IPR they want to install, especially in countries with high R&D expenditures.

5.1. Introduction

Technological progress and innovation are generally considered the main determinants of economic progress and play a key role in theories of endogenous growth (Romer 1986, 1990; Aghion and Howitt 1998). In particular, in endogenous growth models, economic output is not only determined by physical capital and labour, but also by knowledge capital. Aggregate Research & Development (R&D) expenditures are often used as an empirical indicator of a country's or region's investments in the stock of knowledge capital. The higher R&D investments, the bigger the knowledge stock, the higher the chance of innovations taking place, the higher the rate of technological progress, and ultimately, the higher economic output and growth. Unfortunately, innovation is subject to market

failures (e.g., lack of full appropriability) [1] and, therefore, firms' R&D investments may be lower than what is socially desirable (Aerts and Schmidt 2008; European Commission 2017). As a consequence, governments around the world have established public support programs to stimulate innovation activities of firms, where R&D subsidies and tax credits are the most common forms, along with Intellectual Property Rights (IPR) policies (Takalo 2012; Krieger et al. 2018).

However, even if economies succeed in reaching considerable levels of R&D, higher R&D investments and a larger stock of knowledge do not automatically translate in higher economic growth. In order for a given knowledge stock to result in high rates of economic growth, it is crucial that knowledge spillovers, including imitation (Schmitz 1989), occur. Entrepreneurs play an important role in creating such knowledge spillovers, for instance by leaving an incumbent firm and starting their own new firms, exploiting the new knowledge obtained in the incumbent firm (Audretsch and Keilbach 2004; Acs et al. 2013; Erken et al. 2018). However, the ease with which such knowledge spillovers may occur will depend on the strictness of IPR. Hence, although strict IPR increases the incentives to innovate, as it enhances appropriation of the returns to innovation, it may restrict the amount of knowledge spillovers. If the law makes it very difficult to re-use knowledge in different firms from where the knowledge was created (e.g. imitation), knowledge will less easily be diffused, thereby hampering economic progress. This may be especially relevant in countries with high R&D levels, as a bigger knowledge stock implies a higher level of potential spillovers.

All in all, although higher levels of R&D and stricter IPR are generally considered to be benign circumstances to achieve high rates of technological and economic progress (at the macro level) as well as strong entrepreneurial performance (at the individual level), it is not straightforward that the performance of all individual entrepreneurs is positively related to R&D and IPR. This is because strict IPR may be favourable for innovative entrepreneurs but unfavourable for imitative entrepreneurs (Burke and Fraser 2012). Thus, as the quality of the entrepreneurship sector (as approximated by average entrepreneurial performance) is important for achieving economic growth (Acs 2006), it is important to know more about the relationship between these variables. However, an analysis of how country-

[1] Other market failures (in the form of entry barriers) include high risks and sunk costs, scientific, technological and market uncertainty, and unavailability of appropriate financing (European Commission 2017).

level R&D, the strictness of IPR, and their interaction relate to the performance of individual entrepreneurs is lacking to date.

Addressing this research gap is precisely the main aim of this work—that is, analysing the how the interplay between country R&D and IPR laws affect the performance of individual entrepreneurs by using (i) a generally accepted measure of entrepreneurial performance such as earnings; (ii) macro-level measures of R&D investments and IPR protection; (iii) a geographical coverage as wide as 32 European countries, including the EU-28 member states; and (iv) the most recent international microdata available (5th and 6th waves of the European Working Conditions Survey for 2010 and 2015).

The contribution of our paper is as follows. Although it is widely recognised that entrepreneurship and innovation are strongly related (Erken et al. 2018), the two topics are still often investigated separately. This is especially true when different units of observation are concerned. In the present paper we bring together two strongly related streams of research which are still typically investigated in isolation. These are the (macro-level) literature on national systems of innovation and the (micro-level) entrepreneurship literature focusing on the individual. Regarding the former stream, we focus on macro-level R&D (which in this paper is used as a measure of entrepreneurial innovation), IPR (as a measure of technology transfer policy), and individual earnings from entrepreneurship. The last measure is an established indicator of the success and quality of entrepreneurship (Van Praag 2005; Millán et al. 2014). High-quality entrepreneurship is increasingly deemed important in policy circles as it becomes more and more clear that only a minority of entrepreneurs are of considerable quality in the sense of contributing significantly to macro-economic development and job creation (Acs 2006; Shane 2009; Henrekson and Sanandaji 2018). Hence, the current paper contributes to extant literature by investigating how entrepreneurial innovations at the macro level (as measured by R&D expenditures) influences the quality of entrepreneurship at the micro level (as measured by entrepreneurial earnings), and how this relationship is moderated by technology transfer policy (as measured by the strictness of IPR legislation). To the best of our knowledge, this paper is the first to investigate how technology transfer policy influences the quality of individual entrepreneurs in a country, and how the effectiveness of such policy depends on the level of investments in a country's knowledge stock.

The following set-up is used in the paper. In Section 2 we first describe the general context of entrepreneurial innovation policy in Europe, includ-

ing IPR policy. Next, we discuss the impact of the strictness of IPR legislation on the economy and, finally we derive hypotheses regarding the relationship between country-level expenditures on R&D, IPR legislation and individual-level entrepreneurial performance. We then test these hypotheses making use of the 2010 and 2015 waves of the European Working Conditions Survey. This database and the variables that we employ from it are discussed in Section 3. Section 4 describes our methods of analysis while Section 5 describes the empirical results. Section 6 discusses implications for various stakeholders while Section 7 concludes.

5.2. Background and hypotheses

Contextualization: fostering entrepreneurial innovations in the European context

Maintaining a considerable level of R&D expenditures is crucial for economies. In this sense, the most common programs to activate innovation in firms are R&D subsidies, R&D tax credits and IPR policies. R&D subsidies encourage innovation directly (i.e., via direct investments) or indirectly (i.e., via loans). The effect comes through two channels. First, the subsidy itself reduces financial costs to carry out the innovation. Second, the observation that an entrepreneur has received a subsidy for an innovation project provides an informative signal to the market-based financier (Takalo and Tanayama 2009). As regards R&D tax credits, this incentive should raise the cash flow in the period R&D is undertaken by reducing the tax due in the specific period (Elschner et al. 2011). Finally, IPRs are aimed to provide protection to innovators by guaranteeing their economic rents (Acs and Sanders 2012). Other policies like prizes and contests, and public procurement and production are also used but to a lesser extent (Takalo 2012).

Public support to R&D investment in the European context has experienced substantial increases since 2007 when the European Commission launched its 7th Framework Programme for Research and Technological Development, or abbreviated FP7. [2] Thus, with a total budget of over € 50 billion and covering the period 2007-13, the programme has provided grants to research actors all over Europe and beyond, in order to co-finance

[2] More information about FP7 is available at https://ec.europa.eu/research/fp7/index_en.cfm.

research, technological development and demonstration projects. The 8th programme's name has been modified to Framework Programme for Research and Innovation, or abbreviated Horizon 2020, which covers the period 2014-20. The budget has raised to about € 77 billion and the focus is now on innovation, delivering economic growth faster and delivering solutions to end users that are often governmental agencies. [3] Some illustrative projects within these frameworks are Copernicus, i.e., the European Earth Observation Programme;[4] IMPETUS, i.e., the Information Management Portal to Enable the integraTion of Unmanned Systems;[5] or OpenAIRE, i.e., a network of open access repositories, archives and journals that support Open Access policies.[6] Finally, the research initiative meant to succeed the current Horizon 2020 program is the 9th programme Horizon Europe, which has drafted to raise spending levels by 50% to approximately €100 billion over the years 2021-2027. [7] As part of its challenges, this new framework will support programs to encourage disruptive innovation and technology diffusion.

Indeed, the EU-28 Gross Domestic Expenditure on R&D (GERD) accounted for about 1.9% of its GDP in 2016 (OECD 2018). [8] The Figure 1 below shows the international evolution of GERD for selected economies.

[3] More information about Horizon 2020 is available at https://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020.

[4] More information about Copernicus is available at https://ec.europa.eu/growth/sectors/space/copernicus_en.

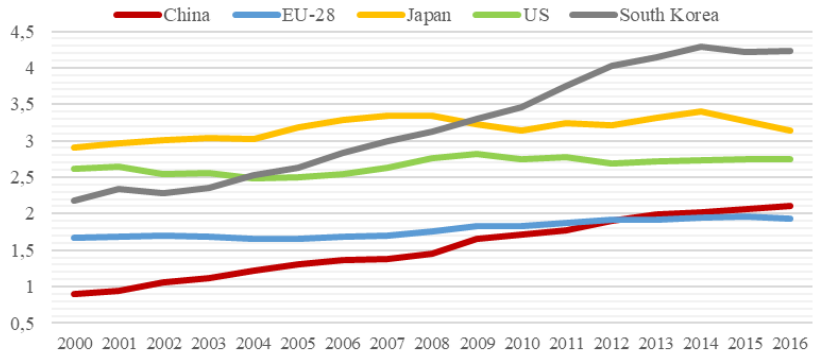
[5] More information about IMPETUS is available at http://impetus-research.eu.

[6] More information about OpenAIRE is available at https://www.openaire.eu.

[7] More information about Horizon Europe is available at https://ec.europa.eu/info/designing-next-research-and-innovation-framework-programme/what-shapes-next-framework-programme_en.

[8] This figure varies substantially across European countries and is correlated with the level of economic development of the country's economy. Thus, this figure rises above 2.5% in countries like Sweden, Austria, Germany, Denmark, and Finland. By contrast, this figure lies below 1% in countries such as Poland, Turkey, and Slovakia, Romania and Latvia (OECD 2018). This large cross-country variation can also be observed in Table 1 in Section 3.3.

Fig. 1. GERD as % of GDP for selected economies, 2000-16



Source: OECD Science, Technology and R&D Statistics: Main Science and Technology Indicators.

We can observe that the EU lags behind its major competitors when it comes to investment in knowledge generation. In addition, the positive relationship between R&D investment and productivity growth in Europe has become significantly weaker (Andrews et al. 2015), with a deceleration in the diffusion of innovation from productivity leading companies to lagging companies as one of its plausible drivers (Andrews et al. 2015; European Commission 2017).

