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Entrepreneurship and economic development

Globalization, economic freedom and innovation

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Preface

This PhD thesis addresses the question of how the entrepreneurship ecosystem influences in entrepreneurship performance and on economic development. In any way this dissertation is the sum of different projects, carried out with different co-authors and with different initial motivations and starting points. Three of the essays are the result of a planned work performed jointly with professors Congregado, Golpe and Roman, whereas the other two, have been the result of two projects related with my main line of research. The first, an essay on convergence, entrepreneurship and innovation in the Spanish regions, published with Jesús Iglesias and Mónica Carmona, and the second, a paper on long memory properties in the exchange rates time series. The origin of this last work was my Master thesis at the University International of Andalusia, on persistence in time series and fractal cointegration.

Several people have been influential during my PhD research. Luis Alberiko Gil-Alañá, already acted as supervisor of my Master's dissertation. He stimulated me to continue doing research on applied macroeconometrics.

I am very grateful to my advisor, Emilio Congregado for this support and inspiration. I am also indebted to Antonio Golpe and Concepción Román. Part I and II of this study gained very much from the joint work with them.

My work also benefited from the comments and the help of numerous people than those mentioned above. Knowing that the list of acknowledgement is incomplete, I would like to thank Luis Alberiko Gil-Alañá for their valuable comments on fractal cointegration, and José Luis Torres, Gonzalo Fernández de Córdoba, Máximo Camacho, Juan Máñez, María Engracia Rochina, Juan Sanchís, and some anonymous referees for theirs valuable comments on preliminary works of this study. Obviously, all remaining errors are my own responsibility.

I would like to thank also all of the faculty and staff in the Department of Economics and my classmates in the Msc in Economics, Finance and Computer Science for continued support and a warm atmosphere in which to work.

Finally, I would mostly like to thank my family for supporting me during the time this work was completed.

Laura Sauci
Huelva, March 2017

Part I: Introduction

Chapter 1: Introduction and outline

1.1. Introduction

The interplay between entrepreneurship and globalization and economic freedom backs into at the heart of the debate about self-employment contributions to the economic development of modern economies. After experienced a process of exceptionally strong globalization, the world is witnessing to an upsurge of protectionism. This new trend is threating not only free trade agreements but also the levels of economic integration achieved in some economic areas like the European Union.

In this framework the less competitive firms and unemployed with low employability, are groups that will treat to lobby and to vote political options that incorporate the concerns of these groups (i.e. protectionist actions like less trade openness and restrictive migration policies. The consequences of this process are a hot policy issue at the time of writing after the great recession, since some industries and large sectors of the population considers globalisation as the ultimate cause of their problems, and advocate by any return to protection for national business and domestic employees against foreign firms and migrant workers. For them, the expected promotion of efficiency and productivity associated to globalisation is not guaranteed if the differences between institutions across countries alter the relative productivity and competitiveness.

Thus, one could argue that the entrepreneurship ecosystem i.e. the institutional framework for business is the main determinant of the capacity of contribution of entrepreneurship to economic growth, job creation and innovation. Therefore, the economic freedom in its different dimensions, such as the rule of law, the regulatory efficiency and in especial business freedom and labor market institutions, the degree of integration into the global economy –i.e. the openness to trade– and the weight of the public sector on the overall economy might be considered as key factors, for determining whether a society is an entrepreneurial one or not[1]

The only way to resolve this type of controversies is providing solid economic propositions and empirical findings in order to evaluate the globalisation impact on economic growth, innovation, job creation and entrepreneurship. In this context, the study of the relationship between economic integration and entrepreneurship is particularly interesting, since entrepreneurship is a determinant of economic growth and job creation.

In principle, the relationship between globalization, economic freedom and entrepreneurship is ambiguous, since one can argue that we can find plausible explanations for expecting both a positive and a negative relationship.

Starting with the relation between entrepreneurship and economic integration, we all agree in that economic integration opens new business opportunities and encourages the self-employed firm size, since sales to foreign markets expands the potential demand.

From this perspective, more trade openness is a positive factor not only for fostering entrepreneurship but also for enhancing the probability of survival and success. On the other hand, globalization increases the intensity of competition the opportunities of jobs and wages in the export sector leading a raise in the number self-employed workers due to the confluence of two phenomena: i) as global competition continuous to intensify some of them, the less competitive ones, could not withstand this competition, thus triggering the shutdown; ii) the greater the exposure to foreign competition, the smaller the fraction of self-employed people as the Díez and Ozdagli's (2011) model suggest. In addition we should also consider whether more openness influences on the relative distribution of entrepreneurship between productive and unproductive activities, i.e. between the so-called formal and informal self-employment.

[1] In this dissertation the terms Entrepreneurship and self-employment are used as interchangeable concepts. We are conscious of the complexity of the entrepreneurship concept and its different dimensions. However, and as it is a common practice in previous literature, we use self-employment as a proxy for entrepreneurship.

However, the key question is to know whether the effect of a higher exposure to international trade, leads, in any case, an optimal reallocation of labour between paid-employment and self-employment and between less productive firms to more productive exporters, and even across countries with positive effects on economic growth, innovation and job creation.

Thus, the challenge is to provide empirical findings in order to shed light to the debate and attitudes towards globalization. To this end it is important to know the effects of more trade openness on the export intensity of self-employment is mutually beneficial, not only for higher-income countries but also for lower-income countries. In order to address these questions this dissertation also includes a second research question. In particular it presents an inquiry about the reasons of why the effects of globalization on national self-employed sectors should be analyzed not only in quantitative terms but also in qualitative ones. In particular we will treat to provide empirical findings for supporting the theoretical view of the effects of globalization on national entrepreneurial systems, provided by Acd and Sanders (2007). For them, globalization does not destroy self-employment but encourage the *entrepreneurial* model of production (Acs and Sanders, 2007. The shift away from large corporations and towards smaller entrepreneurial activity (Acs and Audretsch, 1993; van Stel, 2006) with the associated reduction in the average self-employed firm size, as well as the new business opportunities in the service sector for entrepreneurship thanks to the improvements in the Information and Communication Technologies (ICT) are the two potential factors behind this surprising performance of the self-employment rate. Audretsch and Sanders (2007) reinforce this idea suggesting that globalization and the development of the ICT sector are leading a new international division of work, the advanced economies endowed with high skilled workers are specialized in early stages of the product life cycle introducing innovations in products or process, while the less developed economies endowed with low skilled workers are specialized in the off-shored production stage.

In sum, this dissertation will treat to analyse the triangle entrepreneurship, globalization economic freedom, for providing a better understanding how and why the contribution of a national self-employed sector on economic growth, innovation and job creation can show different intensities.

In this dissertation we present five essays on competitiveness and one on international economics. Four of them are focused on the role of two of the competitiveness pillars –innovation and openness to trade– and the last one focused on the analysis of the two-way relationship between entrepreneurship and economic freedom.

From different perspectives and by using different strategies and econometric approaches, the relationship between competitiveness and entrepreneurship is explored as pillars of an economic growth strategy. To this end, we do not explore the well-known and intensively explored relationship between competitiveness and economic growth but how the relationship between some key pillars of competitiveness and entrepreneurship is.[2]

The two first essays included in this dissertation re-examine the issue of the determinants of self-employment rates at regional level by using a rich data set of countries,

The first essay investigates the impact of the stage of economic development and the degree of openness on the regional self-employment rate while controlling for the effects of other relevant variables which determine if the economy is an entrepreneurial driven one. The second one, examine the nature of Granger causality between trade openness and entrepreneurship for a panel of 20 OECD economies over the period 1960-2014.

The third one explores the link between the economic freedom and entrepreneurship. This is a very important issue since in some extent the institutions play a key role since they determine the conditions for entrepreneurship and the national self-employed sector contribution in terms of in ovation, economic growth and job creation. In that sense, one could argue that economic institutions are key determinants for the well-functioning markets of factors and goods, for trade and then for competitiveness and economic growth. At this point the challenge is to explore the relationship between entrepreneurship and the different dimensions of economic freedom at the macro-level.

The third part of the dissertation presents two essays on convergence. The interest of convergence issue is given by the fact that the export self-

[2] In a broad sense, we could define competitiveness as the set of institutions and factors determine the level of productivity of a region. Then, factors like institutions, infraestructure, health, educational attainment, market efficiency –in both goods and factor markets–, market size, macroeconomic environment among others will be the responsibles of the regional competitiviness.

employment ratio and the innovation effort can converge as a result of different forces. On the one hand a trend to converge might be indicating that the higher integration into the global economy can lead two phenomena with regard to this relationship.

Contributions of this thesis

The contribution of this thesis with respect to previous work on the relation between self-employment, economic freedom and economic development is threefold. *First*, we apply some recent developments for time series and panel data in order to explore more carefully causality relationships. In particular, we apply these techniques on macro databases containing (regional and national) annual observations, which enable us to draw inference on the causality of the different relations under study. *Second*, we investigate if national and regional self-employed sectors show convergence in both innovation and trade intensities, by using different approaches in the context of panel data, including the potential existence of convergence clubs. *Third*, the dissertation ends with a paper in which the long memory properties of the exchange rates, i.e. the hypothesis of persistence or long run PPP hypothesis for twenty Latin American countries using fractional integration techniques. We elaborate on each of these contributions below.

Applying time series and panel data techniques

The rationale for estimating panel data models is that the new availability of pooled and internationally comparable data make possible to check en revisit some previous hypothesis, findings and even to shed new light on some of old controversial relationships in the Economics of Entrepreneurship and self-employment. One of the most popular and unresolved controversies in the Economics of Entrepreneurship is how the relationship between trade openness and entrepreneurship is, since we can provide theoretical arguments and economic propositions suggesting contradictory relationships, and the empirical evidence is not able to provide a clear result. In this context, different explanations might be considered, including the existence of different relationships for different countries or nations. This fact points to the need to take into account the potential existence of unobservable heterogeneity and to revisit the question by using the recent approaches of Granger causality in a linear and non linear framework and by using both time series and panel data. Investigating the robustness of these relationships by using these alternative approaches is one of the objectives of this thesis.

Time-series and panel data analysis of entrepreneurship was one of the least developed fields in previous literature due to the deficiencies of the existing statistics.[3] One of the most likely reasons of the rejection of a relationship between two variables is the presence of nonlinearity in the relationship. When a relation between two variables is time-varying it is likely that estimation of a linear model does not give consistent results. In such cases the estimation method should allow for nonlinearity in the estimated relationship. In several chapters of this thesis we account for nonlinearity.

These deficiencies might be behind to the apparent contradictory empirical results provided by previous literature. From this perspective, the availability of new and internationally comparable time series allow to shed some light on these controversies, revisiting some controversies from a macroeconometric perspective, using different econometric approaches in order to test the robustness of these relationships as a way to conciliate and understand some seemingly contradictory results among them.

1.2. Self-employment and measurement

Although entrepreneurship and self-employment are different variables, self-employment and entrepreneurship are used as interchangeable terms thorough this dissertation. This is a common practice in previous literature since self-employment is used as a way to operationalize empirically the concept (Blanchflower, 2000). However, there is no agreement on the definition of self-employment, nor is there on how to measure the rate of self-employment. The self-employed are usually considered working on their own-account and they often own and control their own business and usually the number of self-employed individuals does not include agricultural self-employed. Because there is no consensus on what actually constitutes a self-employed, there is also no agreed method for calculating the number of self-employed.

In this dissertation we also use the Index of Economic Freedom, obtained from the Heritage Foundation. This composite index considers the

[3] We refer mainly to the following problems: short time-series, with low frequency and non-harmonized data for some countries.

following groups of factors: i) Rule of Law (property rights, freedom from corruption); ii) Limited Government (fiscal freedom, government spending); iii) Regulatory Efficiency (business freedom, labor freedom, monetary freedom); and iv) Open Markets (trade freedom, investment freedom, financial freedom).

1.3. Econometric framework: an overview

As we mentioned before, this study takes a macroeconomic approach and focuses on the long-run in which a wide range of alternative estimation procedures are used, in order to test the robustness of our empirical results, including the sensitivity of our results to the detrending methods. Our starting point is the use of panel data estimates combined with a hierarchical clustering using the Ward's linkage to explore possible countries groups in our panel that can offer additional information for a better interpretation of the results

On the other hand, and in order to explore Granger causality between the variables under study, we use three alternative econometric approaches including the Toda and Yamamoto (1995) test –which exploits the longitudinal dimension of our data–; the bootstrap panel Granger causality test developed by Kónya (2006), and finally, we also explore the potential existence of non-linear causality relationships and asymmetries, following the methodology proposed by Hatemi-J (2012).

In order to explore the relationship between economic freedom and entrepreneurship we use an alternative strategy. In particular, we analyse the integration order of each variable to detect whether they are stationary in levels or by contrast, follow unit root processes and thus, are difference stationary. In the case of all variables be non-stationary in levels but stationary in first differences, that is, all may be I(1), we will apply a set of panel cointegration tests in order to investigate the long-run relationship between our variables. The existence of this long-run relationship should imply that 'deviations from equilibrium are stationary, with finite variance' (Engle and Granger, 1987, p.251). Finally, we employ the Fully Modified OLS (FMOLS) estimation and Dynamic OLS (DOLS) for both the pooled and group-mean versions, to explore the nature of the relationships under study.

The two papers devoted to convergence share the same framework in order to explore two concepts of convergence: *stochastic convergence*, which suggests that the impact of a shock on the relative variable under study is temporary -trend stationary-, and time-series *β-convergence*, which implies that the sample average mean reverts to a common level. Following the Carlino and Mills (1993, 1996 a, b) methodology, we will check the stochastic convergence and time-series β-convergence by applying different approaches for panel data: the Lagrange Multiplier stationarity test without structural breaks proposed by Hadri (2000); the unit root test with structural breaks developed by Carrion-i-Silvestre et al., (2005); and finally, the Phillips and Sul (2007) approach related to convergence club test.

Finally, the most common way to look for hysteresis is to assume as null that the variable under study is non-stationarity (follows a random-walk) against the alternative that there is persistence in the long-run.

Testing the stationarity of individual series is thus, the first step to examine the hypothesis of hysteresis and thereby avoid possible spurious results. Nevertheless, this null hypothesis was also questioned as well as the power of the unit root tests with respect to the data sets. Alternatively we can use tests based on cointegration techniques but results seem to offer, once again, inconclusive results. An alternative is to apply fractional differentiation (Caporale and Gil Alana, 2004). To the best of our knowledge its application of fractional integration approach to the PPP hypotheis for Latin American countries is novel.

1.4. Chapter overview

This thesis consists of six self-contained essays structured as follows. It mainly consists of two parts leaving aside this introduction.

Part II includes chapters 2, 3 and 4. It includes three essays about globalization, economic freedom and entrepreneurship.

Chapter 2, carries out an empirical investigation about the impact of three competitiveness vectors, -growth, openness and innovation- on self-employment rates across 21 different income levels economies over the period 1995-2013. With the aim of shed light about the behavior of these vectors across countries and over time, we apply several static and dynamic techniques both for the whole panel and each sub-sample generated by using a hierarchical clustering based on the Ward's linkage. We find that the most of variables under study are statistically significant and coherent with our hypothesis in terms of expected sign, in particular from a static approach. However, we find ambiguity for some variables such as trade openness and FDI in function of the cluster.

Chapter 3 investigates the relationship between trade openness and entrepreneurship for a panel of 20 OECD economies over the period 1960-2014. This relationship is not a clear-cut one because (i) there are theoretical arguments supporting a positive as well as a negative link and (ii) it could be a bi-directional relationship. Consequently, the empirical literature presents ambiguous results. To shed new light on this issue, we examines the nature of Granger causality by applying three alternative econometric approaches: (i) the Toda and Yamamoto (1995) test which exploits the longitudinal dimension of our data; (ii) the bootstrap panel Granger causality test developed by Kónya (2006) and (iii) the methodology provided by Hatemi-J (2012), which allows for non-linear causality relationships and asymmetries. Our empirical results suggest that causal effects are heterogeneous and country-specific and highlight the importance of considering this heterogeneity for the design of entrepreneurship and trade policies as economic recovery engines.

Chapter 4 explores the two-way relationships between self-employment, labor productivity and the economic freedom for a sample of 19 OECD and non-OECD countries over the period 1995-2013, by using different panel unit roots test in order to look for robustness. The study supports the idea that economic freedom enhances entrepreneurship and economic growth. However, we find evidence on the influence of entrepreneurship on institutions. The proliferation of rent seekers and low competitive firms and entrepreneurs, might lead the development of different forms of lobbying (corruption) on regulation in the domestic market and on trade policy as a way to protect their exposure to external competence the proliferation of rent seekers, monopoly and thriving a preferential treatment thriving by public sector. A poverty trap could emerge.

Part IV deals with two topics related with convergence: the hypothesis of convergence in the ratio of exports by self-employed and the hypothesis of stochastic convergence, for the R&D expenditure for a panel of 17 Spanish regions, as a way to check whether as a result of market forces or by the effect of policy shocks and changes in the institutional framework, national and regional self-employed sectors show trends to convergence in terms of both innovation and export orientation.

Chapters 5 and 6 provide empirical evidence for stochastic convergence, time series β-convergence and convergence clubs in the export-self-employment ratio for a panel of 19 OECD countries and in the R&D expenditure-self-employment ratio for 17 Spanish regions, respectively.

Finally, Chapter 7 examines the long-run PPP hypothesis for twelve Latin American real exchange rates (REERs) using fractional integration techniques. The empirical results, applying parametric approaches, provide evidence of mean reversion in the REERs in the cases of Nicaragua, Belize, Costa Rica, Guyana and Paraguay, and lack of it for the remaining seven countries. Employing semiparametric methods the evidence of mean reversion covers the following countries: Belize, the Dominican Republic, Ecuador and Mexico. Thus, only for Belize and Guyana do we obtain consistent evidence of mean reversion in the real exchange rates. At the other extreme, lack of mean reversion, and thus, lack of PPP is obtained with both methods in Bolivia, Brazil, Colombia and Venezuela. For the remaining six countries, the results are ambiguous. The results for the PPP theory in Belize and Guyana may show the importance of promoting policies based on exchange rate flexibility and economic liberalization to reach a long-run stability scenario that lead to greater international competitiveness and lower external vulnerability.

The study concludes with a final chapter 8, containing some concluding remarks and the future research agenda. The following table summarizes the general structure.

Chapter	Objectives	Scope	Data and sources	Econometric Framework
2	Measuring correlation and testing for causality between self-employment –and its components- and macroeconomic variables	Spain and the US	Non-incorporated self-employment for the US and self-employment for Spain, excluding agriculture, hunting, forestry and fishing 1987:2-2004:4 (quarterly data) Spanish LFS and CPS	Traditional statistics VAR forecast errors (den Haan, 2000) Common features (Vahid y Engle, 1993) Instantaneous and Granger causality
3	Measuring correlation, linear cointegration and testing for causality between self-employment –and its components- and macroeconomic variables	EU-12	Self-employment Annual data LFS, Eurostat 1986-2008	Traditional statistics VAR forecast errors (den Haan, 2000) Cointegration (Johansen, 1989) Instantaneous and Granger causality
4	Testing for causalities between self-employment and unemployment for Spanish regions	Spanish regions	Self-employment for Spain, excluding agriculture, hunting, forestry and fishing Annual regional data NUTS-II (1979-2001)	VAR
5	Reconsidering the push-hypothesis, controlling by non-linearity and using employment rates instead of unemployment rates	Spain	Self-employment for Spain, excluding agriculture, hunting, forestry and fishing 1987:2-2004:4 (quarterly data)	Linear cointegration (Johansen, 1988, 1991) Threshold cointegration (Hansen & Seo, 2002)
6	Exploring the discouraged-added worker hypotheses in Spain by sex, age and status and by time dependence	Spain	Employment and active population data for Spain, 1979:3-2008:4 Spanish LFS	Linear cointegration (Johansen, 1988, 1991) Threshold cointegration (Hansen & Seo, 2002)
7	Testing for Hysteresis and evaluating entrepreneurship policies long-run potential	The US and Spain.	Non-incorporated self-employment for the US and self-employment for Spain, excluding agriculture, hunting, forestry and fishing 1987:2-2004:4 (quarterly data) Spanish LFS and CPS	Kalman filter approach and TAR models
8	Testing for cointegration between the two components of Self-employment	Spain	Self-employment for Spain, excluding agriculture, hunting, forestry and fishing 1987:2-2004:4 (quarterly data) Spanish LFS	Linear cointegration (Johansen, 1988, 1991) Threshold cointegration (Hansen & Seo, 2002)

1.5. Publications

Some chapters of this thesis are based on articles published or submitted to academic journals. The chapters can be read independently of each other.