Therefore, the existing evidence on the European productivity slowdown calls for a better understanding of the knowledge diffusion processes and its potential obstacles, including the existing IPR laws, as a fundamental piece of the technology transfer policy.

IPR and its effects on the economy

Similar to what was observed for R&D investment, the strictness of IPR protection varies severely across geographies and also seems closely related to countries' levels of economic development. [9] However, although stronger levels of IPR protection should encourage technological and economic progress by stimulating the creation of knowledge, it can also limit the spread of new ideas and encourage monopoly (Falvey et al. 2006). Otherwise stated, the effect of stricter IPR on relevant economic outcomes such as growth, productivity, and innovation is not straightforward. In-

[9] See Table 1 in Section 5.3.3.

deed, the impact of IPR protection on these outcomes is likely to vary with a country's income level.

Concerning economic progress, Thompson and Rushing (1996) find a positive and significant relationship between IPR protection and growth in countries with a level of GDP above a certain threshold whereas the relationship is not significant for countries below this level. In a later study, Thompson and Rushing (1999) obtain similar results when analysing the relationship between IPR and total factor productivity. However, Falvey et al. (2006) observe how stronger IPR protection significantly improves growth for high income countries and low income countries but such relationship is not found for middle-income countries. Falvey et al. consider results for high-income countries largely as expected; these countries undertake the vast majority of innovation and strong IPR protection should encourage further innovation by allowing innovators to profit from their inventions. However, technology transfer occurs through other channels for middle-income countries; strong IPR protection encourages imports and inward foreign direct investment from advanced countries that would enhance economic growth without adversely affecting domestic imitative activities.

As regards innovation, Park and Ginarte (1997) find that strictness of IPR explains only the physical and research capital investment behavior of the top 30 economies whereas this relationship is not significant for the lower developed countries. These authors suggest that IPRs affect economic growth by stimulating the accumulation of factor inputs like research and development capital and physical capital. This implies that countries not conducting innovative research or conducting a limited amount would enjoy few, if any, of the benefits of IPR protection because an innovation sector through which IPRs affect economic growth is absent. The same result is obtained by Schneider (2005) for developed countries. However, the positive impact turns to a negative impact for developing countries, possibly because an innovation sector is lacking while at the same time imitation is hampered. Finally, Furman et al. (2002) and Xu and Chiang (2005) concentrate on the relationship between IPR protection and the inflow of foreign patents, which is also observed to be stronger for high-income countries.

Hypotheses derivation

Now that the scenario of policies fostering entrepreneurial innovations has been presented and its complex relationships have been discussed, this

section is aimed to derive three hypotheses regarding the interrelations between the country-level R&D investment (as our proxy of entrepreneurial innovation), the strictness of IPR (as a measure of technology transfer policy) and individual entrepreneurial performance in terms of earnings (as indicator of the success and quality of entrepreneurship).

In this sense, higher R&D investments at country level are associated with a higher rate of technological progress of the economy. If entrepreneurs have the possibility to work with more sophisticated technology, it will be easier for them to make profits, for instance if unit costs are lower as a result of labour-saving technological progress. In this regard, Deeds (2001) observes how the R&D intensity of a high technology venture is positively related to the amount of entrepreneurial wealth created by the venture. Similarly, Hall et al. (2010) observe how for every 100 euros a company invests in R&D, the net benefit it obtains is between 10 and 30 euros for every year the R&D investment is considered not to have become obsolete.

In addition, the rate of return on R&D investment for an economy (i.e., the social rate of return) has been estimated to be much larger (up to two to three times higher) than the return a company achieves due to positive spillover effects (Coe-Helpman 1995; Kao et al. 1999). In this sense, higher R&D levels are associated with a bigger knowledge stock entrepreneurs can draw from. The bigger knowledge stock implies a higher level of potential knowledge spillovers which also increase entrepreneurial opportunities to make profits. Venture capitalists, for instance, look out for such entrepreneurial opportunities and the concentration of knowledge in a region due to the positive effects on start-ups (Mueller 2007). In this sense, the presence of venture capital financing is associated with the acceleration of the innovation and commercialization process accompanied by better firm performance (i.e., greater growth in wages and scale; Kelly and Kim 2018). All in all, governments and policy makers are interested in building innovation clusters to attract entrepreneurial firms, due to the value added and the positive knowledge spillover effects for the regions concerned (Colombelli and Quatraro 2018; Lehmann and Menter 2018). The above arguments lead to the following hypothesis:

Hypothesis 1: Country-level R&D expenditures are positively related to individual-level entrepreneurial earnings

Turning our attention to IPR, its impact on entrepreneurial earnings is twofold. Stricter IPR is positively related to innovation creation as it will make it easier for entrepreneurs to appropriate the returns to their innovations. This, in turn, will have a positive effect on earnings of (innovative) entrepreneurs. Previous research suggests that this positive relationship holds in particular for high-income countries (Thompson and Rushing 1996, 1999; Falvey et al. 2006). [10] On the other hand, stricter IPR is negatively related to innovation access as such strict legislation will make it more difficult for entrepreneurs to make use of innovations created elsewhere (Burke and Fraser 2012). This, in turn, will have a negative effect on earnings of (imitative) entrepreneurs. Policy, then, must solve a difficult trade-off between incentives for innovation and the need to encourage diffusion (Denicolò and Franzoni 2012). In this regard, the study by Burke and Fraser (2012) is informative as they estimate the effects of various IPR-related variables on self-employment rates (as a rough indicator of entrepreneurial opportunities) across a sample of predominantly high-income countries. Although they find that patent activity has a negative effect on self-employment, overall they find that more extensive and strong IPR laws have a net positive effect on self-employment activity. According to Burke and Fraser (2012), this indicates that "positive market opportunity creation effects outweigh negative technology cost/access effects for most of the self-employed sector" (p. 830). Based on their analysis, we expect the positive effects of IPR to dominate. Hence, we hypothesize the following:

Hypothesis 2: Stricter IPR legislation is positively related to individual-level entrepreneurial earnings

Too strict IPR legislation may hamper the diffusion of knowledge created by R&D. This may be especially harmful in countries with high R&D levels, as a bigger knowledge stock implies a bigger flow of potential knowledge spillovers. In such circumstances, a lower level of IPR may be instrumental in actually realising these potential spillovers, i.e. less strict IPR may facilitate not only (earnings from) imitative entrepreneurship but also innovative entrepreneurship that wishes to build further on the earlier innovations made in other firms (Burke and Fraser 2012). Furthermore, under these circumstances, entrepreneurs possessing valuable intellectual property are pushed to grow their ventures quickly as a way to combat misappropriation (Autio and Acs 2010). In contrast, for countries with lower R&D levels, i.e. smaller knowledge stocks, potential

[10] Note that the present paper focuses on high-income (i.e. European) countries.

spillovers are also smaller and hence the amount of potential spillovers foregone by high IPR, is also smaller. Based on the foregoing reasoning, we suggest the following hypothesis:

Hypothesis 3: The positive relationship between country-level R&D expenditures and individual-level entrepreneurial earnings is weaker in economies with strict IPR than in economies with weak IPR.

To the best of our knowledge, however, a conditional analysis on the relationship between country expenditures on R&D, the level of IPR and individual entrepreneurial performance does not exist to date. Addressing this drawback of the literature is the main aim of this work—that is, filling the existing research gap by particularly analysing the moderating role of the strictness of IPR legislation on the relationship between country-level expenditures on R&D and individual-level entrepreneurial earnings by using (i) a generally accepted measure of performance: earnings; (ii) a wide geographical coverage of many European countries, including the EU-28; and (iii) the most recent international microdata available (5th and 6th waves of the European Working Conditions Survey for 2010 and 2015).

5.3. Data and variables

Data and sample

We use data from the Fifth and Sixth waves of the European Working Conditions Survey –EWCS 2010 and 2015– (Eurofound 2012, 2016). This survey is carried out every five years by the EU Agency Eurofound (European Foundation for the Improvement of Living and Working Conditions)[11] and offers key work-related information on 44,000 workers (including both employees and self-employed individuals) covering 35 European countries. [12] These workers are interviewed about several working condition aspects, including physical environment, workplace design, working hours, work organization and social relationships in the work-

[11] This Foundation is an autonomous body of the European Union, created to assist in the formulation of future policy on social and work-related matters. Further information can be found at www.eurofound.europa.eu.

[12] This set includes the EU-28 together with 5 candidate countries (Albania, the Former Yugoslav Republic of Macedonia, Montenegro, Serbia and Turkey) and 2 EFTA countries (Norway and Switzerland).

place. Depending on country size and national arrangements, the sample ranges from 1,000 to 4,000 workers per country.

Our final sample includes men and women aged 18 to 65 who are classified as self-employed individuals within the EU-28 territory, 2 candidate countries (Serbia and Turkey) and 2 EFTA countries (Norway and Switzerland). All individuals working part-time, i.e., working under 15 hours per week, are excluded. The final dataset, after removing cases with missing data for any of the relevant variables, yields 6,300 observations.

Dependent variables

We are interested in explaining how country-level R&D and IPR affect the business performance of entrepreneurs in terms of earnings. To this end, we employ the variable 'net monthly earnings'. Workers in the EWCS are asked to refer to his/her average net earnings in recent months and, in case he/she doesn't know, are asked to give an estimate. [13] The variable is defined in PPP dollars of 2015 and converted to natural logarithms.

Main independent variables

Expenditure on R&D

The fundamental role of technological activities, as drivers of entrepreneurial success and hence of economic development, urges countries to promote innovation in their economies (Van Stel et al. 2014). Therefore, in order to capture the presence and commitment to technological effort and innovation activities in each of the considered economies, our regressions include the Gross Domestic Expenditure on R&D (GERD) for periods 2010 and 2015. This indicator includes expenditures by business enterprises, higher education institutions, as well as government and private non-profit organisations. In order to make fairer comparisons between countries, Eurostat provides this information expressed as Purchasing Power Standards –PPS– per inhabitant at constant 2005 prices. [14]

[13] The interviewer is asked to explain, if necessary, that net monthly earnings are the earnings at one's disposal after taxes and social security contributions.

[14] PPS is the technical term used by Eurostat for the common (artificial) currency in which national accounts aggregates are expressed when adjusted for price level differences using PPPs. Thus, PPPs can be interpreted as the exchange rate of the PPS against the €.

Intellectual property rights

The quality of institutions has a strong bearing on competitiveness and growth (Easterly and Levine 1997; Acemoglu et al. 2001, 2002). Thus, it influences investment decisions and the organization of production and plays a key role in the ways in which societies distribute the benefits and bear the costs of development strategies and policies. For example, owners of land, corporate shares, or intellectual property are unwilling to invest in the improvement and upkeep of their property if their rights as owners are not protected (De Soto 2000). With the purpose of capturing the strictness of IPR protection in each economy in our sample, our specifications incorporate the Intellectual Property Protection indicator (IPP) for periods 2010 and 2015 from the World Economic Forum's Executive Opinion Survey (WEF-EOS; Browne et al. 2014). [15] IPP is evaluated on a scale of 1 to 7, from extremely weak to extremely strong protection.

Table 1 below shows figures as regards these macroeconomic indicators for countries and periods in our sample. Information about national unemployment rates is also provided.

Table 1: GERD, IPP and unemployment rates for 32 European countries

	GERD *PPS per inhabitant*				IPP				Unemployment Rate			
Country	**Rank#**	**2010**	**Rank#**	**2015**	**Rank#**	**2010**	**Rank#**	**2015**	**Rank#**	**2010**	**Rank#**	**2015**
Austria	5	852	3	987	4	6.07	9	5.51	3	4.8	6	5.7
Belgium	9	602	9	733	13	5.27	12	5.29	14	8.3	16	8.5
Bulgaria	31	60	27	114	32	2.63	31	3.02	20	10.3	19	9.2
Croatia	27	99	28	114	28	3.51	28	3.61	23	11.8	29	16.1
Cyprus	26	108	29	103	14	4.75	17	4.35	6	6.3	28	15.0
Czech Republic	18	275	15	428	21	4.02	20	3.92	11	7.3	4	5.1
Denmark	6	838	5	880	5	5.99	13	5.28	12	7.5	8	6.2
Estonia	19	221	18	252	16	4.61	14	4.94	28	16.7	9	6.2
Finland	2	1034	8	784	2	6.09	1	6.19	15	8.4	20	9.4
France	10	574	11	597	8	5.81	6	5.60	18	9.3	24	10.4
Germany	7	790	4	929	9	5.72	11	5.41	7	7.0	3	4.6
Greece	21	126	25	171	20	4.14	21	3.86	25	12.7	32	24.9
Hungary	20	165	21	221	23	3.88	26	3.69	22	11.2	12	6.8
Ireland	12	518	12	545	11	5.57	7	5.60	27	14.6	22	10.0
Italy	17	301	16	313	22	3.91	25	3.69	16	8.4	26	11.9
Latvia	29	74	30	96	26	3.65	19	4.00	31	19.5	21	9.9
Lithuania	24	108	23	187	24	3.80	22	3.83	29	17.8	18	9.1
Luxembourg	4	911	7	798	6	5.93	2	6.08	2	4.6	10	6.5
Malta	22	124	22	191	18	4.39	16	4.52	9	7.3	7	5.9
Netherlands	11	573	10	680	7	5.84	5	5.70	5	5.0	13	6.9

[15] The WEF-EOS draws on the views of over 14,000 executives in over 140 economies and captures valuable information on a broad range of factors that are critical for a country's competitiveness and sustainable development, and for which data sources are scarce or, frequently, non-existent on a global scale. Among several examples of otherwise unavailable data are the quality of the educational system, indicators measuring business sophistication, and labor market variables such as flexibility in wage determination. The Survey results are used in the calculation of the *Global Competitiveness Index* (GCI) and other indexes of the WEF. Further information about WEF can be found at https://www.weforum.org. Further information about the GCI can be found at https://www.weforum.org/reports/the-global-competitiveness-report-2017-2018.

Norway	8	668	6	802	10	5.66	8	5.57	1	3.5	2	4.3
Poland	25	108	24	174	27	3.58	24	3.75	19	9.7	15	7.5
Portugal	16	303	19	240	15	4.61	15	4.57	24	12.0	27	12.6
Romania	32	45	32	57	29	3.38	30	3.35	8	7.0	11	6.8
Serbia	30	64	31	78	30	2.77	32	2.88	30	19.2	30	17.9
Slovakia	23	109	20	235	25	3.73	23	3.78	26	14.5	25	11.5
Slovenia	14	446	14	482	17	4.49	18	4.06	10	7.3	17	9.0
Spain	15	315	17	282	19	4.31	29	3.58	32	19.9	31	22.1
Sweden	3	971	2	1050	1	6.11	10	5.46	17	8.6	14	7.4
Switzerland	1	1052	1	1090	3	6.08	3	6.04	4	4.8	1	4.1
Turkey	28	89	26	129	31	2.68	27	3.66	21	10.7	23	10.2
United Kingdom	13	453	13	485	12	5.33	4	5.94	13	7.8	5	5.3
EU-32 (unweighted)		***405***		***445***		***4.63***		***4.59***		***10.1***		***9.6***

Notes: Countries are ranked from higher to lower GERD, from strict to weak IPP legislation and from lower to higher unemployment rate; *Data source*: Eurostat, World Economic Forum and World Bank.

Control variables

In order to isolate the effect of our hypotheses-related variables, the empirical models also include a set of explanatory variables that are known to influence self-employment earnings (see e.g. Hamilton 2000; Millán et al. 2014; Van Stel et al. 2018; Parker 2018): a distinction between self-employed with and without employees, educational attainment, job-related aspects (tenure, working hours, business sector) and some demographic indicators (gender, immigrant, age, cohabitation status, children, health status). Furthermore, in order to control for the business cycle and some structural differences between countries, the empirical models also include the national unemployment rates for periods 2010 and 2015, which we collect from Eurostat and the World Bank, and a period 2015 (vs. 2010) dummy. We refer to the Appendix for all variable descriptions.

5.4. Methodology

Regarding earnings from self-employment, a considerable proportion of observations are zeros in some human population surveys (see e.g. Van Stel et al. 2018). In these cases the entrepreneur either only earns just enough to cover business expenses or might suffer losses (which are censored). This feature violates the linearity assumption so that the least squares method is inappropriate. As usual under these circumstances, earnings equations are estimated by means of tobit models (Tobin 1958). This feature does not occur in our sample though and, hence, OLS regressions are used in order to estimate earnings from self-employment.

5.5. Results

Descriptive analysis

We aim to explore how self-employed workers compare depending on the country-level GERD and IPP. Table 2 below compares self-employed workers in countries which' GERD and IPP are above and below the unweighted average levels for the 32 countries in our sample during the periods 2010 and 2015 (these benchmarks are 425 for GERD and 4.62 for IPP).

Table 2. Descriptive statistics

Countries	*All*		*High GERD*		*Low GERD*		*Strict IPP*		*Weak IPP*	
# observations	N = 6,300		N = 2,484		N = 3,816		N = 2,409		N = 3,891	
Variables	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Dependent variable										
Net monthly earnings - PPP $ of 2015 (*1 – 55,211*)	2,211	2,032	2,882	2,458	1,775	1,549	2,944	2,464	1,758	1,545
Entrepreneurship types										
Self-employed with employees [a]	0.311		0.348		0.287		0.359		0.281	
Own-account self-employed worker [a]	0.689		0.652		0.713		0.641		0.719	
Educational attainment										
Basic education [a]	0.110		0.028		0.163		0.044		0.151	
Secondary education [a]	0.608		0.584		0.623		0.557		0.639	
Tertiary education [a]	0.283		0.388		0.214		0.400		0.210	
Job aspects										
Tenure (*1 – 53*)	12.8	10.5	12.6	10.7	12.9	10.3	12.8	10.7	12.8	10.3
Working hours (*15 – 98*)	47.0	15.3	45.0	14.2	48.3	15.8	44.8	14.2	48.4	15.8
Business sector dummies										
Agriculture [a]	0.170		0.105		0.213		0.099		0.214	
Industry [a]	0.100		0.088		0.108		0.080		0.112	
Construction [a]	0.108		0.129		0.095		0.136		0.091	
Commerce and hospitality [a]	0.267		0.215		0.301		0.222		0.295	
Transport [a]	0.043		0.040		0.045		0.039		0.045	
Financial services [a]	0.029		0.038		0.024		0.038		0.024	
Public administration and defence [a]	0.002		0.003		0.002		0.002		0.002	
Education [a]	0.015		0.019		0.012		0.020		0.012	
Health [a]	0.047		0.085		0.022		0.087		0.022	
Other services [a]	0.219		0.279		0.179		0.277		0.182	
Demographic characteristics										
Female [a]	0.339		0.340		0.339		0.342		0.337	
Immigrant [a]	0.105		0.174		0.061		0.171		0.065	
Age (*18-65*)	44.2	11.2	45.7	10.8	43.3	11.3	46.0	10.8	43.2	11.3
Cohabiting [a]	0.729		0.725		0.731		0.729		0.729	
Children under 14 [a]	0.319		0.328		0.314		0.323		0.317	
Health (1-5)	3.98	0.76	4.09	0.76	3.91	0.76	4.09	0.76	3.92	0.76

Notes: [a] Dummy variable. Data source: EWCS 2010, 2015

We first explore earnings. We observe how earnings for self-employed are far higher in countries with high GERD than in countries with low GERD, which supports our Hyphotesis 1. Similarly, earnings from self-employment are also far higher in countries with strict IPP than in countries with weak IPP, which is consistent with our Hypothesis 2.

We also observe in our sample that, compared with self-employed in countries with low GERD and weak IPP, self-employed in countries with high GERD and strict IPP, respectively, have more often employees, higher levels of educational attainment, and they work shorter hours. Furthermore, they work more often in construction, financial services, education and health. Finally, they are also more often immigrants, older, with partner, and feeling healthier.