A very early version of chapter 7 was presented in the Seminar Series in Economics and Computer Science SECS-working paper series, University of Huelva (joint with Luis Alberiko Gil Alañá, 2016), and it has submitted for publication in a JCR academic journal.

Chapter 6 is based on an article that was published jointly with Monica Carmona and Jesús Iglesias in Cuadernos Económicos ICE 89, July 2015.

Early versions of chapters 4 and 5 have been submitted to International Conferences.

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Part II: Entrepreneurship, globalisation and economic freedom

Chapter 2: Globalization: industrial and entrepreneurial models of production

This paper carries out an empirical investigation about the impact of three competitiveness vectors, -growth, openness and innovation- on self-employment rates across 21 different income levels economies over the period 1995-2013. With the aim of shed light about the behavior of these vectors across countries and over time, we apply several static and dynamic techniques both for the whole panel and each sub-sample generated by using a hierarchical clustering based on the Ward's linkage. We find that the most of variables under study are statistically significant and coherent with our hypothesis in terms of expected sign, in particular from a static approach. However, we find ambiguity for some variables such as trade openness and FDI in function of the cluster.

2.1. Introduction

This article is an attempt to revisit the issue on the determinants of self-employment from an aggregate perspective. The opportunity to update previous studies (Parker and Robson, 2004; Pietrobelli et al 2004, Millan et al., 2012, Goetz and Rupasingha, 2013) is given by the reversal trend observed recently in the national self-employment rates of most developed economies, being this question a hot policy issue now when practitioners and policy-makers are redefining the goodness of globalization.

Some scholars argue that the reasons of why activity rises in these countries may be related with the economic development. From this perspective, globalization does not destroy self-employment but encourage the entrepreneurial model of production (Acs and Sanders, 2007). In this sense, Acs (2006) suggests that in the most developed economies it is expected that the entrepreneurial activity be positively related to economic development as people shift from wage work to entrepreneurial activity.

The shift away from large corporations and towards smaller entrepreneurial activity (Acs and Audretsch, 1993; van Stel, 2006) with the associated reduction in the average self-employed firm size, as well as the new business opportunities in the service sector for entrepreneurship thanks to the improvements in the Information and Communication Technologies (ICT) are the two potential factors behind this surprising performance of the self-employment rate. Audretsch and Sanders (2007) reinforce this idea suggesting that globalization and the development of the ICT sector are leading a new international division of work, the advanced economies endowed with high skilled workers are specialized in early stages of the product life cycle introducing innovations in products or process, while the less developed economies endowed with low skilled workers are specialized in the off-shored production stage.

Therefore, we should study if the role of the determinants of self-employment has recently changed1 and if it is possible to identify key factors for different groups of countries not only in terms of its degree of economic development but also in terms of the degree of penetration of new technologies and the digitalization in the economy. In some extent, our work is an update of these previous empirical studies to test these hypothesis mentioned including measures for the digital economy and openness in our model of the determinants of aggregate self-employment. To carry out this task, we reports the results of different econometric estimates taking into account first, the possible reverse causality problems, which we try to solve using as instruments for endogenous regressors, the lagged levels of the variables. Secondly, we verify the robustness of the results to different static and dynamic specifications. And finally, we check if the results are stable to different samples defined by groups of homogenous countries obtained through multivariate analysis techniques. Our empirical findings seem to point out towards a relative robustness in the effects of growth, openness and innovation on self-employment as well as the existence of differences between clusters obtained by applying multivariate analysis techniques. These results should help us to a better understanding about the nature of the relationship between economic development and self-employment.

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[1] The lower employment protection legislation, the use of entrepreneurship promotion to turn unemployment into self-employment and the lower requirements of capital in the ICT sector should be also considered as potential factors of this evolution.

2.2. Selected Review of Empirical Literature

The study of the determinants of self-employment has been addressed by a wide body of researches in recent decades. According to Audretsch, et al., (2002) and focusing on the level of analysis, we can distinguish a set of microeconometric studies such as the seminal papers of Ree and Shah (1986), for United Kingdom; Evans and Jovanovic (1989) and Evans and Leighton (1989), for United States; Blanchflower and Meyer (1994) for Australia; Alba-Ramirez (1994) for Spain or Foti and Vivarelli (1994) for Italy. Others address this issue from a macroeconomic perspective. This is the case of Acs and Evans (1994), Cowling (1998), Wildeman and Thurik (1999), Blanchflower (2000), Carree et al., (2002), Parker and Robson (2004), Pietrobelli et al., (2004), Congregado et al., (2010), Millan et al., (2012), Goetz and Rupasingha (2013) or van Stel et al. (2014).

A second classification criteria consists of analysing the possible determinants from the demand and the supply side depending on if they refer to production or labor market and social structure, respectively. So, and according to Audretsch, et al., (2002), the levels of self-employment may be influenced by different demand side factors such as the stage of economic development, technological progress, trade openness, globalization or industrial structure, among others, whose interaction can generate new business opportunities to be exploited by entrepreneurs. From the supply side, the authors point out a set of socio-demographic and labor factors such as the unemployment rate, the level of labor force female in the total employment or the population density.

Last, in a recent publication by OECD called 'Entrepreneurship at a Glance, 2015' we find a new review of the most relevant indicators for the study of entrepreneurship, classifying them into the following six groups: i) Regulatory Framework; ii) Market Conditions; iii) Access to Finances; iv) Creation and Diffusion of Knowledge; v) Entrepreneurial Capabilities and vi) Entrepreneurial Culture.

For ease the analysis, and given that our investigation is focused on three competitiveness vectors, - *growth* (and economic development), *openness* and *innovation*-, we proceed to comment briefly the main evidences in relation to these determinants.

Regarding to the first vector, the empirical finding suggest that the most advanced economies show lower rates of self-employment, that is, there is a inverse relationship between economic development and self-employment rate (Kuznets, 1966; Acs, Audretsch and Evans, 1994; Carree et al., 2001; Pietrobelli et al., 2004; Wennekers, 2006). Indeed, only when workers pass from a situation of necessity self-employment to opportunity self-employment, then the levels of economic development may increase (Acs, 2006; Bosma et al. 2008, Acs and Amorós, 2008). However, Pietrobelli et al., (2004) find that "… in an intermediate stage of the development process, self-employment can represent an important means of fostering development, that later disappears…".

For the second vector, if we analyze it in terms of trade openness, we find a double effect. On the one hand, the disappearance of tariff barriers among nations contributes to internationalization of markets and generates new business opportunities, and thus, new opportunities for self-employment. On the other hand, a more exposure to international trade also increases the competitiveness among firms which requires, for ensuring its survival in the sector, an optimal exploitation of economies of scale, fact that may negatively affect to self-employment. However, there is significant evidence in the link between trade openness and self-employment rate which asserts that a higher levels of trade openness implies lower shares of self-employment in the labour force (Acs et al., 1994; Pietrobelli et al. 2004; Díez and Ozdagli, 2011), being these effects more intense in the short-run than in the medium-run (Scholman et al., 2012). The openness vector measures in terms of foreign direct investment (FDI) -also considered as a proxy of knowledge spillover and technology transfer Audretsch and Sanders (2007)-, presents and ambiguous behavior depending on the development stage of countries.

Finally, the development of ICT has contributed to improve the competitiveness and has favored the innovation and a more efficient production scale (Loveman and Sengenberger, 1991; Jovanovic, 1993). However, the diffusion of the technological change, and in particular, the internet as the main technological change over the last decades, is a country-specific process and does not follow a unique pattern. According to Suárez and Guillén (2000), "... internet development is a complex phenomenon shaped not only by public policy and conditions for entrepreneurship but also by specific contingencies in each country". Likewise, they find the existence of a positive effect of technological change on skills of individual. By contrast, the requirement of new skills and capabilities may decrease the level of self-employment and may form a barrier to entry for new entrepreneurs. (EIM/ENSR, 1993, 1996; Audretsch, Thurik, Verheul and Wennekers, 2002)

In addition, numerous works on the determinants of self-employment have pointed out the importance of others institutional and socio-demographic factors to understand this issue (Rees and Shah, 1986; Evans and Leighton, 1989; Cowling, 1998; Blanchflower, 2000; Pietrobelli, et al., 2004; Verheul et al., 2006; Congregado, et al., 2014). For instance, regarding to self-employment in urban and rural labour markets, Faggio and Silva (2014) point out that "more rural than urban workers become self-employed in areas with comparably poor labour market opportunities" . Klapper and Love (2011) study the impact of financial crisis on new firm registration using a panel data of 95 countries over the six-year period 2004 to 2009. Using domestic credit to the private sector as a measure of financial development, they find that there is a high decline of new business creation in those countries with higher levels of financial development. On the other hand, Loayza and Rigolini (2011) investigate the trend and cycles of self-employed as a measure of informality for a panel data sample of 54 countries over 1984-2008. Their results suggest a negative and significant correlation between self-employment rate and the ratio of government consumption expenditure to GDP, as measure of size of government.

Therefore, and considering all these previous empirical evidences, we can define the following hypothesis:

H.1. There is an inverse relationship between the *growth* vector and self-employment in advanced economies that confirms the Kuznets (1966) hypothesis.

H.2. There is an inverse relationship between the *openness* and self-employment in advanced economies and a direct link in less advanced countries.

H.3. There is a direct link between the innovation vector and self-employment.

H.4a. A high share of rural population increases self-employment

H.4b. A high financial development declines self-employment

H.4c. A large public sector size has negative effects on self-employment.

2.3. Dataset Description

To carry out this investigation, we use a panel data set[2] of 21 economies at different levels of income over the annual period 1995-2013. All variables are obtained from the World Bank Development Indicators (WDI) and are expressed in logs[3].

The dependent variable is the total self-employed workers as percent of total employment (LSELF). This variable is commonly used as a measure of entrepreneurship (Acs et al., 1994; Blanchflower, 2000, 2004; Carree et al., 2002, 2007; Parker, 2004; Verheul et al., 2006; Van Praag and Versloot, 2008; Díez and Ozdagli, 2011; Bjuggren et al., 2012; Congregado et al., 2012; Goetz et al., 2012; Simoes et al., 2015) and, at the same time, as a measure of the informal employment (Yamada, 1996; Loayza, 1996; Maloney, 2001, 2004; Perry et al., 2007; Bosh and Maloney, 2008, 2010; OECD, 2009; Fiess et al., 2010; Loayza and Rigolini, 2011) due to it is well defined and available for both cross-sectional and longitudinal dimensions. This enables us to estimate dynamic regressions and analyse long-run and short-run relationships (Parker, 2009; Loayza and Rigolini, 2011). According to the definition offered by WDI, "self-employed workers are those workers who, working on their own account or with one or a few partners or in cooperative, hold the type of jobs defined as a 'self-employment jobs' i.e. jobs where the remuneration is directly dependent upon the profits derived from the goods and services produced" Thus, in this indicator are included the following four subcategories: employers, own-account workers, members of producers' cooperatives, and contributing family workers.

As explanatory variables, we use the following indicators: i) For the economic growth vector, we consider GDP per person employed (constant 2011 PPP $) and its squared term, that is, LYPE and LYPE_2, respectively, to capture both its initial effect (LYPE) and its long-run effect (LYPE_2) on the dependent variable. ii) The international openness vector is measure through the trade-to-GDP ratio, that is, the sum of exports and imports of goods and services to gross domestic product (LTRD). Last, iii) for the innovation vector is used the number of scientific and technical journal articles published in different fields such as physics, mathematics,

2 The list of countries is shown in Table 1 of Appendix.

3 A brief description of the each variable used in our model as well as its main descriptive statistics are presented in Tables 2 and 3 of Appendix.

engineering and technology among others (LSCI) and the number of Internet users (per 100 people) as a measure of knowledge spillover (LNET).

The effects of these three competitiveness vectors will be controlled taking into account the following regressors: domestic credit to private sector (% of GDP), as a proxy for financial development; general government final consumption expenditure (% of GDP), as a measure for government size; and finally, the rural population (% of total population) which describes the socio-demographic characteristics of national population.

2.4. Methodology

The methodological strategy adopted in this paper is double: First, we carry out a comprehensive study of our model from both a static and dynamic perspective by using different econometric techniques to provide empirical evidence about our hypothesis. Next, we perform a hierarchical clustering using the Ward's linkage to explore possible countries groups in our panel that can offer additional information or nuances for a better interpretation of the results, for which we repeat again all the estimates - static and dynamic- for each sub-sample defined[4].

2.4.1. Pre-clustering analysis

Our starting-point consists of analyzing our model from a static approach by applying several statistical techniques in order to compare the consistency, efficiency and robustness of our estimations. A baseline specification of our model can be describe by:

$$LSELF_{i,t} = \alpha + \beta' X_{it} + \lambda' C_{it} + \eta_i + \gamma_t + \varepsilon_{it} \quad \text{for } i = 1, \dots, N \text{ and } t = 1, \dots, T \tag{1}$$

where the subscripts *i* and *t* denote the cross-section and the time period in the panel, respectively; $LSELF_{i,t}$ is the dependent variable, the logarithms of self-employed rate; α is the intercept; $X_{i,t}$ is a vector of explanatory variables that includes the variables corresponding to the three com-

[4] All results are obtained using Stata.

petitiveness vectors, that is, the *growth* ($LYPE_{i,t}$, $LYPE\_2_{i,t}$), *openness* ($LTRD_{i,t}$) and *innovation* ($LSCI_{i,t}$, $LNET_{i,t}$) vectors, $C_{i,t}$ contains the control variables required ($LDOM_{i,t}$, $LGOV_{i,t}$, $LRURAL_{i,t}$)*;* disturbances may be divided into three components: η_i measures the unobserved heterogeneity which varies across countries but remains constant over the time; γ_t captures the unobserved effects which only varies over time; and $\varepsilon_{i,t}$ which includes the unobserved heterogeneity which varies both across countries and over the time.

According to Equation (1), the behavior of $LSELF_{i,t}$ may be explained by variations of some of the three competitiveness vectors evaluated, for which is taking into account not only the effects of other factors of financial, institutional and demographic nature but also the unobservable individual heterogeneity -individual effects- captured by this model. With this aim, we proceed to apply a set of static estimation methods such as the pooled ordinary least squares (POLS), the random-effect and fixed-effect models and, last the panel-corrected standard errors (PCSE). Focusing on the way of treatment of problem of the individual effects, the POLS model is probably the most restricting specification of our model, assuming that such effects are constant and thus, there is no unobserved individual heterogeneity across country and over the time. By contrast, the fixed-effects method suggest that individual effects vary across cross-sectional units but not over time while the random-effects model establishes that individual effects vary in a random process. In the presence of heterogeneity, a random-effects estimator may be more efficiency than the fixed-effects estimator but also may be inconsistent whether is detected the presence of correlation between the individual effects and at least one of the regressors of the model (Baltagi, 1995; Greene, 1995). To decide between both estimators we apply the Hausman test. Under the null-hypothesis of no correlation between the error term and the regressors, both estimators (fixed-effects and random-effects) are consistent, but in this case, the random-effects estimator is more efficiency. The rejection of the null involves that the fixed effects model is the most appropriate specification. Additionally, we perform two test: the Breusch-Pagan/Cook-Weisberg test for heteroskedasticity and the Breusch-Pagan Lagrange Multiplier (LM) test for random effects versus (pooled) OLS regression, to help to decide about the most suitable model. Finally, we apply the panel-corrected standard error estimates (PCSE) under the assumption that disturbances are heteroskedastic and contemporaneously correlated across panels (Beck and Katz, 1995; Egger, 2002).

However, and according to empirical literature, linear static models (1) may provide biased and inconsistent estimates due to the presence of heteroscedasticity, endogenous regressors or the existence of serial correlation in the disturbances. For these reasons we proceed to apply our second econometric method: the dynamic approach.

$$LSELF_{it} = \alpha + \delta LSELF_{it-1} + \beta' X_{it} + \lambda' C_{it} + \eta_i + \gamma_t + \varepsilon_{it} \quad \text{for } i = 1, \ldots, N \text{ and } t = 1, \ldots, T \qquad (2)$$

In linear dynamic models (2), unobserved panel-level effects, -fixed or random-, are correlated with the lagged dependent variable, providing inconsistent estimations. The Generalized Method of Moments (GMM) allows making estimations in panel-data models affected by these kinds of problems, taking into account unobserved individual effects. In their seminal paper, Arellano and Bond (1991) suggest the first differenced GMM estimator (Diff-GMM), using as instruments for endogenous regressors, the lagged levels of the variables, which implies transform the original model taking first differences. Later, Arellano and Bover (1995) and Blundell and Bond (1998, 2000) proposed an alternative estimator with better properties when the T dimension of panel is small: the GMM system estimator (Sys-GMM). This estimator enables to estimate levels and first differenced equations and offers both efficient estimates in the presence of heteroskedasticity and consistent, whether there is no-second order serial correlation in the residuals. We also use the option *two-step* GMM system estimator given that it provides efficient estimates in the presence of heteroskedasticity and autocorrelation (Windmeijer, F. 2005; Mileva, 2007). Finally, we apply the Least Squared Dummy Variable Corrector (LSDVC) method, which can provide efficient estimators when the sample size is small (Bruno, 2005b). In particular, we use the Anderson-Hsiao option as initial estimator.

2.4.2. Hierarchical clustering analysis (HCA).

The following step consists of performing a HCA with Ward's linkage to the whole panel with the aim of finding out different sub-groups. This agglomerative clustering is an efficient method to define small clusters by minimizing the sum of squares of the distances between clusters. We will perform two HCA: one, when T = 1995 (initial period of the sample) and another, when T = 2013. The different defined groups will be evaluated from the static and dynamic approaches, applying the same techniques discussed in section 4.1.

2.5. Empirical Results

This section presents the results of the estimations and discusses the main findings according to previous literature. These results are reported in Tables 4 to 9 in Appendix.

2.5.1. Pre-clustering results.

Table 4A shows the result of the static analysis performed on the whole panel data sample. Through the different method of estimation, that is, Pooled OLS, Random effect, Fixed effect and Panel-corrected standard errors, we can observe strong robustness in terms of the expected sign and the value of the coefficients of each variable, being statistically significant at 1% and 5% in most cases. The results for the growth vector show that both the coefficients of LYPE and LYPE_2 are statistically significant at the 1% , but opposite in sign, positive for LYPE and negative for LYPE_2, which suggests an inverted U-shape relationship with LSELF. Indeed, among all regressors, we note the strongest effects of LYPE on LSELF, so that, if LYPE increases by 1%, LSELF would increase between 3% and more than 5%, depending on the estimate method used. In relation to the openness vector, we find an inverse and statistically significant relationship at the 5% level (except in POLS and PCSE models) for the variable LTRD but not significant for the variable FDI (except in POLS), which confirms our hypothesis H.2 However, we find a weak influence of this vector on dependent variable. In addition, the coefficients of the variables corresponding to the innovation vector, i.e. LSCI and LNET, both maintain a positive and significant relationship in most of the estimated models (except in POLS and FE models for LSCI and LNET, respectively) confirming, thus, the hypothesis H.3 stated, but its effects, as with LTRD and FDI, are very weak compared to the sensitivity shown by the rest regressors. Likewise, the coefficients of the control variables indicate the existence of an inverse relationship for LDOM and LGOV with respect to LSELF, being significant at the 1% and 5% level, except for LGOV in the POLS, random and fixed effects estimates. By contrast, it should be noted the importance of controlling by LRUR whose results show a positive relationship with LSELF and statistically significant at 1% level in all cases. It would imply that if LRUR increases by 1%, then LSELF will grow between 0.2 and 0.3%. Therefore, the effects of the control variables on LSELF seem to be significant and coherent with the hypothesis H.4a, H.4b and H.4c previously defined. Finally, we complete the static analysis with three statistic tests which will help us to find the most appropriate estimation method for our econometric specification: For Breusch-Pagan / Cook-Weisberg test for heteroskedasticity, we reject the null of constant variance which implies that in this model heteroskedasticity is present. To address this problem, we analysis the results for PCSE model. Secondly, we apply the Breusch-Pagan LM test to decide between POLS or RE model. In our case, the rejection of the null of constant variance implies that RE model is more suitable than POLS model. The third test used is the Hausman test which allows us to choose between RE or FE model. The rejection of the null of no correlation between the error term and one or more regressors implies that FE is the model more appropriate.

Next, we proceed to discuss the results obtained in the dynamic analysis in which are included the lagged levels of the dependent variable as explanatory variable ($LSELF_{i,t-1}$). These results are shown in Table 4B. Both the Diff-GMM and the Sys-GMM model are implemented using the one-step and two-step options. In general, the results are robust in terms of the expected sign but not in terms of the level of significance of the coefficients, which are only statistically significant at 1% and 5% in the one-step estimates (Diff-GMM and Sys-GMM) for the regressors LSELF, LYPE, LYPE_2, LTRD (only in Sys-GMM), LSCI, LNET (only in Sys-GMM), LGOV and LRUR. We also find statistically significant at 5% and 10% levels the variables LYPE, LYPE_2, LSCI (1% in the case of Sys-GMM) LNET (only in Sys-GMM) and LGOV when we perform Diff-GMM and Sys-GMM methods under the option two-step. However, given that the GMM estimator requires the non-existence of second order autocorrelation in first-differenced errors, we proceed to verify it using the Arellano-Bond test. The results show that the null-hypothesis can be rejected only for the one-step GMM estimator, so the two-step GMM estimator (both in Diff-GMM and Sys-GMM) is not robust. On the other hand, we do not take in consideration the results for Sargan test given that, in presence of heteroskedasticity there is a high probability to over-reject the null-hypothesis (Arellano-Bond, 1991)

2.5.2.Post-clustering results.

Figures 1 and 2 show the dendrogram corresponding to the HCA performed in the initial and final periods of the sample (1995 and 2013). In both figures, two large groups are defined: G-I and G-II for the first cluster

(T=1995) and G-III and G-IV for the second cluster (T=2013). Table 5 summarizes the countries included in each group. The objective of this section is to verify if the results of the estimates are stable across clusters and over time.

The first cluster seems to follow a classification criterion based only on the stage of economic development or the income level. Indeed, we find a first group (G-I) composed of the most advanced economies (The G-7) and a second group (G-II) of the remaining countries, excluding Egypt (no country: 21). The static results for the G-I group are not robust in terms of the expected sign and the level of significance of the coefficients across the different estimation models. Only the expected sign for the LDOM and LRUR variables is confirmed. For the most advanced economies, an inverse and statistically significant relationship is detected at the 1% level for the FDI and LSCI variables. By contrast, the results of the estimates for the G-II group confirm the sign of the relationship for most variables. It should be noted that for G-I, the variables FDI and LSCI have negative sign while for G-II, both have positive sign, being only LSCI significant at the 1% level. For both cases, the results of Breusch-Pagan/Cook-Weisberb test verify the absence of heteroskedasticity in the samples. The sign ambiguity for FDI and LSCI was again found in the dynamic analysis, showing an inverse relationship for G-I and direct for G-II. The results are consistent with the expected sign for the variables LSELF (lag), LYPE, LYPE_2, LTRD (except for the LSDVC model in G-I), LDOM and LRUR.

For the second cluster (G-III and G-IV groups) the sub-samples are more heterogeneous, which is reflected in the results of the Breush-Pagan / Cook-Weisberg test for heteroskedasticity. In the static analysis only the variables LYPE, LYPE_2 and LRUR show a behavior consistent with the expected sign, being significant at 1% level in most cases. In addition, a different relationship of the LTRD variable on LSELF is observed depending on the sample: for G-III the relationship is direct and significant at the 1% and 5% level whereas for G-IV the variable maintains an inverse relation with LSELF (except for the PCSE model). The results also show the expected behavior for the LDOM in G-IV at the 1% significance level. In the dynamic analysis we can confirm the expected sign only for the variables LYPE, LYPE_2, LDOM and LRUR which are only statistically signficant in G-IV (Diff- and Sys-GMM).

2.6. Conclusions and policy implications

This paper presents an empirical study of a selected set of determinants of self-employment using a panel data set of 21 different income level economies over the period 1995-2013. By applying both static and dynamic perspectives, our findings seem to point out towards a relative robustness in the effects of growth, openness and innovation on self-employment as well as the existence of differences between clusters obtained by applying multivariate analysis techniques. Indeed, we find that the variables FDI and LSCI have negative impact on LSELF for the G-7 (G-I) while for the less advanced economies (G-II), both variables have a positive sign being only LSCI significant at the 1% level for this last cluster. For LTRD, the results show an ambiguous behavior for the clusters G-III and G-IV. This results should help us to a better understanding about the nature of the relationship between economic development and self-employment.

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APPENDIX

Table 1
List of Countries

The G-7		Latin American countries		Other countries	
CAN	Canada	ARG	Argentina	HRV	Croatia
FRA	France	COL	Colombia	ROM	Romania
DEU	Germany	CRI	Costa Rica	MYS	Malaysia
ITA	Italy	DOM	Dominican Rep.	THA	Thailand
JPN	Japan	ECU	Ecuador	LKA	Sri Lanka
GBR	United Kingdom	SLV	El Salvador	EGY	Egypt
USA	United States	MEX	Mexico		
		PER	Peru		

Table 2
List of Variables. Code and description

Code	List of Variables
LSELF	Self-employed, total (% of total employment), in logs
LYPE	GDP per person employed (constant 2011 PPP $), in logs
LYPE_2	GDP per person employed squared, in logs
LTRD	Trade (% of GDP) , in logs
FDI	
LDOM	Domestic credit to private sector (% of GDP) , in logs
LGOV	General government final consumption expenditure (% of GDP) , in logs
LRUR	Rural population (% of total population) , in logs
LSCI	Scientific and technical journal articles, in logs
LNET	Internet users (per 100 people) , in logs

Source: World Bank. World Development Indicators

Table 3
Univariate summary statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
LSELF	399	3.265	0.609	1.887	4.164
LYPE	399	10.519	0.625	9.373	11.601
LTRD	399	4.045	0.487	2.814	5.395
FDI	399	2.759	2.072	-0.725	12.718
LSCI	398	7.947	2.924	0.095	12.935
LNET	399	2.334	1.959	-5.206	4.498
LDOM	398	3.942	0.834	1.959	5.399
LGOV	398	2.664	0.297	1.521	3.217
LRUR	399	3.413	0.495	2.016	4.403

Table 4A
Pre-cluster static panel results

($LSELF_{it}$)	*POLS*	*RE*	*FE*	*PCSE*
$LYPE_{it}$	5.808***	3.654***	2.998***	6.025***
	(1.002)	(0.756)	(0.771)	(1.101)
$LYPE\_2_{it}$	-0.306***	-0.195***	-0.161***	-0.322***
	(0.047)	(0.037)	(0.038)	(0.052)
$LTRD_{it}$	-0.050	-0.057**	-0.061**	-0.024
	(0.037)	(0.029)	(0.029)	(0.030)
FDI_{it}	-0.014**	0.000	0.000	-0.002
	(0.007)	(0.002)	(0.002)	(0.001)
$LSCI_{it}$	0.001	0.031***	0.039***	0.015*
	(0.010)	(0.010)	(0.011)	(0.008)
$LNET_{it}$	0.026***	0.010**	0.006	0.021***
	(0.009)	(0.004)	(0.005)	(0.005)
$LDOM_{it}$	-0.102***	-0.041**	-0.044**	-0.073***
	(0.023)	(0.017)	(0.017)	(0.020)
$LGOV_{it}$	-0.121*	-0.040	-0.027	-0.089**
	(0.064)	(0.039)	(0.040)	(0.036)
$LRUR_{it}$	0.322***	0.238***	0.245***	0.207***
	(0.038)	(0.043)	(0.044)	(0.045)
Constant	-24.066***	-14.129***	-11.119***	-24.602***
	(5.285)	(3.885)	(3.944)	(5.831)
Observations	397	397	397	397
No. countries	21	21	21	21
R-squared	0.827	0.8014[a]	0.7667[a]	0.997
B-P/C-W test [c]	32.77			
(p-value)	(0.000)			
B-P LM test [c]		2739.59		
(p-value)		(0.000)		
Hausman test[d]		18.03		
(p-value)		(0.021)		

Notes:
Standard errors in parentheses.
Levels of significance: *** p<0.01, ** p<0.05, * p<0.1
[a] R-squared overall.
[b] Breusch-Pagan / Cook-Weisberg test for heteroskedasticity. (*H_o: constant variance*)
[c] Breusch and Pagan Lagrangian multiplier test for random effects. (*H_o: $Var(u) = 0$*)
[d] Hausman test. (*H_o: difference in coefficients not systematic*)

Table 4B
Pre-cluster dynamic panel results

	Difference GMM		System GMM		LSDVC [a]
	One-step	Two-step	One-step	Two-step	
$LSELF_{it-1}$	0.250***	0.029	0.575***	0.260	0.691***
	(0.058)	(0.145)	(0.043)	(0.184)	(0.065)
$LYPE_{it}$	4.475***	9.217**	3.481***	9.214**	0.536
	(0.866)	(4.086)	(0.712)	(4.619)	(1.128)
$LYPE\_2_{it}$	-0.234***	-0.471**	-0.184***	-0.473**	-0.031
	(0.043)	(0.202)	(0.035)	(0.228)	(0.055)
$LTRD_{it}$	-0.031	0.015	-0.075***	-0.006	-0.041
	(0.027)	(0.064)	(0.024)	(0.068)	(0.034)
FDI_{it}	-0.000	-0.001	-0.001	-0.001	-0.001
	(0.002)	(0.001)	(0.002)	(0.001)	(0.003)
$LSCI_{it}$	0.037***	0.020*	0.016**	0.024***	0.018
	(0.011)	(0.011)	(0.006)	(0.007)	(0.017)
$LNET_{it}$	0.001	0.007	0.013***	0.013**	0.000
	(0.004)	(0.005)	(0.003)	(0.006)	(0.007)
$LDOM_{it}$	-0.019	0.066	-0.020	0.096	-0.026
	(0.016)	(0.062)	(0.017)	(0.062)	(0.022)
$LGOV_{it}$	-0.084***	-0.258**	-0.063**	-0.245*	-0.013
	(0.031)	(0.114)	(0.032)	(0.134)	(0.051)
$LRUR_{it}$	0.094**	0.051	0.086***	0.080	0.080
	(0.040)	(0.122)	(0.027)	(0.120)	(0.059)
Constant	-18.793***	-41.489**	-14.666***	-42.137*	
	(4.319)	(20.269)	(3.569)	(23.057)	
Observations	355	355	377	377	377
No. countries	21	21	21	21	21
Sargan test	242.936	6.446	267.675	5.600	-
(p-value)	(0.000)	(1.000)	(0.000)	(1.000)	-
AR(1) test[b]	-2.618	-0.037	-3.290	-0.1216	-
(p-value)	(0.009)	(0.971)	(0.001)	(0.903)	-
AR(2) test[b]	-0.966	-0.168	-0.877	-0.403	-
(p-value)	(0.334)	(0.867)	(0.380)	(0.687)	-

Notes:

Standard errors in parentheses.

Levels of significance: *** p<0.01, ** p<0.05, * p<0.1

[a] Bias correction initialized by Anderson and Hsiao estimator up to order O(1/NT)

[b] Arellano-Bond test for zero autocorrelation in first-differenced errors (H_0: no autocorrelation)
(Arellano-Bond test cannot calculate AR tests with dropped variables)

Figure 1. Dendrogram for hierarchical clustering - Ward's Linkage (T=1995)

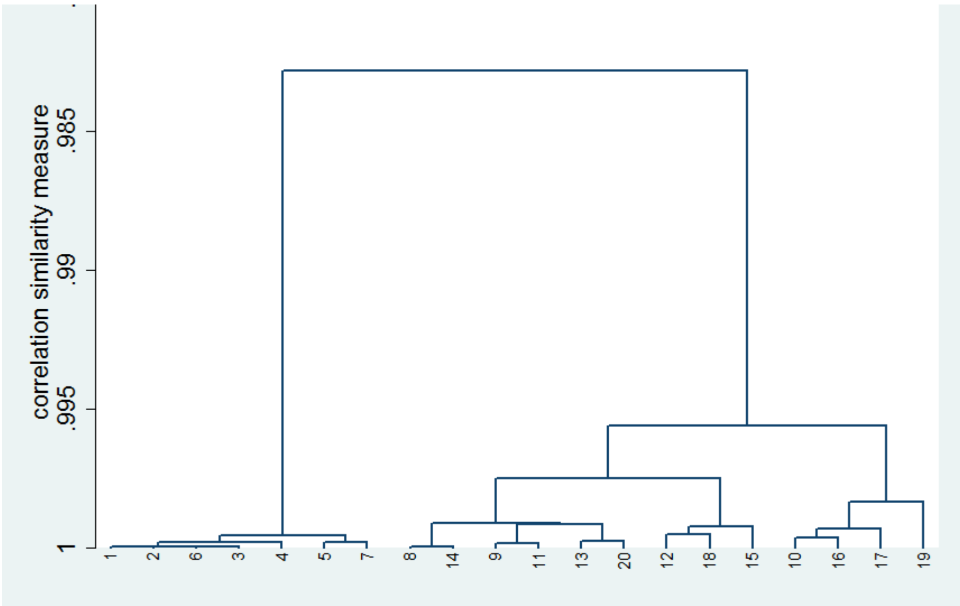

Figure 2. Dendrogram for hierarchical clustering - Ward's Linkage (T=2013)

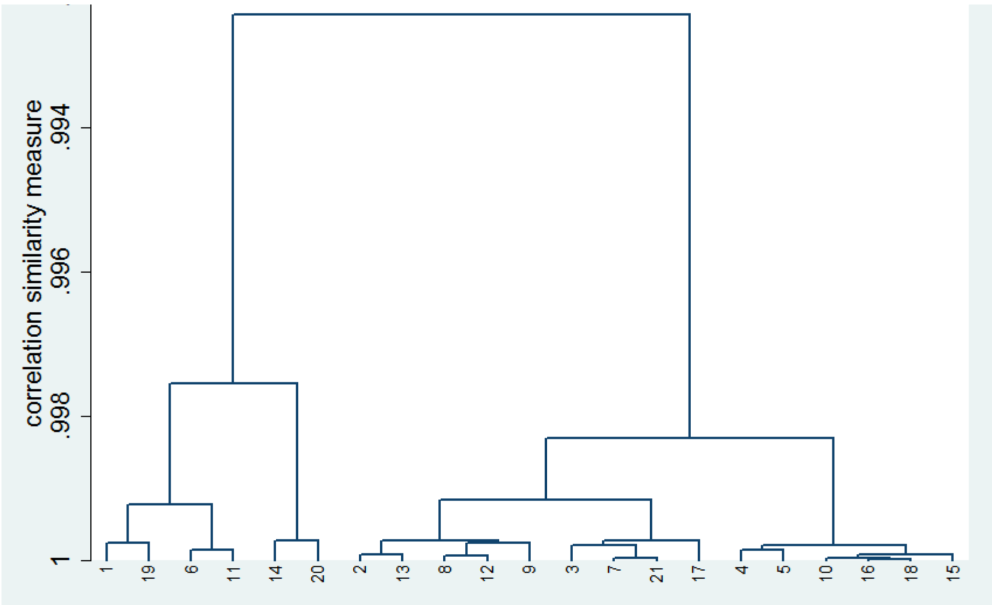

Table 5
Resume of hierarchical clustering

Time	Group	List of countries
1995	G-I	CAN, FRA, DEU, ITA, JPN, GBR, USA (*The G-7*)
	G-II	ARG, COL, CRI, DOM, ECU, SLV, MEX, PER, HRV, MYS, ROM, LKA, THA.
2013	G-III	CAN, GBR, HRV, THA, CRI, LKA
	G-IV	FRA, DEU, ITA, JPN, USA, ARG, COL, ECU, ROM, MYS, MEX, PER, DOM, SLV, EGY

Table 6A

Post-cluster static panel results. G-I & G-II

	G-I				*G-II*			
($LSELF_{it}$)	*POLS*	*RE*	*FE*	*PCSE*	*POLS*	*RE*	*FE*	*PCSE*
$LYPE_{it}$	-46.645*	-46.645*	32.757***	-16.172	8.869***	6.397***	6.407***	6.745***
	(26.046)	(26.046)	(5.328)	(17.330)	(1.564)	(1.063)	(1.078)	(2.100)
$LYPE\_2_{it}$	2.039*	2.039*	-1.437***	0.729	-0.464***	-0.338***	-0.338***	-0.363***
	(1.154)	(1.154)	(0.235)	(0.767)	(0.077)	(0.053)	(0.054)	(0.102)
$LTRD_{it}$	-0.510***	-0.510***	0.264***	-0.029	-0.181***	-0.133***	-0.134***	-0.070*
	(0.089)	(0.089)	(0.038)	(0.054)	(0.034)	(0.033)	(0.034)	(0.037)
FDI_{it}	-0.027***	-0.027***	-0.007***	-0.002	0.008	0.005*	0.005*	-0.000
	(0.010)	(0.010)	(0.002)	(0.002)	(0.006)	(0.003)	(0.003)	(0.002)
$LSCI_{it}$	-0.381***	-0.381***	-0.106***	-0.153***	0.031***	0.054***	0.057***	0.033***
	(0.066)	(0.066)	(0.025)	(0.041)	(0.007)	(0.011)	(0.012)	(0.009)
$LNET_{it}$	0.192***	0.192***	-0.012	0.015	0.026***	0.007	0.005	0.012*
	(0.031)	(0.031)	(0.008)	(0.017)	(0.006)	(0.005)	(0.005)	(0.007)
$LDOM_{it}$	-0.464***	-0.464***	-0.035	-0.144***	0.095***	-0.010	-0.015	0.011
	(0.113)	(0.113)	(0.027)	(0.045)	(0.021)	(0.019)	(0.019)	(0.024)
$LGOV_{it}$	-0.120	-0.120	0.295***	0.134	-0.315***	-0.095**	-0.092**	-0.144***
	(0.256)	(0.256)	(0.088)	(0.143)	(0.047)	(0.040)	(0.042)	(0.035)
$LRUR_{it}$	0.499***	0.499***	0.624***	0.285**	0.209***	0.134**	0.116	-0.043
	(0.125)	(0.125)	(0.038)	(0.116)	(0.028)	(0.063)	(0.072)	(0.082)
Constant	275.856*	275.856*	-186.437***	93.268	-38.284***	-26.432***	-26.474***	-26.857**
	(146.883)	(146.883)	(30.283)	(97.862)	(7.991)	(5.368)	(5.430)	(10.801)
Observations	133	133	133	133	264	264	264	264
No. countries	7	7	7	7	14	14	14	14
R-squared	0.639	0.639[a]	0.204[a]	0.988	0.684	0.515[a]	0.475[a]	0.994
B-P/C-W test [c]	0.01				0.22			
(p-value)	(0.922)				(0.643)			
B-P LM test [c]		0.00				1244.36		
(p-value)		(1.000)				(0.000)		
Hausman test[d]			119.77				5.29	
(p-value)			(0.000)				(0.726)	