Multivariate analysis

Although our univariate analysis seems to support the validity of some of our hypotheses, a conditional analysis is needed to draw robust conclusions. Table 3 in subsection 5.2.1 shows the results from 6 models as regards net monthly earnings and their main predictors, with special focus on country-level GERD and IPP. These results are presented as follows. Average predicted earnings are indicated at the top of each specification. These predicted earnings help to understand the relative importance of our marginal effects presented below. Thus, each specification is presented in a two-column format. The first column shows semi-elasticities in the form of [(dy/dx)/y]%., i.e., percentage changes of earnings caused by unit changes of the respective explanatory variables, whereas t-statistics associated with these effects are presented in the second column. Finally, section 5.2.2 presents some robustness checks which are part of the analysis.

Results

Table 3 shows the estimation results from 6 specifications, Models 1 to 6, which are aimed to test our earnings-related hypotheses.

Table 3. Determinants of net monthly earnings –OLS Linear regressions–

# Model	**1**		**2**		**3**	
Countries	*All*		*All*		*All*	
Average predicted earnings (y) *–in PPP $ of 2015–* [a]	2,211		2,211		2,211	
Independent variables (*x*)	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy/dx}{y}$ %	t-statistic
Hypotheses related variables						
GERD PPS per inhab. ('00) [b] (*0.45 – 10.90*)			6.23	17.2***		
IPP (*2.63 – 6.19*)					14.8	14.8***
Strict IPP (> 4.62) [c]						
GERD x Strict IPP						
Entrepreneurship types						
Self-employed with employees [c]	30.7	16.6***	30.6	15.8***	31.1	16.0***
Own-account self-employed worker [c] (*ref.*)						
Educational attainment						
Basic education [c] (*ref.*)						
Secondary education [c]	28.2	8.99***	17.7	5.85***	19.1	6.31***
Tertiary education [c]	52.3	14.7***	43.0	12.3***	42.5	12.0***
Job aspects						
Tenure (*1 – 53*)	1.18	4.38***	1.53	5.43***	1.62	5.71***
Tenure (squared)	-0.02	-3.00***	-0.02	-3.00***	-0.02	-3.31***
Working hours (*15 – 98*)	2.96	11.8***	2.96	11.3***	3.05	11.5***
Working hours (squared)	-0.02	-9.40***	-0.02	-9.06***	-0.02	-9.18***
Business sector dummies						
Agriculture [c]	-46.2	-13.3***	-52.7	-14.8***	-51.0	-14.2***
Industry [c]	-14.0	-3.83***	-16.1	-4.22***	-13.2	-3.44***
Construction [c] (*ref.*)						
Commerce and hospitality [c]	-17.6	-5.71***	-17.9	-5.60***	-15.9	-4.91***
Transport [c]	-0.75	-0.16	1.16	0.24	1.79	0.36
Financial services [c]	18.8	3.42***	23.1	4.01***	26.2	4.53***
Public administration and defence [c]	-45.4	-2.59***	-50.6	-2.74***	-46.8	-2.52**
Education [c]	-7.48	-1.02	0.61	0.08	0.18	0.02
Health [c]	21.6	4.42***	21.2	4.16***	25.6	4.99***
Other services [c]	-3.33	-1.03	-4.11	-1.21	-1.11	-0.32
Demographic characteristics						
Female [c]	-26.3	-13.8***	-29.2	-14.8***	-29.5	-14.9***
Immigrant [c]	-6.24	-2.19**	-7.51	-2.61***	-7.40	-2.55**
Age (*18 – 65*)	2.12	3.46***	1.52	2.38**	1.27	1.98**
Age (squared)	-0.02	-3.24***	-0.02	-2.48**	-0.02	-2.09**
Cohabiting [c]	5.91	2.84***	5.94	2.72***	5.49	2.50**
Children under 14 [c]	1.19	0.57	2.51	1.14	3.07	1.38
Health (1 – 5)	7.81	6.78***	10.1	8.52***	9.82	8.20***
Business cycle						
Unemployment rate (*3.5 – 24.9*)			-0.45	-2.13**	-0.72	-3.39***
Wave						
2015 [c]	-4.39	-2.49 **	-4.53	-2.52**	-0.88	-0.49
Country dummies	*Yes*		*No*		*No*	

# Model	**4**		**5**		**6**	
Countries	*All*		*Strict IPP*		*Weak IPP*	
Average predicted earnings (y) *–in PPP $ of 2015–* [a]	2,211		2,944		1,758	
Independent variables (*x*)	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy/dx}{y}$ %	t-statistic	$\frac{dy/dx}{y}$ %	t-statistic
Hypotheses related variables						
GERD PPS per inhab. ('00) [b] (*0.45 – IPP (2.63 – 6.19*)	7.49	7.10***	1.73	2.58***	8.58	8.20***
Strict IPP (> 4.62) [c]	28.4	5.69***				
GERD x Strict IPP	-4.21	-3.50***				
Entrepreneurship types						
Self-employed with employees [c]	30.4	15.8***	29.4	9.44***	29.4	12.00***
Own-account self-employed worker [c]						
Educational attainment						
Basic education [c] (*ref.*)						
Secondary education [c]	17.6	5.83***	54.3	7.44***	5.98	1.81*
Tertiary education [c]	41.6	11.9***	75.2	9.99***	31.9	7.71***
Job aspects						
Tenure (*1 – 53*)	1.58	5.61***	1.09	2.40**	1.80	5.11***
Tenure (squared)	-0.02	-3.30***	-0.01	-1.22	-0.03	-3.28***
Working hours (*15 – 98*)	3.00	11.4***	3.19	6.96***	3.09	9.61***
Working hours (squared)	-0.02	-9.07***	-0.03	-5.66***	-0.02	-7.92***
Business sector dummies						
Agriculture [c]	-50.4	-14.1***	-35.3	-5.66***	-54.2	-12.1***
Industry [c]	-14.6	-3.82***	-21.5	-3.36***	-10.7	-2.26**
Construction [c] (*ref.*)						
Commerce and hospitality [c]	-16.7	-5.21***	-28.7	-5.69***	-10.8	-2.61***
Transport [c]	1.98	0.40	0.87	0.11	2.61	0.43
Financial services [c]	24.1	4.20***	22.0	2.62***	25.6	3.28***
Public administration and defence [c]	-50.4	-2.73***	0.27	0.01	-86.5	-3.66***
Education [c]	0.98	0.13	0.14	0.01	-5.27	-0.49
Health [c]	22.3	4.37***	21.5	3.14***	23.4	2.84***
Other services [c]	-2.91	-0.86	-5.54	-1.10	-2.09	-0.46
Demographic characteristics						
Female [c]	-29.0	-14.7***	-31.8	-9.71***	-26.5	-10.9***
Immigrant [c]	-8.28	-2.88***	-3.70	-0.96	-11.7	-2.67***
Age (*18 – 65*)	1.36	2.13**	4.33	3.89***	0.22	0.28
Age (squared)	-0.02	-2.26**	-0.04	-3.37***	-0.01	-0.83
Cohabiting [c]	5.98	2.75***	9.37	2.70***	4.54	1.64
Children under 14 [c]	2.21	1.00	4.30	1.19	0.03	0.01
Health (1 – 5)	9.72	8.18***	5.58	2.89***	12.45	8.34***
Business cycle						
Unemployment rate (*3.5 – 24.9*)	-0.21	-0.97	-2.11	-3.34***	0.25	1.08
Wave						
2015 [c]	-3.49	-1.92*	1.00	0.33	-9.10	-4.01***
Country dummies	*No*		*No*		*No*	

Notes: N = 6,300 for models 1-4; N = 2,409 for model 5; N = 3,891 for model 6; [a] Our dependent variable is the natural logarithm of monthly net earnings. Accordingly, we interpret the regression coefficients as semi-elasticities in the form of [(dy/dx)/y]%., i.e., they show the percentage changes of earnings caused by unit changes of the respective explanatory variables. In the context of dummy variables, these reflect the impact for a discrete change of the dummy variable from 0 to 1; [b] In hundreds of PPS per inhabitant at constant 2005 prices. [c] Dummy variable; * $0.1 > p \geq 0.05$; ** $0.05 > p \geq 0.01$; *** $p < 0.01$; The maximum correlation is 0.559 (between age and tenure), and the VIF values (from model 2) range from 1.05 to 1.84. Thus, multicollinearity does not pose a concern, especially in consideration of the large size of our sample.

Overall, our empirical tests support most of the hypotheses advanced in this article. Model 1 serves as our baseline model and includes country dummies. Models 2 to 6 substitute country dummies by our hypotheses-related variables and some controls for the aggregated conditions, i.e., the unemployment rate and a period dummy. In particular, Model 2 is aimed to test Hypothesis 1 and includes GERD as main explanatory variable. This model shows that each additional hundred PPS per inhabitant in R&D effort increases earnings from self-employment by about 6.2%, in concordance with Hypothesis 1. Model 3 is intended to test Hypotheses 2 and IPP is included as its main predictor. We observe that each unitary increase in the IPP scale (from 1 to 7) raises earning from self-employment by about 14.8%, supporting Hypothesis 2.

Model 4 focuses on testing our Hypothesis 3, i.e., the moderating effect of IPP on the relationship between GERD and earnings from self-employment. Hence, the main predictors are (i) GERD; (ii) a dummy equalling 1 for strict IPP, that is, when the IPP indicator is above 4.62; and (iii) an interaction term intended to capture the differentiated effect of GERD on those economies with strict and weak IPP. Thus, when the IPP is below this benchmark, we find that earnings from self-employment increases by about 7.5% for each additional hundred PPS per inhabitant in GERD. When the IPP is above this benchmark, however, we observe that each each additional hundred PPS per inhabitant in GERD only increases earnings from self-employment by 3.3%.[16] These results are, therefore, coherent with Hypothesis 3.