Notes:
Standard errors in parentheses.
Levels of significance: *** p<0.01, ** p<0.05, * p<0.1
[a] R-squared overall.
[b] Breusch-Pagan / Cook-Weisberg test for heteroskedasticity. (H_o*: constant variance*)
[c] Breusch and Pagan Lagrangian multiplier test for random effects. (H_o: *Var(u) = 0*)
[d] Hausman test. (H_o: *difference in coefficients not systematic*)

Table 6B
Post-cluster dynamic panel results. G-I & G-II

	Diff-GMM[c]	Sys-GMM[c]	LSDVC[a]	Diff-GMM[c]	Sys-GMM[c]	LSDVC[a]
$LSELF_{it-1}$	0.824***	0.990***	0.809***	0.325***	0.560***	0.567***
	(0.056)	(0.021)	(0.110)	(0.065)	(0.051)	(0.077)
$LYPE_{it}$	6.037	2.368	4.467	6.166***	3.992***	2.491
	(3.986)	(3.475)	(27.244)	(1.219)	(1.210)	(4.550)
$LYPE\_2_{it}$	-0.267	-0.108	-0.195	-0.317***	-0.207***	-0.132
	(0.175)	(0.153)	(1.202)	(0.061)	(0.061)	(0.228)
$LTRD_{it}$	-0.011	-0.023*	0.008	-0.056	-0.111***	-0.072
	(0.027)	(0.014)	(0.149)	(0.036)	(0.029)	(0.134)
FDI_{it}	-0.003***	-0.003**	-0.003	0.001	-0.001	0.002
	(0.001)	(0.001)	(0.005)	(0.002)	(0.002)	(0.011)
$LSCI_{it}$	-0.039**	-0.002	-0.042	0.041***	0.009	0.032
	(0.016)	(0.011)	(0.104)	(0.013)	(0.008)	(0.056)
$LNET_{it}$	0.007	0.003	0.008	-0.003	0.014***	-0.000
	(0.005)	(0.005)	(0.033)	(0.006)	(0.004)	(0.027)
$LDOM_{it}$	-0.012	-0.005	-0.020	-0.043**	-0.019	-0.022
	(0.016)	(0.015)	(0.112)	(0.020)	(0.020)	(0.074)
$LGOV_{it}$	0.202***	0.160***	0.198	-0.053	-0.050	-0.050
	(0.055)	(0.039)	(0.392)	(0.036)	(0.035)	(0.156)
$LRUR_{it}$	0.100**	0.027	0.131	0.056	0.135***	0.071
	(0.041)	(0.016)	(0.176)	(0.065)	(0.036)	(0.278)
Constant	-34.115	-13.382		-27.432***	-17.505***	
	(22.662)	(19.677)		(6.019)	(5.984)	
Observations	119	126	126	236	251	251
No. countries	7	7	7	14	14	14
Sargan test	116.115	147.454	-	206.654	218.481	-
(p-value)	(0.090)	(0.019)	-	(0.000)	(0.002)	-
AR(1) test[b]	-2.460	-2.283	-	-2.987	-2.958	-
(p-value)	(0.014)	(0.023)	-	(0.003)	(0.003)	-
AR(2) test[b]	-1.051	-1.001	-	-0.882	-0.846	-
(p-value)	(0.294)	(0.317)	-	(0.378)	(0.398)	-

Notes:
Standard errors in parentheses.
Levels of significance: *** p<0.01, ** p<0.05, * p<0.1
[a] Bias correction initialized by Anderson and Hsiao estimator up to order O(1/NT)
[b] Arellano-Bond test for zero autocorrelation in first-differenced errors (H_0: no autocorrelation)
(Arellano-Bond test cannot calculate AR tests with dropped variables)
[c] Only reported one-step.

Table 7A

Post-cluster static panel results. G-III & G-IV

	G-III				*G-IV*			
($LSELF_{it}$)	*POLS*	*RE*	*FE*	*PCSE*	*POLS*	*RE*	*FE*	*PCSE*
$LYPE_{it}$	11.059***	11.059***	5.442***	11.691***	7.871***	4.897***	4.147***	8.611***
	(0.771)	(0.771)	(1.124)	(0.898)	(1.242)	(1.057)	(1.087)	(1.564)
$LYPE\_2_{it}$	-0.568***	-0.568***	-0.261***	-0.597***	-0.389***	-0.254***	-0.216***	-0.441***
	(0.037)	(0.037)	(0.055)	(0.044)	(0.058)	(0.051)	(0.053)	(0.074)
$LTRD_{it}$	0.093**	0.093**	0.193***	0.132***	-0.107***	-0.085**	-0.087**	0.002
	(0.043)	(0.043)	(0.055)	(0.045)	(0.040)	(0.035)	(0.036)	(0.039)
FDI_{it}	0.005	0.005	-0.007**	0.003	-0.011	0.003	0.003	-0.002
	(0.004)	(0.004)	(0.003)	(0.002)	(0.008)	(0.003)	(0.003)	(0.002)
$LSCI_{it}$	0.034***	0.034***	-0.120***	0.042***	-0.063***	0.051***	0.059***	0.004
	(0.012)	(0.012)	(0.025)	(0.013)	(0.013)	(0.012)	(0.012)	(0.010)
$LNET_{it}$	0.000	0.000	0.030***	-0.006	0.040***	0.006	0.002	0.020***
	(0.007)	(0.007)	(0.009)	(0.007)	(0.010)	(0.005)	(0.005)	(0.007)
$LDOM_{it}$	0.202***	0.202***	-0.004	0.158***	-0.202***	-0.075***	-0.073***	-0.093***
	(0.027)	(0.027)	(0.034)	(0.019)	(0.026)	(0.022)	(0.022)	(0.029)
$LGOV_{it}$	-0.017	-0.017	0.084	-0.078*	0.126*	-0.055	-0.038	-0.078
	(0.055)	(0.055)	(0.051)	(0.044)	(0.073)	(0.059)	(0.060)	(0.052)
$LRUR_{it}$	0.449***	0.449***	0.192*	0.455***	0.378***	0.247***	0.258***	0.124**
	(0.039)	(0.039)	(0.100)	(0.047)	(0.041)	(0.051)	(0.052)	(0.055)
Constant	-53.282***	-53.282***	-25.875***	-56.557***	-36.262***	-20.464***	-16.935***	-38.198***
	(3.956)	(3.956)	(5.955)	(4.570)	(6.617)	(5.434)	(5.561)	(8.261)
Obs.	114	114	114	114	283	283	283	283
No. countries	6	6	6	6	15	15	15	15
R-squared	0.983	0.983[a]	0.662[a]	0.997	0.854	0.725[a]	0.647[a]	0.992
B-P/C-W test[c]	35.53				29.38			
(p-value)	(0.000)				(0.000)			
B-P LM test[c]		0.000				1651.86		
(p-value)		(1.000)				(0.000)		
Hausman test[d]			58.50				14.08	
(p-value)			(0.000)				(0.079)	

Notes:
Standard errors in parentheses.
Levels of significance: *** p<0.01, ** p<0.05, * p<0.1
[a] R-squared overall.
[b] Breusch-Pagan / Cook-Weisberg test for heteroskedasticity. (*H_o: constant variance*)
[c] Breusch and Pagan Lagrangian multiplier test for random effects. (*H_o: Var(u) = 0*)
[d] Hausman test. (*H_o: difference in coefficients not systematic*)

Table 7B

Post-cluster dynamic panel results. G-III & G-IV

	Diff-GMM[c]	Sys-GMM[c]	LSDVC[a]	Diff-GMM[c]	Sys-GMM[c]	LSDVC[a]
$LSELF_{it-1}$	0.815***	0.891***	0.849***	0.310***	0.580***	0.622***
	(0.082)	(0.055)	(0.106)	(0.062)	(0.047)	(0.074)
$LYPE_{it}$	0.381	1.120	0.271	6.396***	3.808***	0.862
	(0.960)	(0.698)	(30.912)	(1.163)	(0.843)	(2.307)
$LYPE\_2_{it}$	-0.017	-0.060*	-0.012	-0.323***	-0.196***	-0.048
	(0.048)	(0.035)	(1.505)	(0.057)	(0.041)	(0.113)
$LTRD_{it}$	0.020	0.001	0.011	-0.024	-0.066***	-0.058
	(0.044)	(0.029)	(1.442)	(0.033)	(0.025)	(0.061)
FDI_{it}	-0.003	-0.002	-0.003	0.000	-0.000	0.000
	(0.002)	(0.002)	(0.062)	(0.002)	(0.002)	(0.005)
$LSCI_{it}$	-0.007	0.017*	-0.010	0.036***	0.005	0.024
	(0.022)	(0.009)	(0.635)	(0.012)	(0.007)	(0.026)
$LNET_{it}$	0.003	0.001	0.003	-0.001	0.013***	0.000
	(0.009)	(0.005)	(0.282)	(0.005)	(0.004)	(0.010)
$LDOM_{it}$	-0.033	-0.012	-0.022	-0.047**	-0.040**	-0.034
	(0.026)	(0.019)	(0.884)	(0.020)	(0.018)	(0.033)
$LGOV_{it}$	0.024	-0.025	0.030	0.011	-0.033	-0.041
	(0.035)	(0.028)	(1.270)	(0.046)	(0.039)	(0.117)
$LRUR_{it}$	0.078	0.010	0.057	0.117**	0.099***	0.089
	(0.071)	(0.040)	(2.870)	(0.049)	(0.031)	(0.089)
Constant	-1.786	-4.847	0.849***	-29.507***	-16.818***	0.622***
	(4.871)	(3.489)	(0.106)	(5.800)	(4.197)	(0.074)
Observations	102	108	108	253	253	253
No. countries	6	6	6	15	15	15
Sargan test	92.354	103.786	-	202.567	233.638	-
(p-value)	(0.300)	(0.459)	-	(0.002)	(0.000)	-
AR(1) test[b]	-1.832	-1.903	-	-3.066	-2.830	-
(p-value)	(0.067)	(0.057)	-	(0.002)	(0.047)	-
AR(2) test[b]	0.508	0.789	-	-1.114	-1.063	-
(p-value)	(0.611)	(0.429)	-	(0.265)	(0.288)	-

Notes:

Standard errors in parentheses.

Levels of significance: *** p<0.01, ** p<0.05, * p<0.1

[a] Bias correction initialized by Anderson and Hsiao estimator up to order O(1/NT)

[b] Arellano-Bond test for zero autocorrelation in first-differenced errors (H_0: no autocorrelation)

(Arellano-Bond test cannot calculate AR tests with dropped variables)

[c] Only reported one-step.

Chapter 3: Trade openness and entrepreneurship in OECD countries: exploring different Granger causality approaches

This paper analyses the relationship between trade openness and entrepreneurship for a panel of 20 OECD economies over the period 1960-2014. This relationship is not a clear-cut one because (i) there are theoretical arguments supporting a positive as well as a negative link and (ii) it could be a bidirectional relationship. Consequently, the empirical literature presents ambiguous results. To shed new light on this issue, we examines the nature of Granger causality by applying three alternative econometric approaches: (i) the Toda and Yamamoto (1995) test which exploits the longitudinal dimension of our data; (ii) the bootstrap panel Granger causality test developed by Kónya (2006) and (iii) the methodology provided by Hatemi-J (2012), which allows for non-linear causality relationships and asymmetries. Our empirical results suggest that causal effects are heterogeneous and country-specific and highlight the importance of considering this heterogeneity for the design of entrepreneurship and trade policies as economic recovery engines.

3.1. Introduction

One of the overriding objectives currently facing OECD countries is to design effective public policies able to give dynamism to labour markets in order to improve its conditions and recover the pre-crisis employment levels. However, nearly ten years after the commencement of 2008 crisis, certain European OECD countries, such as Greece and Spain, continue having dramatic rates of unemployment.[1] In this context, *entrepreneurship* is con-

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[1] Unemployment rates in Greece and Spain in 2015 were 24.9% and 22.1%, respectively (OECD Labour Market Statistics), being youth unemployment rates in both countries close to 50%, which makes the recovery process even more complex.

sidered as a major driver of economic growth, job creation, and competitiveness in global markets.[2] Similarly, policy makers recognise the value of trade and open markets to deliver lower prices and greater consumer choice and consider *trade openness* as other important driver for economic growth and job creation (European Commision, 2010). Therefore, both entrepreneurship and trade openness are considered key elements for the recovery process. However, theoretical and empirical literature provides ambiguous evidences about the relationship between them.

Firstly, the effect of economic openness on entrepreneurship is a priori ambiguous. Thus, there exist arguments to support a positive, as well as a negative relationship. On the one hand, trade openness offers increased opportunities for new entrepreneurs, as give them access to wider product and input markets. Greater international participation allows access to new markets, products and customers that can lead to new business opportunities (Sobel *et al*., 2007). Moreover, the freedom to trade is expected to create competitive pressure for innovation, which affects entrepreneurship positively (McMullen, 2008). In addition, trade openness provides a specific source of spillovers that influences the emergence of new businesses in a country (De Clercq *et al*., 2007). In this sense, entrepreneurship can act as a conduit not only to capture those innovative business opportunities, but also to transform them into successful business (Schumpeter, 1934; Baumol, 2002; Evans and Leighton, 1989; van Stel and Storey, 2004; Van Stel *et al*., 2005). However, the optimum use of the opportunities offered by the international expansion can only be achieved if entrepreneurs are able to develop a suitable export strategy (Salomon and Shaver, 2005). Empirical findings show that learning by exporting (Grossman and Helpman, 1991) helps promote competitiveness and productivity of firms (Ahn, 2001), innovation and dissemination of knowledge (Hessels and Van Stel, 2011) and consequently, reach higher economic growth (Moen, 2002).

On the other hand, trade openness raises the intensity of competition and may result in lower incentives and higher barriers to entry for potential entrepreneurs (Grossman, 1984; Díez and Ozdagli, 2011). Díez and Ozdagli (2011) points out two different channels for this effect: as a result of for-

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2 The key role of entrepreneurship as a major driver of economic growth, job creation, and competitiveness in global markets has been well documented in academic publications (see Van Praag and Versloot, 2007 for a comprehensive survey) and policy reports (see, for instance, OECD (2014) and the *Europe 2020 strategy*).

eign competition, goods become cheaper and domestic real wages go up, increasing the opportunity cost of the marginal entrepreneurs, who find profitable to become employees (the *Lucas* channel). At the same time, increased labor demand of domestic exporting firms leads to a further increase in real wages, making entrepreneurship less lucrative and reallocating marginal entrepreneurs to the more productive firms as employees (the *Melitz* channel). This negative relationship between trade openness may indicate the previous necessity by firms of achieving a high level of productivity and an optimal size for competing successfully in a global market. Therefore, one survival mechanisms of firms in an international competition context is to be able to develop an export-oriented strategy (Congregado *et al*., 2014) once it has produced the so-called effect "reorganization" of firms less efficient (Caballero and Hammour, 1994). This argument is found consistent with previous literature according to which the most productive firms, generally belonging to the formal sector (Aleman-Castilla, 2006; Fiess *et al*., 2010), are able to export to international markets while the least productive are forced to exit (Melitz, 2003).

Secondly, according to the theoretical literature, the relationship between trade openness and entrepreneurship does not have a clear direction and may change from country to country and from sector to sector. Thus, the relationship between institutions and entrepreneurship can be interdependent (e.g., Lee 1991; Clark and Lee 2006; Sobel et al., 2007; Nyström, 2008, Elert and Henrekson, 2017). An example of the reverse relationship is that there are incentives for entrepreneurs to use institutions (e.g. trade policy) against other entrepreneurs to protect their interests (Holmes and Schmitz Jr., 2001). The quality of the pool of entrepreneurs (productive vs. unproductive) is key to understand the role of entrepreneurship on trade openness, via the regulatory framework (Holmes and Schmitz Jr., 2001).

To sum up, the relationship between trade openness and entrepreneurship is not a clear-cut one because (i) there are arguments supporting a positive as well as a negative link and (ii) it could be a bidirectional relationship. The study of this relationship is relevant today given that the forces of globalization and the creation of free trade areas have become a hot-button policy issue which affects, among others macroeconomics factors, to labour markets. So, the natural way for solving any controversy on if a higher degree of trade openness may suppose a threat or by contrast, may be an opportunity for competitiveness of firms, growth and employment, is by providing unambiguous empirical evidence about the character and direction of these links, which constitute the nucleus of our work.

With this purpose, we focus on explaining the Granger causality (Granger, 1969) between trade openness and self-employment for a panel of 20 OECD countries over the period 1960-2014. In order to compare the robustness of our results, the methodology applied is based on a set of different econometric approaches developed by Toda and Yamamoto (1995) for the country-by-country analysis, Kónya (2006) for the panel data and Hatemi-J (2012) for the asymmetric Granger causality.

Our empirical results show that the relationship between trade openness and self-employment is heterogeneous and country-specific and consequently, highlight the importance of considering this heterogeneity when designing entrepreneurship and trade policies.

The rest of the paper is organized as follows. Section 2 makes a brief summary of previous related literature. Section 3 describes the data used. Section 4 explains the econometric methods. Section 5 presents the empirical results. Finally, Section 6 offers some concluding remarks.

3.2. A Brief Survey of Previous Literature

In this section, we present a brief review of the empirical literature related with the relationship between trade openness and entrepreneurship. In order to improve its understanding and given that the works linking both variables are very scarce, first, we present those studies which address the relationship between trade openness and economic growth; then, those analysing trade openness and entrepreneurship, and finally recent works on Granger causality.

3.2.1. Trade Openness - Economic Growth

In the last decades, there have been developed a comprehensive literature that reflects the ambiguity of the relationship between trade openness and economic growth. Some authors find arguments in favor of a positive relationship (Dollar, 1992; Ben-David, 1993; Sachs and Warner, 1995; Edwards, 1998; Frankel and Romer, 1999; Wacziarg, 2001; Alcalá and Ciccone, 2004; Wacziarg and Welch, 2008; Chang, Kaltani and Loayza, 2009; Brückner and Lederman, 2012) while others are more skeptical about it. For instance, Harrison (1996) and Dollar and Kraay, (2004) finds different results depending on using cross-sectional or panel data. Rodríguez and Rodrik (2000) and Rodríguez (2007) discuss the empirical findings from some of the works mentioned above, highlighting significant deficiencies in trade openness measures and econometric methodologies applied. In this sense, Alcalá and Ciccone (2004) propose a new trade measure, "the real openness", defined as the sum of imports plus exports divided to Purchasing Power Parity GDP. This measure is not distorted by cross-country differences in the relative price of non-tradable goods, and thus, is considered better than "nominal openness".

Other authors assert that the relationship between openness and growth may be affected by a set of key factors as the institutional quality, geography or the levels of economic development that it is necessary to control for robustness of results (Alcalá and Ciccone, 2004; Rigobon and Rodrik, 2005). Dowrick and Golley (2004) analyse these relationships for a two 20-year periods using a single-equation estimation methods and the Hausman test for exogeneity. They find that, since 1980, developed economies have been most benefited from trade liberalization than less-developed economies. Following this line, Calderón *et al.*, (2004) research the impact of openness and four types of foreign shocks on economic growth and volatility by using panel data methods for a sample of 76 countries. Their results show that financial and trade openness contribute to economic growth and development, being these effects more significant in developed countries than in poor economies. Wacziarg and Welch (2008) add that policy aimed at trade liberalization leads to increase economic growth on average, but these effects differ across countries depending on the income levels.