Models 5 and 6 are separate regressions for countries with strict and weak IPP in order to check the robustness of the different role of GERD on earnings from self-employment we just identified in Model 4. In this sense, we observe how this effect is indeed stronger for countries with weak IPP, in acordance with Hypothesis 3. In particular, we observe how earnings from self-employment increases in countries with strict and weak IPP, respectively, by about 1.7% and 8.6% for each additional hundred PPS per inhabitant in GERD. Note that Models 5 and 6 also support Hypothesis 2 since average predicted earnings are much higher in the strong-IPP sample (2,944 $) compared to the weak-IPP sample (1,758 $).

[16] Results concerning the situation when the IPP indicator is above 4.62 can be achieved by adding marginal effects associated with GERD and the interaction term in Model 4 (i.e. 7.49-4.21).

As regards the results for our control variables, having employees, education, tenure and the number of working hours increase earnings from entrepreneurship, as expected. As regards tenure, however, the quadratic term begins to dominate the linear term when self-employed reach 29 years of experience, indicating that, beyond this number of years of experience, additional experience does not report additional earnings. Similarly, results as regards working hours indicate that, beyond 64 working hours per week, additional entrepreneurial efforts are no longer productive. We also find that females and immigrants earn less than their male and native counterparts, respectively. Regarding the age of the entrepreneur, we find a non-linear, inverted U-shaped impact on earnings where the turning point is reached when the entrepreneur is 47 years old. Cohabiting individuals report higher earnings than those living withour partner whereas no effect of children on earnings is observed. Reporting good health also seems to be positively associated with earnings from entrepreneurship. Finally, higher unemployment rates are associated with lower earnings, which is also expected.

Robustness checks

We performed several robustness checks. First, although we present only a few models in Table 3, a complete stepwise regression approach (in which models incorporate covariates one-by-one) was followed, which serves as a robustness check for the results obtained in previous models. Second, our findings are also robust to the use of alternative operationalisations of hypotheses-related variables such as (i) GERD expressed as a percentage of GDP and (ii) the Protection of Property Rights indicator from the Economic Freedom of the World Index (EFW; Fraser Institute, Canada). [17] Third, we also obtain similar results when using median (instead of mean) IPP to calculate the benchmark which distinguishes strict from weak IPP countries. Fourth, the robustness of our t-statistics was verified by re-estimating them from variance–covariance matrices of the coefficients obtained by bootstrapping. All results as regards these robustness checks are available upon request.

[17] Further information about the EFW index can be found at https://www.fraserinstitute.org/economic-freedom/approach. Further information about the *Fraser Institute* can be found at https://www.fraserinstitute.org.

5.6. Implications

The results of our empirical analysis have implications for various stakeholders. For policy makers, it is important to strike a balance between the level of R&D in their countries and the strictness of IPR laws. If total R&D expenditures in a country (the sum of public and private R&D) is relatively low, governments may directly increase R&D by increasing public R&D. However, it may also stimulate (primarily private) R&D indirectly by installing stricter IPR laws. This will increase the incentives for private firms to conduct R&D as the strict IPR makes it easier to appropriate the returns to their R&D efforts. On the other hand, if R&D is already at a relatively high level, it may be wise to exploit such a big knowledge stock by lowering the strictness of IPR, which will in turn stimulate knowledge spillovers. As we have shown, the association of country-level R&D with average entrepreneurial income is stronger in a weak-IPR regime, hence installing less strict IPR laws will be especially beneficial to entrepreneurs in countries with high R&D investments.

For innovative entrepreneurs with an international orientation, it may be wise to consider the strictness of IPR in various countries as part of their decision in which country to locate. Nevertheless, this is not just a matter of choosing a country with a strict IPR regime: although this will help appropriating the returns to their innovations, innovative entrepreneurs will find it harder to use existing innovations on which they may wish to build further. Hence, whereas innovative entrepreneurs pursuing radical innovations are likely to benefit from a strict IPR regime, innovative entrepreneurs pursuing incremental innovations (building further on earlier innovations made in other firms) as well as imitative entrepreneurs will be better off in a country that combines high R&D levels with a low IPR regime, facilitating knowledge spillovers. In such countries entrepreneurs will have easy access to a big knowledge stock, which benefit incremental innovation and imitation.

Finally, our work also has implications for researchers as we show that the impact of R&D and IPR on entrepreneurial outcomes should be considered in tandem with each other rather than in isolation.

5.7. Conclusions

Using recent data drawn from the European Working Conditions Survey for 32 European countries, we have explored the relationship between country-level expenditures on R&D, Intellectual Property Rights (IPR), and individual-level entrepreneurial performance as measured by earnings. Our results show that both R&D expenditures and IPR are positively associated with earnings of individual entrepreneurs. However, we have also found an intriguing moderation effect in the sense that IPR reduces the positive relationship between country R&D and entrepreneurial earnings.

Our results suggest that too strict IPR may hamper the diffusion of knowledge created by R&D, including imitation. Current entrepreneurship research has a tendency to strongly emphasise (if not overemphasise) the role of the innovative or Schumpeterian entrepreneur (e.g. Henrekson and Sanandaji 2018). It goes without saying that these entrepreneurs are very important for achieving economic growth as they contribute strongly to increasing a country's knowledge stock, and hence technological progress. However, knowledge diffusion and imitation may be equally important for achieving high rates of economic growth, i.e. many imitative entrepreneurs are also to be considered high-quality in the sense of contributing significantly to macro-economic development and job creation (Schmitz 1989). Results of the current paper suggest that high-R&D countries may (unintentionally) hamper economic progress by setting too strict IPR levels which discourage high-quality imitative entrepreneurship and the associated diffusion of knowledge.

In conclusion, the present paper has contributed to our knowledge of how country levels of R&D and IPR play out for the earnings of individual entrepreneurs, and hence, the average quality of a country's entrepreneurs. To the best of our knowledge, this paper is the first to investigate how technology transfer policy influences the quality of individual entrepreneurs in a country, and how the effectiveness of such policy depends on the level of investments in a country's knowledge stock. A limitation of this study is that we are unable to distinguish empirically between innovative and imitative entrepreneurs. It is likely that the interaction between R&D and IPR plays out differently for the earnings of these two types of entrepreneurs. We consider the identification of these two types a fruitful direction for future research. Future research may also focus on investigating the relationship between R&D, IPR and earnings outside of the European context as used in this paper. Especially in low- and middle-income

countries, the relationship might be different (Thompson and Rushing 1996, 1999; Falvey et al. 2006).

5.8. References

Acemoglu, D., S. Johnson, J. Robinson (2001). The colonial origins of comparative development: An empirical investigation. *American Economic Review*, 91(5), 1369–1401. https://doi.org/10.1257/aer.91.5.1369.

Acemoglu, D., S. Johnson, J. Robinson (2002). Reversal of fortune: Geography and institutions in the making of the modern world income distribution. *Quarterly Journal of Economics*, 117(4), 1231–1294. https://doi.org/10.1162/003355302320935025.

Acs, Z.J. (2006). How is entrepreneurship good for economic growth?. *Innovations: Technology, Governance, Globalization*, 1(1), 97–107. https://doi.org/10.1162/itgg.2006.1.1.97

Acs, Z.J., D.B. Audretsch, E.E. Lehmann (2013). The knowledge spillover theory of entrepreneurship. *Small Business Economics*, 41(4), 757–774. https://doi.org/10.1007/s11187-013-9505-9.

Acs, Z.J., M. Sanders (2012). Patents, knowledge spillovers, and entrepreneurship. *Small Business Economics* 39(4), 801–817. https://doi.org/10.1007/s11187-011-9322-y.

Aerts, K., T. Schmidt (2008). Two for the price of one? Additionality effects of R&D subsidies: A comparison between Flanders and Germany. *Research Policy*, 37(5), 806–822. https://doi.org/10.1016/j.respol.2008.01.011.

Aghion, Ph., P. Howitt. (1998). *Endogenous Growth Theory*. Cambridge, MA: MIT Press.

Andrews, D., C. Criscuolo, P.N. Gal (2015). Frontier firms, technology diffusion and public policy: micro evidence from OECD countries. The future of productivity: main background papers, OECD. https://www.oecd.org/eco/OECD-2015-The-future-of-productivity-book.pdf.

Audretsch, D.B., M. Keilbach (2004). Entrepreneurship capital and economic performance. *Regional Studies*, 38(8), 949–959. https://doi.org/10.1080/0034340042000280956.

Autio, E., Z. Acs (2010). Intellectual property protection and the formation of entrepreneurial growth aspirations. *Strategic Entrepreneurship Journal*, 4(3), 234-251. https://doi.org/10.1002/sej.93.

Browne, C., A. Di Battista, T. Geiger, T. Gutknecht (2014). The Executive Opinion Survey: The Voice of the Business Community. In K. Schwab (Ed.). *The Global Competitiveness Report 2014–2015*. Geneva: World Economic Forum. pp. 85–96.

Burke, A., S. Fraser (2012). Self-employment: the role of intellectual property right laws. *Small Business Economics*, 39(4), 819–833. https://doi.org/10.1007/s11187-011-9336-5.

Coe, D.T., E. Helpman (1995). International R&D spillovers. *European Economic Review*, 39(5), 859–887. https://doi.org/10.1016/0014-2921(94)00100-E.

Colombelli, A., F. Quatraro (2018). New firm formation and regional knowledge production modes: Italian evidence. *Research Policy*, 47(1), 139–157. https://doi.org/10.1016/j.respol.2017.10.006.

De Soto, H. (2000). *The Mystery of Capital: Why Capitalism Triumphs in the West and Fails Everywhere Else*. New York: Basic Books.

Denicolo, V., L.A. Franzoni (2011). Weak intellectual property rights, research spillovers, and the incentive to innovate. *American Law and Economics Review*, 14(1), 111–140. https://doi.org/10.1093/aler/ahr017.

Deeds, D.L. (2001). The role of R&D intensity, technical development and absorptive capacity in creating entrepreneurial wealth in high technology start-ups. *Journal of Engineering and Technology Management*, 18(1), 29–47. https://10.1016/s0923-4748(00)00032-1.

Falvey, R., N. Foster, D. Greenaway (2006). Intellectual property rights and economic growth. *Review of Development Economics*, 10(4), 700–719. https://10.1111/j.1467-9361.2006.00343.x.