3.2.2. Trade Openness – Entrepreneurship

The promotion of entrepreneurship has become an essential issue in the agenda of policymakers and practitioners as effective mechanism for adjusting major existing imbalances between the labour supply and demand, especially after the last financial crisis. It is also considered an important vehicle for capturing and developing new business opportunities (Carree *et al.*, 2002; Pietrobelli, C. *et al.*, 2004; Audretsch *et al.*, 2008). Studies as Acs and Vargas (2005) and Acs (2006) find that higher levels of economic development are linked to lower self-employment rates, so only when a worker leaves necessity self-employment and becomes an entrepreneur from a position of opportunity, then, economic development increases. Pietrobelli *et al.* (2004) confirm the Kuznets hypothesis in the same way of Acs *et al.* (1994) for 64 developing and 19 developed countries over the period 1960-1990. They consider two measures of openness: the ratio of exports and imports over GDP and the manufacturing exports per worker.

Using the first indicator, they observe that the relationship with self-employment is ambiguous (in some cases is negative and in others, positive) according to the previous studies. Using the second indicator, they find a negative and significant relationship between both variables. Díez and Ozdagli (2011), following Lucas's (1978) model, conclude that "more-open economies show lower rates of self-employment", that is, there exists a negative relationship between self-employment and the trade cost and between the self-employment and the exporting firms rates. Finally, Scholman *et al*., (2014) find that the result of this estimations have to be analyzed taking into account the differences between the short, medium or long-run. Their outputs show that "when open economies are booming, the share of self-employed in the total labour force may be decreasing in the short-run but increasing in the medium-run".

3.2.3. Recent works on Granger Causality

It is difficult to find empirical studies that address the Granger causality between trade openness and entrepreneurship; normally each variable is analysed in relation to others macroeconomic indicators such as GDP or Foreign Direct Investment (FDI), for the case of trade openness, or unemployment rates and business cycles, for entrepreneurship.

Concerning trade openness, we highlight the work of Gries and Redlin (2012). These authors research the Granger causality between per capita GDP growth and trade openness for 158 countries from 1970 to 2009. By using a panel cointegration tests, panel error-correction models (ECM) and Generalized Method of Moments (GMM), they find that high-income countries have positive bidirectional causality both in the long and short-run (Harrison, 1996) while lower-income countries show a negative short-run causal effect from openness to growth and a negative long-run effect from growth to openness. Sakyi *et al*. (2012) investigate a panel of 85 middle-income countries over the period 1970-2009 using heterogeneous panel cointegration techniques. Their empirical findings suggest a bi-directional long-run relationship between trade openness and economic development.

Regarding to entrepreneurship, Baptista and Preto (2007) find ambiguous relationships between self-employment and unemployment rates, independently of using business ownership rates or entry rates as measures of entrepreneurship. Moreover, Faria *et al*., (2009) point out the existence of a nonlinear and bidirectional relation between these variables for a set of OECD countries, using a business creation as measure of entrepreneurship. For the case of Spain, Carmona *et al*. (2012) provide evidence of bi-directional causality between self-employment and unemployment (Thurik *et al*., 2008), but unidirectional causality from GDP to self-employment. Finally, Koellinger and Thurik (2012) study the Granger causality relationship between entrepreneurship and GDP and unemployment variables for a sample of 22 OECD countries for 1972 to 2007 period. They conclude that "*fluctuations in global trends of entrepreneurship Granger-cause the world business cycle*" but the reverse sense may be not true.

The present work contribute to this research line by exploring Granger causality from different approaches in order to provide empirical evidence on the existence o absence of causality between trade openness and entrepreneurship in OECD countries, and so, fill in the gap existing in literature.

3.3. Data and Sample

To carry out our empirical strategy, we present bivariate models for a panel data of 20 OECD countries over the period 1960-2014.[3]The variables used are *trade openness* (*TO*) and the *rate of self-employment* (*SELF*). *TO* is provided by the World Bank and is defined as the sum of exports and imports to GDP. Although there is a broad debate related the advantages and disadvantages of using this indicator, it is the most commonly used indicator of trade openness in the empirical literature to analyse the effects of trade liberalization on productivity and growth (see e.g. Alcalá and Ciccone, 2004; Calderón *et al*., 2004; Wacziarg and Welch, 2008).

SELF is defined as the number of self-employed in the total economy divided by civilian labour force and is obtained from AMECO database.[4] This indicator is frequently used as a proxy for entrepreneurship, (see e.g. Acs *et al*., 1994; Blanchflower, 2000, 2004; Carree *et al*., 2002, 2007; Parker, 2004; Verheul *et al*., 2006; Nyström, 2008; Van Praag and Versloot, 2008; Díez and Ozdagli, 2011; Bjuggren *et al*., 2012; Congregado *et al*., 2012; Goetz *et al*., 2012; Simoes *et al*., 2015). Besides its appropriateness

[3] The countries included in the analysis are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom and United States.

[4] AMECO is the annual macro-economic database of the European Commission's Directorate General for Economic and Financial Affairs.

as proxy of entrepreneurship, the main advantage of the *SELF* indicator is its availability for long time and many countries, which allow us to make dynamic estimations and to capture short-run shocks and long-run trends across countries (Parker, 2009; Loayza and Rigolini, 2011).

3.4. Methodology

In this section we present the econometric models that we use to analyse the relationship between trade openness and self-employment.

3.4.1. Augmented VAR-model, by Toda and Yamamoto (1995)

The standard Wald test commonly used to check Granger causality in a vector autoregressive (VAR) framework might not have an asymptotic chi-square distribution if the system is integrated or cointegrated (Dolado and Lütkepohl, 1996). The Toda and Yamamoto (1995) methodology allows for estimating a VAR model in levels with non-stationary processes – integrated or cointegrated of an uncertain order– avoiding the bias introduced by pre-tests for unit root(s), cointegration or cointegration ranks. If we denote by I(d) an integrated process of order d, and CI(d,b) a cointegrated process of order d, b, the authors show that by estimating an over-fit VAR's of order (k+d_{max})th –where k is the optimal lag length chosen and d_{max} is the maximal order of integration suggested by the process–, and using a modified Wald test for Granger non-causality, this method confirm the validity of the standard asymptotic theory for linear and non-linear restrictions on the parameters of levels VAR's, pointing out that if the series are integrated but not cointegrated, d cannot exceed k. Applying this methodology to our variables, *SELF* and *TO*, we can write a bivariate VAR model as follows:

$$SELF_t = \alpha_1 + \sum_{i=1}^{m+d_{max}} \beta_{1i}\, SELF_{t-i} + \sum_{j=1}^{n+d_{max}} \gamma_{1j}\, TO_{t-j} + \varepsilon_{1t} \qquad (1)$$

$$TO_t = \alpha_2 + \sum_{i=1}^{m+d_{max}} \beta_{2i}\, TO_{t-i} + \sum_{j=1}^{n+d_{max}} \gamma_{2j}\, SELF_{t-j} + \varepsilon_{2t} \qquad (2)$$

where d_{max} is the maximum order of integration of the time series in the VAR's, *m* and *n* are lag length structure selected according to Aikaike's information criterion (AIC) and the residual terms, ε_{1t} y ε_{2t}, are white noise processes with zero mean, constant variance and no serial correlation.

In order to analyse Granger causality between these two variables, we define, for each equation, its null hypothesis –and consequently, its alternative hypothesis–. For the first equation, the null indicate that TO does not Granger-cause SELF, if $\sum_{j=1}^{n} \gamma_{1j} = 0$. In the second equation, the null expresses that *SELF* does not Granger-cause TO, if $\sum_{j=1}^{n} \gamma_{2j} = 0$. Thus, the rejection of the null in one of these two equations would evidence the existence of unidirectional Granger causality, while the rejection of the null in both equations would indicate bidirectional Granger causality. The non-rejection of the null hypothesis in the two equations would show absence of Granger causality between this two variables.

3.4.2. Bootstrap panel Granger causality test, by Kónya (2006)

Kónya (2006) develops a new Granger causality test for panel data, based on Seemingly Unrelated Regressions –SUR– (Zellner, 1962) for a model with and without time trend, and Wald tests with country-specific bootstrap critical values. Among its main advantages we may point out the possibility to consider jointly cross-sectional dependence and heterogeneity across countries. It is well known that more openness allows for greater access to world markets of goods, services and capital implying higher opportunities of growth and welfare for countries. However, globalization may also be a mechanism of propagation of external shocks and it may lead to increase their vulnerability (Eichengreen *et al*., 1996; Glick and Rose, 1999; Calderón *et al*., 2004; Rose and Spiegel, 2010; Kali and Reyes, 2010). Thus, it is necessary to analyse previously this cross-sectional dependence to overcome distortions that may occur if these factors are ignored. To this end, we apply the following tests: i) the Lagrange multiplier test, by Breusch and Pagan (1980) –LM test–; ii) the new Lagrange multiplier test, by Pesaran (2004) –CD test–; and iii) the Lagrange multiplier test by Pesaran, Ullah and Yamagata (2008) –bias-adjusted LM test–. In addition, Kónya (2006) highlights the importance to determinate, as previous step to estimation, the optimal (maximal) lag length in order to avoid the bias introduced by omitted variables (too few lags) or missing values (too many lags). To solve computational limitations linked to large panels, the author allows the lag structure to vary across variables but not across countries, implying a maximal lag range from 1 to 4. The optimal lag length is chosen by applying the Akaike Information Criterion (AIC) and the Schwarz's Bayesian Information Criteria (AIC and SBIC). The SUR system can be formulated as follows:

$$\begin{aligned}
y_{1,t} &= \alpha_{1,1} + \sum_{l=1}^{mly_1} \beta_{1,1,l}\, y_{1,t-l} + \sum_{l=1}^{mlx_1} \gamma_{1,1,l}\, x_{1,t-l} + \varepsilon_{1,1,t} \\
y_{2,t} &= \alpha_{1,2} + \sum_{l=1}^{mly_1} \beta_{1,2,l}\, y_{2,t-l} + \sum_{l=1}^{mlx_1} \gamma_{1,2,l}\, x_{2,t-l} + \varepsilon_{1,2,t} \\
&\vdots \\
y_{N,t} &= \alpha_{1,N} + \sum_{l=1}^{mly_1} \beta_{1,N,l}\, y_{N,t-l} + \sum_{l=1}^{mlx_1} \gamma_{1,N,l}\, x_{N,t-l} + \varepsilon_{1,N,t}
\end{aligned} \tag{3}$$

and

$$\begin{aligned}
x_{1,t} &= \alpha_{2,1} + \sum_{l=1}^{mly_2} \beta_{2,1,l}\, y_{1,t-l} + \sum_{l=1}^{mlx_2} \gamma_{2,1,l}\, x_{1,t-l} + \varepsilon_{2,1,t} \\
x_{2,t} &= \alpha_{2,2} + \sum_{l=1}^{mly_2} \beta_{2,2,l}\, y_{2,t-l} + \sum_{l=1}^{mlx_2} \gamma_{2,2,l}\, x_{2,t-l} + \varepsilon_{2,2,t} \\
&\vdots \\
x_{N,t} &= \alpha_{2,N} + \sum_{l=1}^{mly_2} \beta_{2,N,l}\, y_{N,t-l} + \sum_{l=1}^{mlx_2} \gamma_{2,N,l}\, x_{N,t-l} + \varepsilon_{2,N,t}
\end{aligned} \tag{4}$$

where y represents self-employment (*SELF*); x refers to trade openness (TO); N is the number of the OECD countries ($i = 1, \dots, N$); t is the time period ($t = 1, \dots, T$); and ml is the maximal lag length for each variable. According to Kónya (2006), it is likely that exists contemporaneous correlation in our system due to the traditional economic links among OECD countries.

By using TSP5.0 programme, we calculate SUR estimators considered consistent but more efficient estimators in presence of contemporaneous correlation than OLS estimators. Finally, to test Granger causality, the author describes a procedure that ends with the Wald test and the country-specific bootstrap critical values obtained by applying resampling methods. Under the null hypothesis of no causality, there is a one-way Granger causality from *x* to *y* if not all $\gamma_{1,i,l}$ are zero but all $\beta_{2,i,l}$ are zero; there is a one-way Granger causality from *y* to *x* if not all $\beta_{2,i,l}$ are zero but all $\gamma_{1,i,l}$ are zero; and thus, taking into account both effects, there is a two-way Granger causality between *x* and *y* if neither all $\gamma_{1,i,l}$, nor all $\beta_{2,i,l}$ are zero. By contrast, there is absence of Granger causality relationship between the variables if all $\gamma_{1,i,l}$ and all $\beta_{2,i,l}$ are zero.

3.4.3. Asymmetric Granger causality test, by Hatemi-J (2012)

According to this approach, the empirical results of Granger causality tests may differ depending on whether it is introduced or not in our VAR model asymmetric information on the positive or negative nature of cumulative shocks that affect the underlying variables. The likely existence of omitted non-linear relationships or asymmetries may lead to the erroneous rejection of the null hypothesis and, consequently, to a wrong interpretation of the Granger causality. To overcome this problem, Hatemi-J (2012) extends the initial work of Granger and Yoon (2002), referred to cointegration (*Hidden Cointegration*), to study Granger causality. For a panel data framework (Hatemi-J, 2011), the asymmetric causality between our two integrated variables, *SELF* and *TO,* can be explained as follows. The first step is to define the variables as random-walk processes:

$$SELF_{i,t} = SELF_{i,t-1} + e_{i1,t} = SELF_{i,0} + \sum_{j=1}^{t} e_{i1,j} \quad (5)$$

$$TO_{i,t} = TO_{i,t-1} + e_{i2,t} = TO_{i,0} + \sum_{j=1}^{t} e_{i2,j} \quad (6)$$

For $i = 1, \dots, N$ and $t = 1, \dots, T$. N is the cross sectional dimension of our panel and T is the time series dimension; $SELF_{i,0}$ and $TO_{i,0}$ are time-invariant constants, and $e_{i1,j}$ and $e_{i2,j}$ are assumed to be white noise error terms. Then, we introduce in (5) and (6) the positive and negative cumulative shocks which can be defined as: $e_{i1,t} = e_{i1,t}^{+} + e_{i1,t}^{-}$ and $e_{i2,t} = e_{i2,t}^{+} + e_{i2,t}^{-}$, where $e_{i1,t}^{+} := max(e_{i1,t}, 0)$, $e_{i1,t}^{-} := min(e_{i1,t}, 0)$, $e_{i2,t}^{+} := max(e_{i2,t}, 0)$, $e_{i2,t}^{-} := min(e_{i2,t}, 0)$, respectively. Therefore, equations (5) and (6) can be rewritten in terms of cumulative sum of shocks as follows:

$$SELF_{i,t}^{+} = SELF_{i,0}^{+} + e_{i1,t}^{+} = SELF_{i,0}^{+} + \sum_{j=1}^{t} e_{i1,j}^{+} \tag{7}$$

$$SELF_{i,t}^{-} = SELF_{i,0}^{-} + e_{i1,t}^{-} = SELF_{i,0}^{-} + \sum_{j=1}^{t} e_{i1,j}^{-} \tag{8}$$

$$TO_{i,t}^{+} = TO_{i,0}^{+} + e_{i2,t}^{+} = TO_{i,0}^{+} + \sum_{j=1}^{t} e_{i2,j}^{+} \tag{9}$$

$$TO_{i,t}^{-} = TO_{i,0}^{-} + e_{i2,t}^{-} = TO_{i,0}^{-} + \sum_{j=1}^{t} e_{i2,j}^{-} \tag{10}$$

The second step is to test the asymmetric Granger causality by estimating a VAR-SUR(k) seemingly unrelated regression model of order k (11). To simplify, we focus only on the case of cumulative positive shocks, denoted by the vector $\left(SELF_{i,t}^{+}, TO_{i,t}^{+}\right)$, although this explanation can be presumed for negative shocks $\left(SELF_{i,t}^{-}, TO_{i,t}^{-}\right)$ or mix vectors $\left(SELF_{i,t}^{+}, TO_{i,t}^{-}\right)$, $\left(SELF_{i,t}^{-}, TO_{i,t}^{+}\right)$.

The VAR-SUR(p) model can be written as follows:

$$\begin{bmatrix} SELF_{i,t}^{+} \\ TO_{i,t}^{+} \end{bmatrix} = \begin{bmatrix} \beta_{i,0} \\ \gamma_{i,0} \end{bmatrix} + \begin{bmatrix} \sum_{r=1}^{p} \beta_{i1,r} & \sum_{r=1}^{p} \beta_{i2,r} \\ \sum_{r=1}^{p} \gamma_{i1,r} & \sum_{r=1}^{p} \gamma_{i2,r} \end{bmatrix} \times \begin{bmatrix} SELF_{i,t-r}^{+} \\ TO_{i,t-r}^{+} \end{bmatrix} + \begin{bmatrix} \varepsilon_{i1,t}^{+} \\ \varepsilon_{i2,t}^{+} \end{bmatrix} \tag{11}$$

where $\varepsilon_{i1,t}^{+}$ and $\varepsilon_{i2,t}^{+}$ are residuals or disturbances which may be correlated across cross-sectional dimension. The optimal lag length, p, is chosen according an information criterion proposed by Hatemi-J (2003, 2008). The null hypothesis of the Wald test that $TO_{i,t}^{+}$ does not cause $SELF_{i,t}^{+}$, that is, $H_0: \beta_{i2,r} = 0, \forall\, r,$ where $r = 1, \dots, p$, is rejected at the α level of significance (1%, 5% or 10%) according to the bootstrap critical values generated by an algorithm in GAUSS provided by the author.

3.5. Estimation results

In accordance with the econometric strategy outlined above, this section reports the results of our empirical analysis to test the Granger causality between *TO* and *SELF*. The outputs are presented in three subsections, depending on the direction of the causality. Thus, section 3.5.1 presents results concerning Granger causality from *TO* to *SELF*, section 3.5.2. shows results related with Granger causality from *SELF* to *TO* and section 3.5.3 reports bidirectional Granger causality results. All these results are presented in the appendix (tables 1 to 12).[5]

3.5.1. Granger causality from *TO* to *SELF*: *Competitiveness hypothesis*

The Toda and Yamamoto (1995) test –table 1, dependent variable: *SELF*– only suggests the existence of Granger causality for Belgium. However, for the bootstrap panel Granger causality approach developed by Kónya (2006) –table 4–, we find evidence of Granger causality in 5 out of 20 OECD economies (Denmark, France, Italy, Sweden and the United States) when we assume a model without time trend; for a bivariate model with time trend, the results show the existence of Granger causality in France and Sweden at the 1% significance level. Allowing for non-linear behaviours and asymmetries in the model according to Hatemi-J (2012) approach –tables 7 to 11–, we find evidence of Granger causality in 7 OECD economies: for positive cumulative shocks ($\boldsymbol{TO^+ \nRightarrow SELF^+}$) we can reject the null hypothesis in Denmark at the 10% significance level, in Canada at the 5% significance level, and in Germany at the 1% significance level; for negative cumulative shocks ($\boldsymbol{TO^- \nRightarrow SELF^-}$), we cannot reject the null in any case except for Netherlands at the 5% significance level; for mixed cumulative shocks ($\boldsymbol{TO^- \nRightarrow SELF^+}$ and $\boldsymbol{TO^+ \nRightarrow SELF^-}$) there exist evidence of Granger causality in Belgium, France and Australia at the 10% significance level; when we consider global shocks –positive and negative cumulative shocks–, it is found absence of causality.

These results show that the controversy on the causality relationship for *competitiveness hypothesis* seems to be supported by empirical evidence

[5] Table 1 presents results of Toda-Yamamoto test. Tables 2 to 6 report results concerning Kónya approach. Tables 7 to 11 show results as regards Hatemi-J asymmetric Granger causality methodology. Finally, table 12 presents a summary of the results.

across OECD countries. According to previous literature, *TO* can generate knowledge spillovers that may have a positive effects on firm competitiveness, contributing to improve their capability to find out and capture new business opportunities (Aitken *et al*., 1997; De Clercq *et al*., 2008; van Stel *et al*., 2014). However, a greater international openness may also cause a "crowding-out effect" due that a higher competition across countries may affect to the entrepreneurial networks and make them more vulnerable to external shocks with its evident repercussion in macroeconomic variables as the unemployment rate. It seems that there must be stronger factors than the mere trade liberalization process affecting the composition of the national entrepreneurial network. In other words, the effect of openness on national business sector is heterogeneous and country-specific. In this sense, we cannot affirm that Granger causality from *TO* to *SELF* follows a unique pattern in OECD countries.

3.5.2. Granger causality from *SELF* to *TO*: *Growth/scale hypothesis*

For the analysis by country, the Toda-Yamamoto test –table 1, dependent variable: *TO*– reveals Granger causality in 4 OECD economies: Austria at the 10% significance level, Germany at the 5% significance level, and Portugal and Sweden at the 1% significance level. The bootstrap panel Granger causality approach developed by Kónya (2006) –table 5 provides evidence of causality in 5 countries: in a model without time trend, we can reject the null hypothesis for Spain at the 10% significance level, France at the 5% significance level and Portugal at the 1% significance level; in a model with time trend, the results show evidence of causality for Norway at the 10% significance level, France and Portugal at the 5% significance level, and the Netherlands at the 1% significance level. Concerning the asymmetric Granger-causality test developed Hatemi-J (2012) –tables 7 to 11–, our results show the following: for positive cumulative shocks ($SELF^{+} \nRightarrow TO^{+}$) we can reject the null hypothesis for Austria and Japan at the 10% significance level, Sweden at the 5% significance level, and Australia, Belgium and Canada at the 1% significance level; for negative cumulative shocks ($SELF^{-} \nRightarrow TO^{-}$), we cannot reject the null in any case; for mixed cumulative shocks ($SELF^{-} \nRightarrow TO^{+}$ and $SELF^{+} \nRightarrow TO^{-}$) there are causality links for Japan and the United Kingdom at the 10% significance level, Italy and Finland at the 5% significance level, and Portugal and the Netherlands at the 1% significance level; for global cumulative shocks, there is Granger causality in Germany at the 10% significance level, Sweden at the 5% significance level, and Portugal at the 1% significance level.

Consequently, we can point out that there is a set of OECD economies in which self-employment shocks cause effects on trade openness, which can be translated in the adoption of a successful export-strategy by companies. Indeed, export-oriented firms contribute to improve the levels of competitiveness and productivity of business sector through "learning by exporting" (Grossman and Helpman, 1991). It can also be related to the positive relationship between the firm size and the propensity to export, studied by previous literature (e.g. Mittelstaedt, Harben and Ward, 2003) which enable firms achieve greater international market penetration, and thus, increase economic growth (Moen, 2002).

3.5.3. Bidirectional Granger causality: *Feedback hypothesis*

There is no evidence of bidirectional causality in the results from Toda-Yamamoto test. By contrast, we find evidence of feedback links for France, by applying the bootstrap panel causality test, and for Canada, by applying the asymmetric causality test under the positive cumulative shocks assumption. The bidirectional relationship in our context supports the feedback hypothesis and allows understanding the lack of unambiguous results. However, its existence is difficult to detect by the tests due to we only aspire to capture a net effect. The fact that in this net effect the opposing forces (the two directions of causality) are counterbalanced may reveal apparently contradictory results.

3.6. Concluding remarks and policy implications

This paper has analysed the Granger causality relationship between self-employment -as a proxy of entrepreneurship- and trade openness for a panel data of 20 OECD countries over 1960-2014. Depending on the direction of the causality, two hypotheses have been defined in our specification: i) the trade-led self-employment hypothesis –competitiveness hypothesis- and, ii) the self-employment-led trade hypothesis –growth/scale hypothesis-. A set of time-series and panel data tests were applied in order to detect Granger causality following the approaches by Toda and Yamamoto (1995) Kónya (2006) and Hatemi-J (2012). Empirical results show that the effect of Granger causality is heterogeneous and country-specific and thus, there is not a unique pattern able to describe these links across OCED economies.

For the competitiveness hypothesis, we found evidence of Granger causality in 10 out of 20 OECD economies –Australia, Belgium, Canada, Denmark, France, Germany, Italy, Netherlands, Sweden and the United States–, which may be related with the dynamic effects that trade openness may have on entrepreneurship and new ventures in terms of specialization, knowledge transfer or scale effects. For the growth/scale hypothesis, we find evidence of Granger-causality in 15 out of 20 OECD countries — Austria, Australia, Belgium, Canada, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden and the United Kingdom–, considering the three approaches mentioned. This may indicate that the benefits derived from scale economies in a global market may be related with the capability of entrepreneurs to develop a export-oriented strategy with the aim of being more competitive and able to take advantage of new international business opportunities. In this sense, may occur a "feedback" effect between entrepreneurial activity and trade openness as we observed in France and Canada, where it is found bidirectional Granger causality.

All these results seem to suggest the promotion of self-employment by the policymakers on the basis of an export-oriented strategy in order to contribute not only to improve trade openness but also the competitiveness and productivity of entrepreneurial networks.

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Appendix[6]

A. Augmented VAR-model, by Toda & Yamamoto (1995)

Table 1. Toda-Yamamoto test

	Countries	Dependent variables		*d.o.f.*
		SELF	*TO*	
1	Australia	2.57	5.05	3
2	Austria	0.04	**2.88***	1
3	Belgium	**5.44***	0.52	2
4	Canada	0.91	3.44	2
5	Denmark	1.61	0.33	1
6	Finland	1.82	0.31	1
7	France	1.18	2.16	2
8	Germany	0.42	**4.29****	1
9	Greece	1.23	3.69	2
10	Ireland	0.16	1.09	1
11	Italy	2.30	0.00	1
12	Japan	0.17	3.33	3
13	Luxembourg	0.00	1.27	1
14	Netherlands	1.24	0.38	1
15	Norway	0.17	1.18	1
16	Portugal	0.14	**11.55*****	2
17	Spain	0.04	0.10	1
18	Sweden	1.65	**8.86*****	2
19	United Kingdom	0.01	1.02	1
20	United States	0.85	0.21	1

H_o: No Granger causality from independent to dependent

[6] For all tables, ***, ***, *, imply rejection of the null hypothesis at 1%, 5% and 10% level of significance, respectively.

B. Bootstrap panel Granger causality test, by Kónya (2006)

Table 2. Cross-sectional independence tests[7]

Dependent variable	*SELF*		*TO*	
Tests	Statistic	p-value	Statistic	p-value
Breusch and Pagan (1980) LM test	3167	0.0000	2787	0.0000
Pesaran, Ullah and Yamagata (2008) bias-adjusted LM test*	637.7	0.0000	555.3	0.0000
Pesaran (2004) CD test*	41.38	0.0000	42.07	0.0000

**two-sided test*

Table 3. Lags selection procedure

	No trend				*With trend (z = tend)*			
	TO → SELF		*SELF → TO*		*TO → SELF*		*SELF → TO*	
Lags	AIC	SBIC	AIC	SBIC	AIC	SBIC	AIC	SBIC
1	**-1.455**	**-1.345**	**3.880**	**3.990**	-1.459	**-1.306**	**3.771**	**3.924**
2	-1.450	-1.339	3.887	3.999	-1.451	-1.296	3.797	3.951
3	-1.451	-1.339	3.907	4.019	**-1.460**	-1.304	3.811	3.967
4	-1.446	-1.332	3.926	4.040	-1.460	-1.302	3.823	3.980

Table 4. Direction of causality: TO → SELF (dependent variable: SELF)

	Test statistic	Bootstrap critical values			Test statistic	Bootstrap critical values		
Countries	(no trend)	10%	5%	1%	(with trend)	10%	5%	1%
1 Australia	3.614	6.303	8.930	15.232	3.223	6.689	10.055	17.216
2 Austria	1.753	8.505	11.565	20.300	0.225	8.500	11.931	21.110
3 Belgium	0.59E-03	6.654	9.541	16.730	1.517	6.859	9.889	17.127
4 Canada	0.71E-04	8.659	11.958	19.460	1.203	9.187	12.941	22.531
5 Denmark	**16.441****	8.968	12.001	20.615	4.463	9.144	12.625	21.892
6 Finland	6.727	8.173	11.130	18.613	5.026	8.356	12.194	22.435
7 France	**36.999*****	9.380	12.803	20.688	**24.099*****	7.699	11.263	19.160
8 Germany	0.2992	6.943	9.851	17.184	1.110	9.283	13.794	25.207
9 Greece	0.24E-01	9.176	12.370	20.311	0.233	7.076	10.510	18.733
10 Ireland	0.114	8.728	12.675	22.323	5.988	8.490	12.195	22.030
11 Italy	**7.696***	6.964	9.396	15.892	0.205E-04	8.147	11.351	21.048
12 Japan	0.17E-02	6.200	8.586	14.195	0.314	8.664	11.956	20.737
13 Luxembourg	2.548	7.440	10.731	18.278	9.924	12.034	17.522	30.720
14 Netherlands	0.79E-01	6.601	9.398	17.434	0.64E-01	7.073	10.112	16.840
15 Norway	2.661	7.027	10.179	17.956	1.683	7.485	10.690	19.461
16 Portugal	1.058	7.802	11.387	19.825	0.310	7.326	10.412	18.222
17 Spain	2.629	12.889	16.721	26.370	2.145	7.750	11.339	19.601
18 Sweden	**16.415****	7.465	10.429	19.9646	**29.851*****	8.114	11.432	22.004
19 United Kingdom	0.689	7.576	10.342	18.352	0.28E-01	7.730	11.375	19.783
20 United States	**17.033****	9.471	13.167	23.417	1.154	7.650	11.329	19.725

[7] Tests implemented in Stata. The null hypothesis is the following:
H_0: $Cov(u_{it},u_{jt}) = 0$ (no cross-section dependence) for all t and $i \neq j$

Table 5. Direction of causality: *SELF → TO (dependent variable: TO)*

Countries	Test statistic (no trend)	Bootstrap critical values			Test statistic (with trend)	Bootstrap critical values		
		10%	5%	1%		10%	5%	1%
1 Australia	0.37E-01	11.189	15.596	27.0499	7.071	11.842	17.520	30.766
2 Austria	5.858	16.949	22.923	35.181	8.311	23.466	31.634	46.776
3 Belgium	0.601	13.251	18.609	31.163	1.779	19.783	27.076	43.222
4 Canada	0.405	8.799	12.277	21.026	0.262	14.551	20.106	34.314
5 Denmark	9.001	22.624	28.601	41.196	3.336	23.688	33.165	53.612
6 Finland	6.691	10.370	14.289	23.482	0.890	14.885	20.066	33.277
7 France	**27.565****	14.790	20.404	33.484	**27.127****	19.891	27.133	43.351
8 Germany	1.859	18.537	23.826	36.441	18.643	21.877	29.989	46.027
9 Greece	8.724	12.372	17.028	28.592	4.747	11.771	16.119	29.733
10 Ireland	0.91E-01	15.990	21.368	33.475	6.600	16.089	22.644	36.478
11 Italy	10.228	10.825	14.581	24.897	3.464	15.301	21.963	35.343
12 Japan	0.819	11.219	15.649	28.202	3.657	14.144	19.546	34.457
13 Luxembourg	0.574	11.425	16.224	23.896	18.725	20.440	26.989	41.735
14 Netherlands	5.397	18.485	24.332	37.272	**16.059*****	12.516	17.296	31.500
15 Norway	5.786	6.481	9.797	17.367	**13.260***	9.575	13.713	24.418
16 Portugal	**37.685*****	8.415	11.944	20.480	**23.310****	13.209	18.970	33.848
17 Spain	**12.767***	11.745	16.808	26.179	0.128	17.452	24.808	37.600
18 Sweden	1.029	10.262	13.708	26.760	3.363	18.593	24.747	38.958
19 United Kingdom	0.581	9.799	13.923	23.824	0.615	14.719	20.855	35.139
20 United State	7.954	11.765	16.417	27.894	0.773	15.772	21.679	39.984

Table 6. Summary of Kónya (2006) approach

Countries	No trend	With trend	Countries	No trend	With trend
1 Australia			11 Italy	→	
2 Austria			12 Japan		
3 Belgium			13 Luxembourg		
4 Canada			14 Netherlands		←
5 Denmark	→		15 Norway		←
6 Finland			16 Portugal	←	←
7 France	⇆	⇆	17 Spain	←	
8 Germany			18 Sweden	→	→
9 Greece			19 United Kingdom		
10 Ireland			20 United States	→	

Note: (→) *means that TO causes SELF* [Table 4]; (←) *means that SELF causes TO* [Table 5]; (⇆) *means bidirectional Granger causality*

C. Asymmetric Granger causality test, by Hatemi-J (2012)

Table 7. Asymmetric Granger causality –Global cumulative shocks–

	$TO \nRightarrow SELF$ (dependent variable: SELF)				$SELF \nRightarrow TO$ (dependent variable: TO)			
	Test statistic	Bootstrap critical values			Test statistic	Bootstrap critical values		
Countries		1%	5%	10%		1%	5%	10%
1 Australia	2.571	14.134	9.225	7.159	5.057	14.485	8.953	7.146
2 Austria	0.044	7.803	4.211	2.908	2.881	7.733	4.149	2.934
3 Belgium	5.629	12.064	7.736	6.332	3.271	13.396	9.272	7.292
4 Canada	0.918	10.093	6.578	4.969	3.447	11.960	6.304	4.863
5 Denmark	1.617	6.932	3.804	2.782	0.333	7.008	4.265	3.125
6 Finland	1.829	6.671	3.806	2.522	0.310	8.255	4.131	2.923
7 France	1.187	9.649	6.145	4.752	2.167	12.769	7.525	5.522
8 Germany	0.422	7.985	4.111	2.743	**4.300***	10.802	4.908	3.175
9 Greece	1.234	10.896	5.942	4.966	3.693	10.216	6.083	4.871
10 Ireland	0.164	7.654	4.163	3.039	1.093	7.642	4.181	3.024
11 Italy	2.304	8.253	3.912	2.987	0.000	6.660	4.035	2.913
12 Japan	0.133	11.202	6.926	4.931	3.372	10.729	7.182	5.238
13 Luxembourg	0.007	7.673	4.440	2.823	1.272	6.966	4.221	2.942
14 Netherlands	1.245	7.830	3.981	2.815	0.382	6.414	3.606	2.717
15 Norway	4.756	12.942	8.455	6.657	1.425	14.065	8.596	6.694
16 Portugal	0.141	10.151	6.850	5.025	**11.552*****	11.038	6.526	4.699
17 Spain	0.045	7.573	3.770	2.678	0.108	7.648	4.353	3.141
18 Sweden	1.656	10.093	6.504	4.858	**8.862****	10.516	6.471	5.040
19 United Kingdom	0.015	7.124	4.240	2.868	1.025	7.344	4.028	2.689
20 United States	0.851	7.356	4.579	3.042	0.217	7.031	3.873	2.712

Note: The symbol $A \nRightarrow B$ express that variable A does not cause variable B

Table 8. Asymmetric Granger causality –Positive cumulative shocks–

	$TO^{+} \nRightarrow SELF^{+}$ (dependent variable: $SELF^{+}$)				$SELF^{+} \nRightarrow TO^{+}$ (dependent variable: TO^{+})			
	Test statistic	Bootstrap critical values			Test statistic	Bootstrap critical values		
Countries		1%	5%	10%		1%	5%	10%
1 Australia	0.182	10.764	6.416	4.953	**12.265*** **	11.078	6.436	4.906
2 Austria	0.028	9.123	3.769	2.933	**3.899***	8.710	4.374	2.735
3 Belgium	5.201	15.509	10.191	7.549	**12.768*****	13.505	9.355	7.235
4 Canada	**7.882****	10.266	6.952	5.258	**21.172*****	10.795	6.769	5.020
5 Denmark	**8.151***	15.335	9.109	6.655	2.628	14.191	8.208	6.853
6 Finland	1.755	6.816	3.524	2.650	0.198	6.447	3.995	2.629
7 France	0.008	7.302	3.774	2.603	0.298	7.427	3.738	2.696
8 Germany	**20.271*****	13.440	9.385	7.366	3.043	15.011	9.268	7.143
9 Greece	2.927	19.966	11.575	8.454	0.717	14.369	9.277	6.833
10 Ireland	0.000	6.829	3.925	2.848	0.001	6.881	3.700	2.953
11 Italy	0.568	11.408	4.687	2.895	0.230	10.049	3.838	2.601
12 Japan	0.463	28.877	11.711	7.179	**6.951***	11.858	8.795	6.738
13 Luxembourg	2.765	7.448	3.962	2.915	0.210	8.472	4.777	3.215
14 Netherlands	0.007	8.588	4.772	3.391	1.613	7.331	4.370	3.139
15 Norway	0.786	10.008	4.628	2.606	0.983	10.973	4.452	2.940
16 Portugal	0.015	8.670	4.743	3.124	1.421	7.495	4.121	2.860
17 Spain	0.000	7.345	4.436	2.612	0.193	7.325	4.163	2.889
18 Sweden	1.164	14.880	7.379	4.887	**7.801****	16.801	7.503	5.392
19 United Kingdom	0.325	9.142	5.087	3.155	0.351	7.301	4.038	2.866
20 United States	1.636	8.154	4.015	2.805	0.893	9.961	4.419	2.771

Note: The symbol $A \nRightarrow B$ express that variable A does not cause variable B

Table 9. Asymmetric Granger causality –Negative cumulative shocks–

	$TO^{-} \nRightarrow SELF^{-}$ (dependent variable: $SELF^{-}$)				$SELF^{-} \nRightarrow TO^{-}$ (dependent variable: TO^{-})			
	Test statistic	Bootstrap critical values			Test statistic	Bootstrap critical values		
Countries		1%	5%	10%		1%	5%	10%
1 Australia	3.043	7.174	4.169	2.954	0.334	6.551	3.844	2.820
2 Austria	0.065	7.290	3.822	2.725	0.056	8.151	4.306	3.268
3 Belgium	1.800	13.753	7.868	6.348	0.560	13.759	9.328	7.244
4 Canada	0.055	10.933	3.736	2.444	1.275	11.918	3.915	2.432
5 Denmark	0.423	8.834	4.473	2.807	0.337	8.554	3.910	2.599
6 Finland	0.197	9.366	4.381	2.858	0.249	9.576	4.505	2.886
7 France	0.695	11.906	6.784	4.852	0.660	11.917	7.979	5.783
8 Germany	0.012	12.012	3.985	2.393	2.010	17.988	4.627	2.499
9 Greece	2.990	7.098	4.178	3.143	0.919	6.753	3.689	2.461
10 Ireland	0.002	7.469	4.383	2.844	2.624	8.986	4.218	2.726
11 Italy	0.912	8.151	4.363	2.824	1.571	8.683	4.515	2.818
12 Japan	0.018	10.625	6.366	4.625	2.292	12.096	6.626	5.026
13 Luxembourg	0.652	9.515	3.881	2.695	0.163	7.700	3.820	2.598
14 Netherlands	**12.741****	17.394	8.693	5.737	0.302	12.811	7.572	5.228
15 Norway	0.023	9.105	3.928	2.733	0.072	9.058	4.400	2.931
16 Portugal	0.431	8.701	4.066	2.707	1.288	10.184	3.940	2.741
17 Spain	0.217	7.938	3.747	2.839	0.361	6.868	4.031	2.878
18 Sweden	0.439	10.708	6.523	4.830	4.758	14.658	7.621	5.422
19 United Kingdom	0.024	12.338	4.353	2.811	1.099	12.417	4.534	2.506
20 United States	0.325	5.668	4.049	2.640	1.758	6.711	4.027	3.027