Furman, J.L., M.E. Porter, S. Stern (2002). The determinants of national innovative capacity. *Research Policy*, 31(6), 899–933. https://10.1016/s0048-7333(01)00152-4.

Easterly W., R. Levine (1997). Africa's growth tragedy: Policies and ethnic divisions. *Quarterly Journal of Economics*, 112(4), 1203–1250. https://doi.org/10.1162/003355300555466.

Elschner, C., C. Ernst, G. Licht, C. Spengel (2011). What the design of an R&D tax incentive tells about its effectiveness: a simulation of R&D tax incentives in the European Union. *The Journal of Technology Transfer*, 36(3), 233–256. https://doi.org/10.1007/s10961-009-9146-y.

Erken, H., P. Donselaar, R. Thurik (2018). Total factor productivity and the role of entrepreneurship. *The Journal of Technology Transfer*, 43(6), 1493–1521. https://doi.org/10.1007/s10961-016-9504-5.

Eurofound (2012). Fifth European Working Conditions Survey – Overview report, Publications Office of the European Union, Luxembourg. https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1182en.pdf (accessed 28 November 2018).

Eurofound (2016). Sixth European Working Conditions Survey – Overview report, Publications Office of the European Union, Luxembourg. https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1634en.pdf (accessed 28 November 2018).

European Commission (2017). The economic rationale for public R&I funding and its impact. Brussels: European Commission. https://ri-links2ua.eu/object/document/326/attach/KI0117050ENN_002.pdf. (accessed 28 November 2018).

Hall, B.H., J. Mairesse, P. Mohnen (2010). Measuring the returns to R&D. In *Handbook of the Economics of Innovation*, Volume 2, Chapter 24, pp. 1033–1082. https://doi.org/10.1016/S0169-7218(10)02008-3.

Hamilton, R.T. (2000). Does entrepreneurship pay? An empirical analysis of the returns to self-employment. *Journal of Political Economy*, 108(3), 604–631. https://doi.org/10.1086/262131.

Henrekson, M., T. Sanandaji (2018). Schumpeterian entrepreneurship in Europe compared to other industrialized regions. *International Review of Entrepreneurship*, 16(2), 157–182.

Kao, C., M-H. Chiang, B. Chen (1999). International R&D spillovers: an application of estimation and inference in panel cointegration, *Oxford Bulletin of Economics and Statistics*, 61(4), 693–711. https://doi.org/10.1111/1468-0084.0610s1691.

Kelly, R., H. Kim (2018). Venture capital as a catalyst for commercialization and high growth. *The Journal of Technology Transfer*, 43(6), 1466–1492. https://doi.org/10.1007/s10961-016-9540-1.

Krieger, B., G. Licht, M. Pellens (2018). New perspectives in European innovation policy. ZEW policy brief, No. 7/2018. Mannheim: Zentrum für Europäische Wirtschaftsforschung (ZEW). http://hdl.handle.net/10419/183222.

Lehmann, E.E., M. Menter (2018). Public cluster policy and performance. *The Journal of Technology Transfer*, 43(3), 558–592. https://doi.org/10.1007/s10961-017-9626-4.

Millán, J.M., E. Congregado, C. Román, M. van Praag, A. van Stel (2014). The value of an educated population for an individual's entrepreneurship success. *Journal of Business Venturing*, 29(5), 612–632. https://doi.org/10.1016/j.jbusvent.2013.09.003.

Mueller, P. (2007). Exploiting entrepreneurial opportunities: the Impact of entrepreneurship on growth. *Small Business Economics*, 28(4), 355–336. https://doi.org/10.1007/s11187-006-9035-9.

OECD (2018), Gross domestic spending on R&D (indicator). http://dx.doi.org/10.1787/d8b068b4-en. (accessed 28 November 2018)

Park, W.G., J.C. Ginarte (1997). Intellectual property rights and economic growth. *Contemporary Economic Policy*, 15(3), 51–61. https://10.1111/j.1465-7287.1997.tb00477.x.

Parker, S.C. (2018). *The Economics of Entrepreneurship*. Cambridge, UK: Cambridge University Press. https://doi.org/10.1017/9781316756706.

Romer, P.M. (1986). Increasing returns and long-run growth. *Journal of Political Economy*, 94(5), 1002–1037. https://doi.org/10.1086/261420.

Romer, P.M. (1990). Endogenous technological change. *Journal of Political Economy*, 98(5, Part 2), S71–S102. https://doi.org/10.1086/261725.

Schmitz Jr, J.A. (1989). Imitation, entrepreneurship, and long-run growth. *Journal of Political Economy*, 97(3), 721–739. https://doi.org/10.1086/261624.

Schneider, P.H. (2005). International trade, economic growth and intellectual property rights: A panel data study of developed and developing countries.

Journal of Development Economics, 78(2), 529–547. https://10.1016/j.jdeveco.2004.09.001.

Shane, S. (2009). Why encouraging more people to become entrepreneurs is bad public policy. *Small Business Economics*, 33(2), 141-149. https://doi.org/10.1007/s11187-009-9215-5.

Takalo, T. (2012). Rationales and instruments for public innovation policies. *Journal of Reviews on Global Economics*, 1, 157-167. http://dx.doi.org/10.6000/1929-7092.2012.01.14.

Takalo, T., T. Tanayama (2009). Adverse selection and financing of innovation: is there a need for R&D subsidies? *The Journal of Technology Transfer*, 35(1), 16–41. https://doi.org/10.1007/s10961-009-9112-8.

Thompson, M.A., F.W. Rushing (1996). An empirical analysis of the impact of patent protection on economic growth. *Journal of Economic Development*, 21(2), 61–77. http://jed.or.kr/full-text/21-2/4.pdf.

Thompson, M.A., F.W. Rushing (1999). An empirical analysis of the impact of patent protection on economic growth: An Extension. *Journal of Economic Development*, 24(1), 67–76. http://jed.or.kr/full-text/24-1/thompson.PDF.

Tobin, J. (1958). Estimation of relationships for limited dependent variables. *Econometrica*, 26(1), 24–36. https://doi.org/10.2307/1907382.

Van Praag, C.M. (2005). *Successful Entrepreneurship: Confronting Economic Theory with Empirical Practice*. Cheltenham, UK: Edward Elgar Publishing.

Van Stel, A., A. Millán, J.M. Millán, C. Román (2018). The relationship between start-up motive and earnings over the course of the entrepreneur's business tenure. *Journal of Evolutionary Economics*, 28(1), 103–123. https://doi.org/10.1007/s00191-017-0499-3.

Van Stel, A., J.M. Millán, C. Román (2014). Investigating the impact of the technological environment on survival chances of employer entrepreneurs. *Small Business Economics*, 43(4), 839–855. https://doi.org/10.1007/s11187-014-9565-5.

Xu, B., E.P. Chiang (2005). Trade, patents and international technology diffusion. *The Journal of International Trade & Economic Development*, 14(1), 115–135. https://doi.org/10.1080/0963819042000333270..

Appendix. Variable definitions

Variable	Description
	Dependent variables
Earnings	
Net monthly earnings – PPP $ of 2015 (logs)	Average net earnings in recent months. The variable is defined in PPP $ of 2015 and converted to natural logarithms.
	Main independent variables
Hypotheses related variables	
GERD PPS per inhab.	Gross Domestic Expenditure on R&D by business enterprises, higher education institutions, as well as government and private non-profit organisations. Data for periods 2010 and 2015 are used. The variable is expressed as Purchasing Power Standards –PPS– per inhabitant at constant 2005 prices (Data source: Eurostat).
IPP	Intellectual Property Protection indicator. Data for periods 2010 and 2015 are used. The variable is evaluated on a scale of 1 to 7, from extremely weak to extremely strong protection (Data source: World Economic Forum's Executive Opinion Survey).
Strict IPP	Dummy equals 1 for observations corresponding to countries which' IPP is above 4.62, this benchmark being the unweighted average IPP for the 32 countries in our sample during the periods 2010 and 2015 (Data source: World Economic Forum's Executive Opinion Survey).
	Control variables
Entrepreneurship types	
Self-employed with employees	Dummy equals 1 for workers who declare being self-employed with employees.
Own-account self-employed worker	Dummy equals 1 for individuals who declare being self-employed without employees
Educational attainment	
Basic education	Dummy equals 1 for workers with less than lower secondary education (ISCED-1997, 0-1).
Secondary education	Dummy equals 1 for workers with, at least, lower secondary education but non-tertiary education (ISCED-1997, 2-4).
Tertiary education	Dummy equals 1 for workers with tertiary education (ISCED-1997, 5-6).
Job aspects	
Tenure	Years of experience in the company or organization.
Working hours	Working hours per week.
Business sector dummies	
Agriculture	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is A = Agriculture, forestry and fishing.
Industry	Dummy equals 1 for workers whose codes of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) are B = Mining and quarrying, C = Manufacturing, D = Electricity, gas, steam and air conditioning supply, and E = Water supply; sewerage, waste management and remediation activities.
Construction	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is F = Construction.
Commerce and hospitality	Dummy equals 1 for workers whose codes of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) are G = Wholesale and retail trade; repair of motor vehicles and motorcycles,

	and I = Accommodation and food service activities.
Transport	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is H = Transportation and storage.
Financial services	Dummy equals 1 for workers whose codes of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) are K = Financial and insurance activities, and L = Real estate activities.
Public administration and defence	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is O = Public administration and defence; compulsory social security.
Education	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is P = Education.
Health	Dummy equals 1 for workers whose code of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) is Q = Human health and social work activities.
Other services	Dummy equals 1 for workers whose codes of main activity of the local unit of the business, by means of the Nomenclature of Economic Activities (NACE rev. 2, 2008) are J = Information and communication, M = Professional, scientific and technical activities, N = Administrative and support service activities, R = Arts, entertainment and recreation, S = Other service activities, T = Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use, and U = Activities of extraterritorial organisations and bodies.
Demographic characteristics	
Female	Dummy equals 1 for females.
Immigrant	Dummy equals 1 for citizens of a different country from that of residence.
Age	Age reported by the workers.
Cohabiting	Dummy equals 1 for individuals cohabiting with spouse/partner.
Children under 14	Dummy equals 1 for individuals cohabiting with any son or daughter aged under 14.
Health	Variable ranging from 1 to 5. The scale refers to the level of health declared by the worker. It equals 1 for individuals whose health is very bad and 5 for individuals whose health is very good.
Business cycle	
Unemployment rate	National annual unemployment rate for periods 2010 and 2015 (source: Eurostat, World Bank).
Wave	
2015	Dummy equals 1 for observations corresponding to the EWCS 2015 and 0 for observations corresponding to the EWCS 2010.
Country dummies	32 dummies equaling 1 for individuals living in the named country: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Part V: Concluding remarks

Universidad Internacional de Andalucía, 2022

Chapter 6: Conclusions and limitations

6.1. Conclusions

Throughout the current dissertation, the scope regarding the impact of innovation on entrepreneurship across the Euro Zone have been questioned. For the fulfilment of the proposed hypothesis, distinct econometric models have been performed in order to quantify, segment and conceptualize a framework to unravel the impact of Information and Communication Technologies adoption, expenditures on Research and Development, as well as Intellectual Property Rights strictness. The hypotheses proposed respond to the effects provoked in self-employment in terms of the allocation of the different types and the variation of performance.