Note: The symbol $A \nRightarrow B$ express that variable A does not cause variable B

Table 10. Asymmetric Granger causality –Mixed cumulative shocks (I)–

	$TO^{-} \nRightarrow SELF^{+}$ (dependent variable: $SELF^{+}$)				$SELF^{-} \nRightarrow TO^{+}$ (dependent variable: TO^{+})			
	Test statistic	Bootstrap critical values			Test statistic	Bootstrap critical values		
Countries		1%	5%	10%		1%	5%	10%
1 Australia	0.042	9.077	3.726	2.569	0.600	11.832	8.626	6.741
2 Austria	0.673	14.203	4.237	2.269	6.553	11.343	8.344	6.797
3 Belgium	**9.678***	22.023	11.716	8.019	4.214	13.996	9.313	7.592
4 Canada	0.100	14.229	7.973	5.344	0.427	10.200	6.022	4.810
5 Denmark	0.342	14.577	5.348	2.189	1.280	6.389	3.904	2.737
6 Finland	3.918	17.015	11.485	8.742	0.087	7.234	4.131	3.000
7 France	**11.330***	20.850	11.972	8.981	0.445	11.986	7.327	5.254
8 Germany	9.752	21.097	13.231	9.842	1.718	7.248	3.92000	2.751
9 Greece	0.057	22.192	5.410	2.681	3.843	10.955	6.785	5.108
10 Ireland	0.577	12.158	8.254	5.766	0.913	7.111	3.677	2.595
11 Italy	0.407	10.050	4.190	2.681	**7.477****	10.328	6.857	5.202
12 Japan	0.068	21.702	5.129	2.297	**7.440***	14.864	8.368	6.440
13 Luxembourg	0.475	18.196	5.249	2.839	1.649	6.891	4.005	2.728
14 Netherlands	3.561	18.320	12.696	9.458	0.033	8.506	3.895	2.832
15 Norway	1.662	9.132	4.270	2.652	0.756	10.021	5.196	3.546
16 Portugal	0.556	8.754	4.930	2.919	**11.365*****	7.903	4.543	3.043
17 Spain	0.208	15.581	4.036	2.252	0.085	6.726	4.019	2.729
18 Sweden	3.729	19.064	8.234	5.256	2.480	9.100	4.395	2.994
19 United Kingdom	0.551	9.012	4.250	3.138	**2.700***	13.452	4.046	2.469
20 United States	0.075	17.700	6.531	3.279	2.630	10.833	6.451	4.928

Note: The symbol $A \nRightarrow B$ express that variable *A* does not cause variable *B*

Table 11. Asymmetric Granger causality –Mixed cumulative shocks (II)–

	$TO^{+} \nRightarrow SELF^{-}$ (dependent variable: $SELF^{-}$)				$SELF^{+} \nRightarrow TO^{-}$ (dependent variable: TO^{-})			
		Bootstrap critical values				Bootstrap critical values		
Countries	Test	1%	5%	10%	Test	1%	5%	10%
1 Australia	**7.555***	13.694	8.749	6.605	1.508	8.127	4.234	2.612
2 Austria	1.384	12.737	8.238	6.658	0.139	16.007	4.686	2.579
3 Belgium	4.056	13.005	8.377	6.383	2.715	16.565	9.993	7.470
4 Canada	1.901	11.724	6.755	5.135	3.339	15.036	7.855	5.600
5 Denmark	0.298	8.319	4.170	2.805	0.900	19.821	5.906	2.440
6 Finland	0.174	8.552	4.072	2.986	**10.927****	20.566	12.466	9.420
7 France	2.076	10.084	6.809	4.944	4.605	18.737	13.008	9.795
8 Germany	0.414	8.446	4.228	2.800	4.276	20.867	12.353	9.166
9 Greece	2.880	11.224	7.258	5.518	0.618	12.124	4.338	2.400
10 Ireland	0.195	7.221	4.156	2.908	0.648	13.798	6.884	5.136
11 Italy	1.112	10.041	6.201	4.626	0.255	16.339	6.395	3.312
12 Japan	1.208	14.180	9.273	7.331	0.044	27.558	5.949	2.596
13 Luxembourg	0.170	8.565	4.176	2.791	0.087	12.691	4.130	2.335
14 Netherlands	0.013	7.898	3.926	2.790	**31.006*****	24.345	11.134	8.646
15 Norway	0.034	7.431	4.112	2.924	0.881	9.531	4.950	3.244
16 Portugal	0.485	7.308	4.543	2.926	2.071	9.520	3.693	2.623
17 Spain	2.205	7.732	4.069	2.692	0.090	18.342	5.379	2.337
18 Sweden	2.224	6.370	3.694	2.684	2.530	12.831	6.797	4.756
19 United Kingdom	0.132	11.892	4.612	2.883	0.246	10.111	4.936	3.357
20 United States	1.631	10.554	6.128	4.694	0.620	12.335	5.066	2.892

Note: The symbol $A \nRightarrow B$ express that variable A does not cause variable B

D. Summary of Results

Table 12. Summary of Results

	Competitiveness hypothesis $H_0: TO \nRightarrow SELF$ (dep. var.: SELF)		Growth/scale hypothesis $H_0: SELF \nRightarrow TO$ (dep. var.: TO)		Feedback hypothesis ***Bidirectionality***
A. Toda-Yamamoto test					
	Belgium	5.447*	Austria Germany Portugal Sweden	2.881* 4.299** 11.552*** 8.862***	
B. Bootstrap panel Granger causality test, by Kónya (2006)					
Without time trend	Denmark France Italy Sweden United States	16.441** 36.999*** 7.696* 16.415** 17.033**	France Portugal Spain	27.565** 37.685*** 12.767*	France
With time trend	France Sweden	24.099*** 29.851***	France Netherlands Norway Portugal	27.127** 16.059*** 13.260* 23.310**	France
C. Asymmetric Granger causality test, by Hatemi-J (2012)					
Global cumulative shocks			Germany Portugal Sweden	4.300* 11.552*** 8.862**	
Positive cumulative shocks	Canada Denmark Germany	7.882** 8.151* 20.271***	Australia Austria Belgium Canada Japan Sweden	12.265*** 3.899* 12.768*** 21.172*** 6.951* 7.801**	Canada
Negative cumulative shocks	Netherlands	12.741**			
Mixed cumulative shocks (I & II)	Belgium France Australia	9.678* 11.330* 7.555*	Italy Japan Portugal UK Finland Netherlands	7.477** 7.440* 11.365*** 2.700* 10.927** 31.006***	

Chapter 4. Entrepreneurship, Economic Growth and Economic Freedom: a panel cointegration and causality analysis for 19 OECD and non-OECD Countries

Abstract: This paper explores the two-way relationships between self-employment, labor productivity and the economic freedom for a sample of 19 OECD and non-OECD countries over the period 1995-2013, by using different panel unit roots test in order to look for robustness. The study supports the idea that economic freedom enhances entrepreneurship and economic growth. However, we find evidence on the influence of entrepreneurship on institutions. The proliferation of rent seekers and low competitive firms and entrepreneurs, might lead the development of different forms of lobbying (corruption) on regulation in the domestic market and on trade policy as a way to protect their exposure to external competence the proliferation of rent seekers, monopoly and thriving a preferential treatment thriving by public sector. A poverty trap could emerge

4.1. Introduction

The relationship between economic freedom and entrepreneurship is a complex interaction in which some different dimensions of freedom play a role.

We will agree in that an adequate institutional framework for enhancing entrepreneurship and economic growth –understood as pillars of the entrepreneurship ecosystem–, should be associated to a number of vectors that define the so called economic freedom –such factors may relate, for example, to the degree of global trade openness, to the size of government and the extent in which public sector crowds out private sector, to the legal framework governing business firms including labour market institutions and to the regulation of credit and property rights.

In fact, business ventures need an adequate environment characterised by open settings in which factors, goods and services are exchanged in friction-free markets, including the freedom to trade internationally. Accordingly, the more economic freedom, the better the environment for entrepreneurial success is. In other words, openness to competition in both domestic and international, should stimulate the decision to become entrepreneurs among those individuals most likely to achieve entrepreneurial success, and it should lead to economic growth. From this perspective, the lack of institutional obstacles to entrepreneurship is a necessary condition for a successful entrepreneurship and for economic growth (Fogel et al., 2006). By the same reasoning, the more developed countries should have the more productive and dynamic self-employed sectors, which demand entrepreneurship ecosystems that guarantee optimal conditions for competing both internally and internationally.

In general, previous literature provides empirical evidence supporting a positive relationship between various of the dimensions associated to economic freedom and entrepreneurship, maybe with the exception maybe of the degree of openness to trade (Nystrom, 2008). The most part of this body of literature has focused on the relationship between institutions of economic freedom and entrepreneurship. However, the study of how entrepreneurship may affect institutions, or even the analysis of the interdependence between these two variables –i.e. the existence of a bidirectional relationship between economic freedom and entrepreneurship– seems to have been overlooked in the Economics of entrepreneurship.[1] This element is a hot policy issue at the time of writing when the phantom of trade protectionism re-emerges after decades in which the rapid pace of international market integration seemed to be an inexorable trend. In this new context, segments of business owners, firms and workers –the less competitive ones– pressures on national governments for introducing new regulations in the domestic economic activity in order to low the exposure to foreign competition and a backtracking in the process of globalisation and integration of markets. This is an example of the interest of this reverse relationship in which the causality runs from entrepreneurship to economic free-

[1] With the exceptions of Lee (1991) y Clark and Lee (2006)

dom, since the domestic self-employed sector has an incentive to influence on the legislative authorities in order to achieve a favourable institutional framework against foreign entrepreneurs to protect their interests.

In this paper we explore the potential bidirectionality in the nexus between entrepreneurship and economic freedom. We hypothesise that the relationship between entrepreneurship and economic freedom could be different depending on the balance of forces between productive/competitive and non-competitive self-employment in the economy. The intuition behind this hypothesis is that economic freedom enhances true/opportunity/formal/competitive entrepreneurship while obstaculise informal/necessity/ and less competitive entrepreneurship.

Developing this idea still further we can argue how the proliferation of rent seekers and low competitive firms and entrepreneurs, might lead the development of different forms of lobbying (corruption) on regulation in the domestic market and on trade policy as a way to protect their exposure to external competence (see Gilligan, 1997 and Bombardini, 2008), the proliferation of rent seekers, monopoly and thriving a preferential treatment thriving by public sector.

As a result, the extensión of rent-seeking activities and the barriers to free trade –the lower economic freedom– will lead a crowding out effect on the most competitive firms and entrepreneurs inhibiting innovation, job creation and economic growth. Taking these factors into consideration, we should expect not only an effect of economic freedom on entrepreneurship but also an opposite relationship. The characteristics of the self-employed sector could try to lobby in order to reduce economic freedom limiting the capacity of contributing to economic growth and to entrepreneurship.

By contrast, a competitive entreprenurial sector will propitiate an entrepreneurship ecosystem in which institutions must guarantee free trade and in which the role of public sector, the legal framework should be limited to ensure and stimulate competition.

From this perspective, the relationship between economic freedom and entrepreneurship should be reconsidered for taking into account not only the effect of economic freedom on entrepreneurship but also how self-employed sectors, dominated by informality and non-competitive markets, can feedback and perpetuate since in these entrepreneurship ecosystems, the self-employed sector treats to perpetuate the situation lobbying on regulation in the domestic market and on trade. In this way in a context in which protectionism seem to place again at the heart of the debate, the existence and direction of causality between economic freedom should be considered as a key element for the formulation of entrepreneurship policies and their interaction with the regulatory framework.

For example, if causality does not exist –neutrality hypothesis– in both directions or if causality is only in one direction such as from economic freedom to entrepreneurship, then a general strategy oriented to have a smaller government sector, better conditions for international trade and an adequate quality of regulation of labour, credit and business legal structure, less strict regulation of credit, labour and business may be appropriate since it will have a positive effect on the entrepreneurship ecosystem environment enhancing innovation, economic growth and job creation.

In some ecosystems, this strategy can consist in doing nothing –laissez-faire laissez-passer–, to prevent distortions and frictions, and sometimes in a process of deregulation, elimination of barriers or different types of frictions.

By contrast, if there is causality from entrepreneurship to economic freedom, less entrepreneurship –i.e. a small and non-competitive self-employed with a high proportion of rent-seekers looking for monopoly rent seekers, will create a complex network of rent seekers who will lobby to manipulate the regulatory framework for their own ends. Then a poorer and non-competitive entrepreneurial network may harm economic freedom and constrain economic growth.

Finally, if there is a bi-directional causality, economic freedom not only does economic freedom increase the quantity of entrepreneurial activity, but it also dramatically increases the quality of entrepreneurial activity, interpreted in terms of productivity, that is if the growth hypothesis also holds. In other words, economic freedom may foster the productive entrepreneurship whereas an unproductive and non-competitive self-employed sector will lobby for government entry restrictions and barriers to both the internal market and external trade–feedback hypothesis-.[2]

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[2] The other options are related with the relationships of causality between entrepreneurship and economic growth and economic freedom and economic growth. The first relationship can be summarized into three possible results: no causality or neutrality hypothesis the uni-directional causality from entrepreneurship to economic growth or growth hypothesis, and the causality relationship

To this end, we proceed to study the two way causality relationships between (i) self-employment rate (ii) the GDP per capita (in logs), as a measure of labor productivity, and (iii) a global index of economic freedom as indicator of openness and flexibility of markets.

For a sample of 12 developing countries from Latin America, Europe and Asia, we develop our econometric strategy consisting of applying different panel unit root and cointegration tests in order to compare the robustness of our results. Likewise, we employ the Dynamic OLS (DOLS) and Fully modified (FMOLS) estimators to avoid possible spurious results.

The empirical results show both for the first and the second generation of panel unit root tests that all variables are stationarity in first differences. Using three tests of cointegration proposed by Pedroni's (1999, 2001), Kao's (1999) and Westerlund's (2007), we find in general, weak evidence of cointegration for the different samples, being necessary to consider a time-trend. The results for FMOLS and DOLS estimators show a negative and significant relationship between labor productivity and self-employment, which is consistent with previous studies, and a positive but only significant link for some cases between economic freedom and self-employment. The results for the panel Fisher test reveal evidence of Granger causality from economic freedom to labor productivity for both the whole sample and subsample of non-OECD countries, and bidirectional Granger causality between self-employment and labor productivity in Poland.

The rest of the paper is organized as follows. Section 2 describes some empirical findings of previous studies. Section 3 presents de data used for analysis. Section 4 explains our methodological strategy and Section 5 reports the empirical results. Finally, Section 6 offers the summary and conclusions.

4.2. Briefly Review of Literature

The empirical relationships between entrepreneurship, labor productivity and economic freedom have been studied in different ways by previous

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which goes from economic growth to entrepreneurship or push and pull hypotheses.

literature. The most common approach has been to check them in the framework of works on the determinants of economic growth and entrepreneurship including different proxies of the quality of institutions (see e.g., Robson, 2003; Parker and Robson, 2004;Torrini, 2005; Loayza and Rigolini, 2011).

Specific literature on the relationship between entrepreneurship and economic freedom is however scarce and mainly analysing the role of economic freedom as determinant of entrepreneurship.[3] This body of literature usually test the hypothesis of that the quality of the institutions of each entrepreneurship ecosystem are determinants of regional entrepreneurship and economic growth. The studies of, Kreft and Sobel (2007), Sobel et al. (2007), Bjornskov and Foss (2008), Hall and Sobel (2008) or Nÿstrom (2008) provide empirical findings on this topic. These last studies are cross-country ones *Economic freedom of the world* index published by the Fraser Institute as a measure of economic freedom. In general these studies provide support to the positive effect of economic freedom on entrepreneurial activity.

Sobel (2008) tests and confirms the Baumol's theory (Baumol, 1990) demonstrating how good institutions and economic freedom favours the emergence of productive entrepreneurship sustaining economic growth.

Following this idea, some recent works have explored how the quality of institutions determines the prevalence of formal or informal, entrepreneurship. Saunoris and Sjany (2017) provide evidence suggesting that economic freedom promotes formal entrepreneurship (inhibiting informal entrepreneurship). Importantly, they also explores the potential bidirectionality in the nexus between entrepreneurship and economic freedom. They hypothesise that the relationship between entrepreneurship and economic freedom could be different depending on the balance of forces between formal and informal self-employment in the economy in a way that is important to take into account the possible reverse causality.

There also exists a large body of empirical literature exploring the relationship between entrepreneurship and economic growth, controlling by the institutional framework. Some of these works includes, at least the work of Wennekers and Thurik (1999) or Parker and Robson (2004). This last article analyses the determinants of self-employment for a sample of

[3] See Bjornskov and Foss (2016) for a survey about the relationship between institutions, entrepreneurship and economic growth.

12 high-income OECD countries. Taking into account a set of regressors, - real GDP per capita, unemployment rates, the value added of services, the average rate of tax, among others- and applying the Pedroni (1999) methodology, they find evidences of cointegration relationships for all regressors. Moreover, it is found that estimations for real per capita GDP and average rate of tax are positive and significant by employing FMOLS estimator, which may suggest that these variables have more explanatory power than other traditional factors as unemployment or value added. More recently, Harbi et al., (2011) investigate the Granger causality and the long-run relationships between entrepreneurship (self-employment rate) and economic growth (GDP per capita) for a sample of 34 OECD countries. The estimation also includes the influence of other determinants of growth such as the institutional context (measured by Trade Freedom, Financial Freedom and Property Rights) or the degree of openness (exports as a percentage of GDP). The empirical results reveal, on the one hand, that self-employment causes economic growth. In particular, self-employment may increase GDP per capita in the short-run but in the long-run, this relationship seems to be negative, which may be related to the idea of “necessity entrepreneurship" (Acs, 2006). On the other hand, they find that growth does not cause self-employment, trade freedom and property rights but has impact on financial freedom and export.

Other factors such as the size of the public sector, the level of corruption and tax evasion are also considered by literature for their influence on entrepreneurial activity. This is the case of Torrini (2005) who finds a negatively correlation between self-employment rate and the size of public sector while for tax evasion, the empirical results show that "... a higher tax rate reduces the incentive to enter self-employment." (Torrini 2005, p. 681). Albulescu et al. (2016) analyze for 15 European economies, the link between entrepreneurial activity, (using Global Entrepreneurship Monitor - GEM- data which distinguishes between necessity-driven versus innovation-driven entrepreneurs, NDE vs. IDE) and institutional weaknesses, in terms of tax evasion and corruption. By employing cointegration techniques for heterogeneous and homogenous panels suggested respectively by Pedroni's (1999, 2001) and Kao's (1999) and using FMOLS and DOLS estimation methods, they conclude that all variables are cointegrated. They also find that corruption has a greater negative impact on entrepreneurship than tax evasion, both on NDE and the total entrepreneurial activity.

4.3. The data set and the model

We use a sample of annual panel data for 19 OECD and no-OECD countries over the period 1995- 2013. In our study, we will analyse both the whole panel, denoted by G-I, and the different sub-panels depending on whether or not they belong to the OECD Group. The first subsample is formed by 11 OECD economies (G-II) in which are included: the Group of 7 (the world's largest industrialized economies, G7) that is, Canada, France, Germany, Italy, Japan, the United Kingdom and the United States, as well as Chile, Hungary, Poland and Korea Republic. The second sub-sample includes 8 no-OECD countries (G-III) of which 3 are from Latin America -Argentina, Colombia and Ecuador-; 2 from Europe -Croatia and Romania- and 3 from Asia -Malaysia, Sri Lanka and Thailand-.