Regarding the adoption and use of ICT, binary discrete choice models, ordered logit and ordinary least squares have been developed aiming to decode the existing relation between the level of adoption, use and entrepreneurial earnings. Confirming our hypothesis regarding the nonlinear relationship between frequency of use and entrepreneurial earnings, affirming that the step of using entails a substantial improvement in terms of earnings compared to subsequent steps. In addition, we demonstrate an indirect and negative relationship between the job tenure versus adoption, use and entrepreneurial earnings, so that, the greater the activity time, the greater the reticence to the adoption and use of ICT, being these positively related with higher earnings. Likewise, the positive relationship between adoption and use of ICT with earnings is stronger for self-employed with employees and dependent self-employed workers than for independent own-account self-employed, being, in the first case, the greater size of the company increases the inherent complexity forces greater efforts in communication and organization, whose could be alleviated by ICT integration. Regarding the second case, the justification lies in a lower adoption by self-employed of said typology, obtaining a higher potential benefit, in comparison to the same share, by including innovative technologies in the daily business op-

erations. In regard of barriers, lower educated entrepreneurs with long job tenures are more exposed to the plausible inertia effects due to reluctance of change in organization issues or lack of information concerning potential long-term performance increase.

On the other hand, the allocation of the self-employed population affected by external factors has been justified. The importance of registered trademarks as a relative indicator of the proportion of self-employed Kirznerian or opportunists over the total of self-employment in a given region or country has been confirmed. According to our results, patent activities is robustly associated to R&D expenditures, nevertheless, there is no significant relationship in relation to the small sized entrepreneurship, in terms of occupation status and start-up motivation. Regarding the trademarks, the relation is undoubtedly positive and significant for self-employed with employees and independent own-account self-employed as well as opportunity entrepreneurs, forming part of the lower share of innovators, leveraging the market opportunities offering services instead of tangible products, that usually are provided by SMEs and self-employers linked to the Kirznerian entrepreneurship.

Following the allocation affair, higher amounts of investment in Research and Development boost the predominance of self-employed with dependent workers and / or opportunity against the self-employed dependent and / or by necessity. Therefore, according to the theoretical conceptualization based on the existing literature, endowing with higher quality the proportion of existing self-employment, due to the distribution of knowledge also created by the aforementioned expenditures in R&D. In addition, the descriptive statistics of our data set also revealed that these higher quality types of entrepreneurs were on average higher educated, worked longer hours and felt healthier.

Going even further, the relationship between these expenditures, the Intellectual Property Rights and the individual-level earnings of the self-employed was postulated, reaching the conclusion of the existence of a positive relationship between them. Higher spending on R & D allows higher individual-level income, conditioned by the level of protection of Intellectual Property Rights. In this sense, the knowledge spillovers obtained by the efforts in R & D, is burdened in the case of a strict protection policy, thus preventing its diffusion and diminishing both the innovative and imitative self-employment, reducing economic development and employment creation. Hence, fixing the optimal level is significant to boost

the progress and balance out the proper allocation of both scope of entrepreneurship. In case of innovative or Schumpeterian entrepreneurs, allow the increase of knowledge stock and technological progress, and in the other hand, support imitative ones due their importance in terms of contribution to macro-level development and the employment creation.

The studies presented in this thesis have certain limitations that should be mitigated in future research. Mainly, to carry out studies of a similar nature considering a different geographical area from the European one that plausibly can throw new and interesting details. On the other hand, the unavailability of certain data limits the testing of certain hypotheses that would provide greater explanatory power, such as obtaining longitudinal data, which allows tracking over time to quantify possible future variations. It would be interesting in the case of the process of adoption and use of ICTs, as well as, if the innovation process allows the business to expand, going from self-employed on its own to self-employed with employees. Likewise, an explicitly defined segmentation between innovative self-employed and imitators would provide a more accurate view of the variations between them in the face of increases or decreases in expenditures in R & D and the level of protection of Intellectual Property Rights. Likewise, the aggregate component referring to investments in Research and Development only allows a general understanding of the effects on the proportions of self-employed. The possibility of obtaining a more detailed segmentation would make it possible to draw more accurate conclusions regarding the type of expenditures, private or public nature, and measure the consequent impact on the the composition of the self-employment market.

Eventually, it has been demonstrated, from different angles, the importance of the innovation process in self-employment and entrepreneurship, stimulating not only the increase of performance but increasing the quality of the self-employment at European level. Our results help to better understand the current situation and provide an additional vision to the existing literature and allow launching certain implications to guide future actions, measures and policies. Among others, raise the efforts to promote the integration of ICT by the self-employed in their respective businesses, allowing operating more efficiently, creation of additional value and increasing the contribution to development and economic growth due its impact on labour market. At the same time, reduce the barriers that hamper this process, such as, for example, previously demonstrated inertia effects, persistent in entrepreneurs with long job tenure regardless their age. On the other hand, analyse the stimulation of the level of expenditures in Research

and Development since it is an external determinant factor in the distribution of quality self-employment, taking into account, in addition, the optimal establishment of the protection of Intellectual Property Rights, with the ultimate purpose of promoting an appropriate deamination of knowledge that allows efficient growth and development.

Breve resumen en castellano

Breve resumen en castellano

El emprendimiento y la innovación pueden entenderse como dos caras de la misma moneda. La innovación está más relacionada con la creación de novedades, mientras que el emprendimiento está más relacionado con la creación de valor. Dicho de otro modo, la innovación es la fuente del emprendimiento, y el emprendimiento permite que la innovación emerja y genere su valor económico y social (Zhao 2005).

El reto es poder comprender todo el proceso, desde las ideas iniciales hasta las realizaciones finales. Desafortunadamente, no se ha alcanzado todavía un consenso sobre el modo en que este proceso tiene lugar (Brem 2011). Esta tesis doctoral cubre una importante variedad de tópicos relevantes para la investigación en innovación y emprendimiento y aspira a ser un paso más en la comprensión de la relación existente entre ambos fenómenos.

Esta tesis doctoral se estructura en 6 capítulos, estando el Capítulo 1 dedicado a presentar el enfoque, los objetivos y la estructura de la investigación. El cuerpo principal está organizado en 4 capítulos del siguiente modo: el Capítulo 2 investiga la adopción y frecuencia de uso de las Tecnologías de la Información y la Comunicación (TIC) según los diferentes tipos de emprendimiento y el impacto de esta adopción / frecuencia de uso en su desempeño, capturado este por las ganancias empresariales. El Capítulo 3 explora la interrelación entre el peso relativo del empleo por cuenta propia en un determinado país que puede considerarse "emprendedor" –que se asocia con el peso de emprendedores Kirznerianos– y el registro de marcas a nivel nacional. El Capítulo 4 examina si el carácter innovador de una economía, capturado este por su nivel de gasto en I+D, afecta al peso relativo de los diferentes tipos de trabajadores por cuenta propia según su situación ocupacional y sus motivaciones para emprender. El Capítulo 5 analiza cómo la interacción entre el gasto agregado en I+D y las Leyes sobre los Derechos de Propiedad Intelectual (DPI) afecta al desempeño de los empresarios a nivel individual. El capítulo final presenta un resumen de los principales hallazgos e implicaciones de esta tesis doc-

toral, así como de las futuras líneas de investigación asociadas a los diferentes tópicos analizados.

El análisis empírico está basado en los microdatos de las olas 5ª y 6ª de la Encuesta Europea de Condiciones de Trabajo (European Working Conditions Survey – EWCS 2010 y 2015; Eurofound). Los datos sobre marcas registradas a nivel nacional se obtienen de la Organización Mundial de la Propiedad Intelectual (OMPI). Los datos sobre el gasto en I+D a nivel nacional se obtienen a través de Eurostat. Finalmente, los datos sobre la protección de los DPI en cada economía se derivan de la Encuesta de Opinión de Ejecutivos del Foro Económico Mundial (World Economic Forum's Executive Opinion Survey – WEF-EOS). En cuanto a la metodología empírica empleada, se utilizan regresiones lineales y modelos de elección discreta (binarios, ordenados y no ordenados).

Referencias

Brem, A. (2011). Linking innovation and entrepreneurship – literature overview and introduction of a process-oriented framework. *International Journal of Entrepreneurship and Innovation Management*, 14(1), 6–35.

Zhao, F. (2005). Exploring the synergy between entrepreneurship and innovation. *International Journal of Entrepreneurial Behavior and Research*, 11(1), 25–41.

Brief summary in English

Brief summary in English

Entrepreneurship and innovation can be viewed as different sides of the same coin. Innovation is more related to novelty creation whereas entrepreneurship is more related to value creation. In other words, innovation is the source of entrepreneurship and entrepreneurship allows innovation to flourish and to realize its economic and social value (Zhao 2005).

The challenge is to understand the whole process from initial ideas to lasting realisations but, unfortunately, there is no common sense about how such process shall look like (Brem 2011). This dissertation covers a wide variety of topics relevant to the research into innovation and entrepreneurship and aims to represent a step forward in the understanding of the relationship between both concepts.

This dissertation is structured in 6 chapters, being Chapter 1 devoted to present the research focus, objectives and structure. The main body is organised in 4 chapters as follows: Chapter 2 investigates Information and Communication Technology (ICT) adoption/usage frequency by different entrepreneurship types and the impact of this adoption/usage frequency on their performance, which is captured by earnings. Chapter 3 explores the interrelation between the share of the self-employed workforce in a given country that can be considered 'entrepreneurial' –which is associated with the share of Kirznerian entrepreneurs– and trademark registration at the country level. Chapter 4 examines whether the innovative nature of an economy as expressed by its level of R&D expenditure, affects the relative weight of different self-employment types based on occupational status and start-up motive. Chapter 5 analyses how the interplay between country R&D expenditure and Intellectual Property Rights (IPR) laws affect entrepreneurs' performance at the individual-level. The final chapter presents a summary of the main findings and implications of the work, and gives an outlook on future research areas on the various topics investigated in this dissertation.

The empirical analysis is based on microdata drawn from the Fifth and Sixth waves of the European Working Conditions Survey –EWCS 2010

and 2015– (Eurofound). Data on registered trademarks at the country-level is derived from the World Intellectual Property Organization (WIPO). Data on R&D expenditure at the country-level is derived from Eurostat. Finally, data on IPR protection in each economy is derived from the World Economic Forum's Executive Opinion Survey (WEF-EOS). As regards empirical methods, linear regressions and discrete choice models (binary, ordered and non-ordered) are used.

References

Brem, A. (2011). Linking innovation and entrepreneurship – literature overview and introduction of a process-oriented framework. *International Journal of Entrepreneurship and Innovation Management*, 14(1), 6–35.

Zhao, F. (2005). Exploring the synergy between entrepreneurship and innovation. *International Journal of Entrepreneurial Behavior and Research*, 11(1), 25–41.

Conclusiones en castellano

Universidad Internacional de Andalucía, 2022

Conclusiones en castellano

6.1. Conclusiones

A lo largo de la presente tesis doctoral, se ha cuestionado el alcance del impacto de la innovación en el emprendimiento en la Zona Euro. Para la demostración de las hipótesis propuestas, se han realizado distintos modelos econométricos para cuantificar, segmentar y conceptualizar un marco para desvelar el impacto de la adopción de las Tecnologías de la Información y la Comunicación, los gastos en Investigación y Desarrollo, así como la rigurosidad de los derechos de propiedad intelectual. Las hipótesis propuestas buscan dar respuesta a los efectos provocados en el autoempleo en términos de distribución de los diferentes tipos, así como de la variación en los rendimientos.

Con respecto a la adopción y el uso de las TIC, se han desarrollado modelos binarios de elección discreta, logit ordenado y mínimos cuadrados ordinarios con el objetivo de descodificar la relación existente entre el nivel de adopción, uso y ganancias empresariales. Confirmando así nuestra hipótesis sobre la relación no lineal entre la frecuencia de uso y los ingresos empresariales, consiguientemente demostrando que el paso de no usar a usar implica una mejora sustancial en términos de ingresos en comparación con los pasos posteriores. Además, demostramos una relación indirecta y negativa entre los años de tenencia frente a la adopción, el uso y los ingresos empresariales, de modo que, cuanto mayor es el tiempo de actividad, mayor es la reticencia a la adopción y el uso de las TIC, que a su vez se asocian positivamente con mayores ganancias. Asimismo, la relación positiva entre la adopción y el uso de las TIC con los ingresos es más fuerte para los autoempleados con empleados a cargo y los autoempleados dependientes frente a autoempleados independientes por cuenta propia, siendo, en el primer caso, un mayor tamaño de la empresa incrementa la complejidad inherente, obligando a realizar mayores esfuerzos en sistemas de comunicación y de organización, a los que podría paliarse mediante la

integración de las TIC. Con respecto al segundo caso, la justificación se encuentra en una menor adopción por parte de los autoempleados dependientes, obteniendo un mayor beneficio potencial, en comparación a autoempleados de la misma categoría, al incluir tecnologías innovadoras en las operaciones comerciales diarias. En lo que respecta a las barreras, los empresarios con menores niveles de educación y con mayores años de actividad están más expuestos a los posibles efectos de la inercia debido a la reticencia al cambio en la estructura organizacional o la falta de información sobre el posible aumento del rendimiento a largo plazo.

Por otro lado, se ha demostrado que la distribución del mercado del autoempleo está afectada por factores externos. Se ha confirmado la influencia de las marcas registradas como un indicador adicional de la proporción de autoempleados kirznerianos u oportunistas sobre el total de autoempleados en una determinada región o país. De acuerdo con nuestros resultados, las actividades referentes a las patentes están fuertemente asociadas a los gastos en I + D, sin embargo, no existe una relación significativa con el pequeño emprendimiento, en función del tipo de autoempleo y la motivación para el inicio. Respecto a las marcas registradas, la relación es, sin duda, positiva y significativa para los autoempleados con empleados a cargo y autoempleados por cuenta propia independientes, así como para los empresarios de oportunidad, que forman parte a su vez, de la menor proporción de innovadores, equilibrando así las oportunidades del mercado ofreciendo servicios en lugar de productos tangibles, y proporcionados al mercado por parte de las pymes y autoempleados vinculadas al espíritu empresarial kirzneriano.

Siguiendo la línea referente a la distribución del mercado del autoempleo, se demuestra que mayores cantidades de inversión en Investigación y Desarrollo incrementan el predominio de autoempleados por cuenta propia con trabajadores a cargo y / o de oportunidad frente autoempleados dependientes y / o por necesidad. Por lo tanto, de acuerdo con la conceptualización teórica basada en la literatura existente, se otorga una mayor calidad al autoempleo existente, en mayor medida por la diseminación del conocimiento, creado así mismo por los gastos en I + D anteriormente mencionados. Además, las estadísticas descriptivas de nuestro conjunto de datos también revelaron que estos tipos de empresarios de mayor calidad tenían, en promedio, una educación superior, trabajaban más horas y se sienten más saludables.

Yendo aún más lejos, se postuló la relación entre estos gastos, los derechos de propiedad intelectual y las ganancias a nivel individual de los autoempleados por cuenta propia, llegando a la conclusión de la existencia de una relación positiva entre ellos. Un mayor gasto en I + D incrementa ingresos a nivel individual, condicionado por el nivel de rigurosidad de los derechos de propiedad intelectual. En este sentido, la diseminación del conocimiento obtenido debido al I + D, es obstaculizado en el caso de una política de protección estricta, impidiendo así su difusión y disminuyendo el autoempleo innovador e imitativo, y consiguientemente el decremento en el desarrollo económico y la creación de empleo. Por lo tanto, fijar un nivel óptimo es importante para promover al progreso y equilibrar la distribución del mercado del autoempleo. En el caso de los empresarios innovadores o schumpeterianos, incrementar el conocimiento disponible y favorecer el progreso tecnológico, y por otro lado, apoyar al emprendimiento imitativo, debido a su importancia en términos de contribución al desarrollo a nivel macroeconómico y a la creación de empleo.

Los estudios presentados en esta tesis tienen ciertas limitaciones que deben mitigarse en futuras investigaciones. Principalmente, para realizar estudios de naturaleza similar, se debería considerar un área geográfica diferente a la europea que plausiblemente puede arrojar nuevos e interesantes detalles. Por otro lado, la falta de disponibilidad de ciertos datos limita la contrastación de ciertas hipótesis que podrían proporcionar matices con un mayor poder explicativo, como por ejemplo la obtención de datos longitudinales, que permitirían el seguimiento a lo largo del tiempo para cuantificar posibles variaciones inherentes y futuras. Sería interesante en el caso del proceso de adopción y uso de las TIC, así como, si el proceso de innovación permite que la expansión empresarial, por ejemplo, pasando de los autoempleados por cuenta propia a los autoempleados por cuenta propia con los empleados. Del mismo modo, una segmentación explícitamente definida entre trabajadores autónomos innovadores e imitadores proporcionaría una visión más precisa de las variaciones entre ellos ante los aumentos o disminuciones de los gastos en I + D y el nivel de protección de los derechos de propiedad intelectual. Del mismo modo, el componente agregado referente a las inversiones en Investigación y Desarrollo solo permite una comprensión general de los efectos en las proporciones de autoempleados por cuenta propia. La posibilidad de obtener una segmentación más detallada permitiría extraer conclusiones más precisas sobre el tipo de gastos, de naturaleza privada o pública, y medir el impacto consiguiente en la composición del mercado de autoempleo.

En conclusión, se ha demostrado, desde diferentes ángulos, la importancia del proceso de innovación en el autoempleo y el emprendimiento, estimulando no solo el aumento de los rendimientos sino también la calidad del autoempleo a nivel europeo. Nuestros resultados ayudan a comprender mejor la situación actual y a proporcionar una visión adicional a la literatura existente y permiten lanzar ciertas implicaciones para establecer acciones, medidas y políticas futuras. Entre otros, aumentar los esfuerzos para promover la integración de las TIC por parte de los autoempleados por cuenta propia en sus respectivas empresas, lo que permitiría operar de manera más eficiente, crear valor añadido adicional y aumentar la contribución al desarrollo y al crecimiento económico debido a su impacto en el mercado laboral. Al mismo tiempo, reduciendo las barreras que dificultan este proceso, como, por ejemplo, los efectos de inercia demostrados previamente, persistentes en los empresarios con una larga permanencia en el puesto de trabajo, independientemente de su edad. Por otro lado, observar los efectos en la estimulación del nivel de gastos en Investigación y Desarrollo, ya que es un factor determinante externo en la distribución del autoempleo de calidad, teniendo en cuenta, además, el establecimiento óptimo de la protección de la propiedad intelectual, con el fin último de promover una adecuada desaminación del conocimiento que permita un crecimiento y desarrollo eficientes.