Our empirical strategy will be applied taking into account the whole panel as well as each group defined, with the aim to compare the validity of our results and to present the conclusions that from them can be drawn. Based on Torrini (2005) and using the specification proposed by Parker and Robson (2004), the long-run equilibrium relationship among our variables can be expressed by the following equation:

$$S_{it} = \alpha_i + \delta_i t + \beta_{GDP,i} Y_{it} + \beta_{F,i} F_{it} + \varepsilon_{it}$$
$$\text{for } i = 1, \dots, N \text{ and } t = 1, \dots, T \tag{1}$$

where the subscripts *i* and *t* refer to country and time period, respectively. All variables are expressed in logs: variable *S* represents the self-employment rate in country *i* at time *t*; *Y* is the GDP per capita, in constant 2010 US$, both collected from World Bank database; and *F* denotes the Index of Economic Freedom[4], obtained from the Heritage Foundation. α_i and $\delta_i t$ represent the country-specific intercepts and time trend, respectively; the β parameters are the slope coefficients of each independent variable; and finally, ε_{it} expresses the disturbance term.

[4] The Index of Economic Freedom considers the following groups of factors: i) Rule of Law (property rights, freedom from corruption); ii) Limited Government (fiscal freedom, government spending); iii) Regulatory Efficiency (business freedom, labor freedom, monetary freedom); and iv) Open Markets (trade freedom, investment freedom, financial freedom). The use of a synthetic index has the advantage of avoiding some problems related to multicolinearity.

4.4. Methodology

For analysing the causality relationships between these three variables, we follow the next econometric strategy. First, we analyse the integration order of each variable to detect whether they are stationary in levels or by contrast, follow unit root processes and thus, are difference stationary. In the case of all variables be non-stationary in levels but stationary in first differences, that is, all may be I(1), we will apply a set of panel cointegration tests in order to investigate the long-run relationship between our variables. The existence of this long-run relationship should imply that 'deviations from equilibrium are stationary, with finite variance' (Engle and Granger, 1987, p.251). Finally, we employ the Fully Modified OLS (FMOLS) estimation and Dynamic OLS (DOLS) for both the pooled and group-mean versions, to explore the nature of the impact of *Y* and *F* on *S and of S on Y and F.*

A. Panel Unit Root Tests[5].

The first step consists in analysing whether our variables are stationary or non-stationary, for which it is used two types of tests: (i) A first generation of panel unit root tests that allows the cross-sectional independency. In particular, we perform the tests provided by: Levin, Lin and Chu (1992, 2002) -LLC- and Breitung (2000) -B test-, based on common unit root process (homogeneous hypothesis), and Im, Pesaran and Shin (2003) -IPS- and Maddala and Wu (1999) and Choi (2001) -Fisher-ADF chi-square and Fisher-PP chi-square-, based on individual unit root process (heterogeneous hypothesis). All of them are defined under the null hypothesis of non-stationarity unlike the Hadri test (2000), also belonging to the first generation of homogeneous tests, but founded on the null of stationarity. (ii) A second generation of common factors panel unit root tests complete this analysis taking into account the cross-sectional dependencies across the panel units, such as the cross-sectionally augmented IPS (CIPS) test of Pesaran (2007).

B. Panel Cointegration Tests[6]

To estimate the long-run relationships among variables, once determined the integration order of individual series, we proceed to apply three different approaches in order to compare our results, given the diverse

[5] For a survey of panel unit root tests, see Hurlin 2007 and Breitung and Pesaran 2008.

[6] For more detail, see Pedroni (2004), Kao (1999) and Westerlund (2007).

problems linked to panel cointegration such as heterogeneity or asymptotic properties of tests in relation to N and T dimension. The first test used is the residual-based panel cointegration test suggested by Pedroni (1999, 2004). This test is based on the assumption that all variables are I(1) and is built under the null hypothesis of that "all of the individuals of the panel are not cointegrated". In this sense, two types of test statistics are proposed: the panel statistics and the group-mean statistics, related to the within- and between-dimension of data, respectively, that are asymptotically distributed as N(0,1). The main contribution of this test is that "both the short-run dynamics and the long-run slope coefficients are permitted to be heterogeneous across individual members of the panel" (Pedroni, 2004, p. 597). The second approach considered, is the residual-based cointegration tests suggested by Kao (1999) which, unlike Pedroni (2004) test, assumes the homogenous short-run dynamics on the first-stage regressors. This test extends the use of Dickey Fuller (DF) and augmented Dickey Fuller (ADF) unit root tests under the null of no cointegration. Finally, we examine the four error-correction–based panel cointegration tests provided by Westerlund (2007). On the null hypothesis of no cointegration, this test is not based on residual dynamics, but variance ratio structure. Two types of statistics are specified: For panel statistics, the rejection of the null implies that there is evidence of cointegration for panel as a whole. For group-mean statistics, the rejection of the null suggests cointegration for at least one of the cross-sections.

C. Panel FMOLS and DOLS estimations.

The following step consists in estimating of cointegrating relationships in panel data, following the Fully-Modified OLS (FMOLS) approach for heterogeneous cointegrated panels developed by Phillips and Moon (1999) and Pedroni (2000, 2001) and complete the analysis with the Dynamic OLS (DOLS) estimator proposed by Saikkonen (1991) and extending by Kao and Chiang (2000) and Mark and Sul (2003). The FOMLS estimator, $\hat{\beta}_{FM}$, introduces adjustments for endogenous regressors and serial correlation respect to OLS estimator and has the form:

$$\hat{\beta}_{FM} = \left[\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{it}-\bar{x}_i)(x_{it}-\bar{x}_i)'\right]^{-1} \times \left[\sum_{i=1}^{N}\left(\sum_{t=1}^{T}(x_{it}-\bar{x}_i)\,\hat{y}_{it}^{+} - T\hat{\Delta}_{\varepsilon u}^{+}\right)\right] \quad (2)$$

where $\hat{\Delta}_{\varepsilon u}^{+}$ is the serial correlation correction term and a kernel estimates of $\Delta_{\varepsilon u}$. for the asymptotic covariance matrix. If specific assumptions hold, the limiting distribution of $\hat{\beta}_{FM}$ is:

$$\sqrt{N}T(\hat{\beta}_{FM} - \beta) \Longrightarrow N(0, 6\Omega_{\varepsilon}^{-1}\Omega_{u,\varepsilon}) \quad (3)$$

On the other hand, DOLS estimator, $\hat{\beta}_D$, is obtained from the regression:

$$y_{it} = \alpha_i + x_{it}^{'}\beta + \sum_{j=-q}^{q} c_{ij}\Delta x_{it+j} + \dot{v}_{it} \quad (4)$$

$$\text{where } \dot{v}_{it} = v_{it} + \textstyle\sum_{|j|>q} c_{ij}\varepsilon_{it+j}$$

If determinate assumptions hold, the limiting distribution of $\hat{\beta}_D$ is:

$$\sqrt{N}T(\hat{\beta}_D - \beta) \Longrightarrow N(0, 6\Omega_{\varepsilon}^{-1}\Omega_{u,\varepsilon}) \quad (5)$$

According to Kao and Chiang (2000) "the DOLS differs from the FMOLS estimator in that the DOLS requires no initial estimation and no non-parametric correction" (Kao and Chiang 2000, p. 206). However, the authors prove that "FMOLS estimator share the same limiting distributions as those based on the DOLS estimator" for the heterogeneous panels (Kao and Chiang 2000, p. 191). Nevertheless, DOLS is less biased than the OLS and FMOLS estimator for both homogeneous and heterogeneous panels.

D. Panel Granger Causality.

The last step consists to study the long-run Granger causality between series, for which we will use the Panel Fisher Test proposed by Emirmahmutoglu and Kose (2011). This test extends the LA-VAR methodology suggested by Toda and Yamamoto (1995) by employing Meta analysis in heterogeneous mixed panels through Monte Carlo experiments. Focusing on our variables, we can define the following hypothesis[7]:

i) Entrepreneurship-led growth hypothesis, postulates that the economic growth of countries can be generated by expanding entrepreneurship: *S* causes *Y*

ii) Pull Hypothesis: economic growth creates new business opportunities and then new entrepreneurs: *Y* causes *S*

iii) Lobby Hypothesis: if *S* causes *F*

iv) Economic freedom improves the entrepreneurship ecosystem: *F* causes *S*

4.5. Empirical Results

A. Panel Unit Root Tests.

Firstly, we consider a first generation of panel unit root tests based on the assumption of cross-sectional independence. Table 1A presents the results of the non-stationary tests based on the homogeneous –LLC and B test– and heterogeneous hypothesis –IPS and Fisher-type tests–, while Table 1B shows results of the stationary test provided by Hadri (2000). Then, these results are compared with obtained by applying a second generation of unit root tests that allow cross-sectional correlation, such as Pesaran (2007) test (Table 1C). All tests are implemented for variables in levels and in first differences, taking into account the whole panel and each group in order to compare the robustness of our results. To this end, it is also included the different options in each test equation: (*i*) individual intercept, (*t*) individual intercept and trend and (*n*) no intercept and trend.

The results of Table 1A suggest non-stationarity of time series in levels -I(1)- and stationarity in first differences, which will allow us to address the subsequent analysis of cointegration. Nevertheless, the variable self-employment (S) shows mixed results when the (n) option is modelled. These results are only confirmed by the Hadri test of stationarity (Table

[7] We also resport estimates on the two way relationship between economic freedom and economic growth although this analysis is not at the centre of this paper.

1B) for the subsample G-III under the (i) option. Therefore, the majority of the first generation of panel unit root tests seem to point out that our variables are integrated of order one, or I(1), being these results more consistent for the (i) and the (t) options than (n). Results of applying a the second generation tests, in particular, the cross-sectionally augmented IPS (CIPS) test of Pesaran (2007), are reported in Table 1C. The results show the non-stationarity of all series in levels except for the variable S in the sample G-II when a time-trend is not considered. By taking first differences, we can reject the null hypothesis that there is a unit root for each variable in each sample analyzed at the significance level of 1%, both with and without trend. Therefore, the results obtained by applying the CIPS test -which allows for the cross-sectional dependence- are consistent, in general, with those offered by the first generation tests -which assume the cross-sectional independence-.

B. Panel Cointegration Tests

Results of the panel cointegration tests can be found in Tables 2A, 2B and 2C. The first test performed is the Pedroni's (1999, 2004) residual cointegration test. Under the null hypothesis of no cointegration, this test offers four panel statistics and three group statistics corresponding to within-dimension (homogeneous panels) and between-dimension (heterogeneous panels), respectively. Two of four panel statistics (PP and ADF statistics) show the existence of cointegration relationships among variables at 1% significance level (5% significance level for G-III) when the (*i*) and (*t*) options are considered. These results are extensible for the group PP and ADF statistics, for all samples, at a 1% significance level (5% significance level for G-II). By contrast, the results from Kao's (1999) residual cointegration test suggest a long-run relationship between variables only for the sub-panel G-III at 10% significance level. Finally, we examine the Westerlund (2007) panel cointegration test results. Regarding the group test statistics (Gt and Ga), the null hypothesis of no cointegration for all cross-sections cannot be rejected in any case. For the second group of test statistics, the Pt statistic suggests that there is evidence of at least one cointegration relationship among variables for both G-I and G-III, under the (t) option, at 10% significance level. For the Pt statistic, we can reject the null hypothesis at 5% and 1% significance level for subsample G-I and G-II, respectively under the (t) option. Therefore, we find weak evidence of cointegration for the different samples when a temporal trend is taken into account, which must be defined in our estimation equation.

C. Panel FMOLS and DOLS estimation.

Tables 3A and 3B present the pooled and group-mean FMOLS and DOLS estimators when we include a linear trend (c@t). For the variable Y, the results from both estimations -FMOLS and DOLS, pooled and grouped-, seem to be robust in relation to its sign (negative) and significant, except for the samples G-II and G-III, in pooled and grouped DOLS estimations, respectively. On the other hand, it is found that the coefficient of variable F is positive for all samples being not significant in the majority of cases. Only it is shown significant for grouped FMOLS and DOLS estimations, for G-I and G-II. Therefore, our findings evidence the existence of a negative and significant relationship between Y and S for all samples, and a positive link between F and S that seems to be not significant in the case of G-III.

D. Panel Granger Causality Test

Table 4 presents the results of the panel Granger causality test. We find evidence for the Entrepreneurship-led growth hypothesis in three cases: the United States, Poland and Malaysia; the results also reveal causal links for the pull hypothesis in France, Chile, Poland and Romania; thus, it is found bidirectional Granger causality between S and Y in Poland. There are signs for the lobby hypothesis in Hungary, Poland and Sri Lanka while that, for the fourth hypothesis, we find out Granger causality in Argentina, Ecuador, Korea Republic and Malaysia; the causality relationship which goes from economic freedom to economic growth appears in four cases: the United Kingdom, the United States, Chile and Croatia; and finally, three countries, Japan, Ecuador and Thailand show evidence for the which goes from economic growth to economic freedom. The results of the Fisher test statistic show only evidence of Granger causality from F to Y in two cases: for the whole panel G-I and for the Non-OECD countries (G-III) at 10% significance level.

4.6. Summary and Conclusions

This paper has analysed the long-run relationship between the self-employment rate -as a proxy of entrepreneurship-, the GDP per capita -as a measure of labor productivity- and the index of economic freedom -as proxy of the degree of openness of an economy-, for a sample of 19 OECD and no-OECD countries over the period 1995-2013.

Using the panel unit root test of Pesaran (2007) which allows for the cross-sectional dependence of the series, the results are consistent with obtained by applying a set of the first generation panel unit root tests based on the cross-sectional independence. Focusing on the cointegration analysis, the Pedroni's (1999, 2004) test finds evidences of cointegration for all samples. By contrast, the Kao's (1999) tests only suggest a long-run relationship between variables for G-III while Westerlund's (2007) shows weak signs for G-I and G-II. On the other hand, using FMOLS and DOLS estimators, we find a negative and significant relationship between Y and S, both for whole panel and each group mentioned (van Stel et al., 2005; Harbi et al., 2011) while estimations for the effects of F on S seems to be positive but not significant in the majority of cases. Finally, by applying the panel Granger causality approach suggested by XXX(2011) we find evidence of bidirectional Granger causality between S and Y in Poland and according to the results for the Fisher test statistic, causal links from F to Y in G-I and G-III.

The findings in this paper suggest important policy implications. In general, countries stand to benefit from policies that support economic freedom; however, less competitive entrepreneurs will treat to lobby obstaculising economic growth and entrepreneurship.

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APPENDIX

Table 1A. First Generation of Non-Stationary Panel Unit Root Tests[1]

			Tests with Common Unit Root Process				Tests with Individual Unit Root Process							
			LLC test (t)*			*B (t-stat)*	*IPS (W-stat)*		*Fisher-ADF (Chi-square)*			*Fisher-PP (Chi-square)*		
	Var		*i*	*t*	*n*	*t*	*i*	*t*	*i*	*t*	*n*	*i*	*t*	*n*
G-I All	S	Stat.	0.1298	-0.2710	-6.5408	1.6795	1.7284	-0.4894	30.7026	46.4463	91.8383	28.2837	51.7096	97.3844
		Prob.	0.5516	0.3932	0.0000	0.9535	0.9580	0.3123	0.7938	0.1634	0.0000	0.8746	0.0681	0.0000
	ΔS	Stat	-7.8127	-7.0358	-12.1816	-4.6614	-9.8826	-9.3870	162.129	144.245	213.836	217.793	155.985	244.498
		Prob.	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**
	Y	Stat.	-2.6570	0.0754	12.1244	2.9057	2.1217	1.7141	36.0424	29.1823	1.1098	32.7196	18.6560	0.8431
		Prob.	0.0039	0.5301	1.0000	0.9982	0.9831	0.9567	0.5603	0.8471	1.0000	0.7118	0.9965	1.0000
	ΔY	Stat.	-6.9862	-5.9510	-9.0592	-8.2208	-7.7653	-7.2147	126.949	114.368	151.705	127.935	110.525	147.876
		Prob.	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**
	F	Stat.	-1.4938	-0.3085	0.8765	-0.5096	-0.2260	0.1980	37.3405	37.2286	22.6970	37.1910	37.4762	20.7473
		Prob.	0.0676	0.3788	0.8096	0.3052	0.4106	0.5785	0.4998	0.5049	0.9767	0.5067	0.4935	0.9897
	ΔF	Stat.	-10.8652	-9.3820	-16.3592	-7.6670	-11.4795	-9.4080	185.429	138.567	271.647	184.157	137.980	272.599
		Prob.	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**
G-II oecd	S	Stat.	0.9973	-0.7682	-6.7765	1.5929	3.2055	-0.6847	10.1318	28.9485	72.5227	8.5312	37.1651	79.0219
		Prob.	0.8407	0.2212	0.0000	0.9444	0.9993	0.2467	0.9851	0.1463	0.0000	0.9954	0.0227	0.0000
	ΔS	Stat	-5.0022	-5.0267	-7.8286	-4.5932	-6.7051	-7.3351	84.8330	85.3842	95.8037	139.692	96.2264	126.151
		Prob.	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**
	Y	Stat.	-4.8349	0.4940	8.2678	2.6953	-1.1627	1.3351	29.7485	19.5431	1.0218	27.3580	12.2293	0.6796
		Prob.	0.0000	0.6894	1.0000	0.9965	0.1225	0.9091	0.1247	0.6116	1.0000	0.1979	0.9525	1.0000
	ΔY	Stat.	-5.2147	-4.5465	-6.6224	-5.8863	-5.7472	-5.5188	72.0847	66.8579	86.8441	72.4296	64.6207	84.1950
		Prob.	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**
	F	Stat.	-1.9121	-0.6762	1.1402	-0.3203	-1.1956	-0.0483	27.7450	24.2415	8.3617	27.5076	25.2335	7.4235
		Prob.	0.0279	0.2495	0.8729	0.3744	0.1159	0.4807	0.1843	0.3347	0.9961	0.1926	0.2860	0.9984
	ΔF	Stat.	-9.5097	-8.5681	-13.7240	-5.8405	-9.8337	-8.6229	121.299	93.8966	174.344	120.344	93.9769	175.314
		Prob.	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**
G-III Non Oec	S	Stat.	-1.8526	0.7726	-1.4113	0.4990	-1.1371	0.0573	20.5708	17.4978	19.3156	19.7525	14.5446	18.3625
		Prob.	0.0320	0.7801	0.0791	0.6911	0.1278	0.5228	0.1956	0.3541	0.2526	0.2316	0.5582	0.3031
	ΔS	Stat	-5.8936	-4.5299	-10.2076	-1.9889	-7.3823	-5.8613	77.2963	58.8605	118.033	78.1002	59.7590	118.347
		Prob.	**0.0000**	**0.0000**	**0.0000**	**0.0234**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**
	Y	Stat.	1.8640	-0.5052	9.2864	1.1209	4.6065	1.0760	6.2939	9.6392	0.0880	5.3617	6.4267	0.1636
		Prob.	0.9688	0.3067	1.0000	0.8688	1.0000	0.8590	0.9846	0.8848	1.0000	0.9936	0.9828	1.0000
	ΔY	Stat.	-4.6575	-3.8421	-6.2685	-5.7883	-5.2276	-4.6470	54.8638	47.5099	64.8604	55.5054	45.9047	63.6810
		Prob.	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0001**	**0.0000**	**0.0000**	**0.0001**	**0.0000**
	F	Stat.	-0.1392	0.3245	-0.2957	-0.4103	1.0573	0.3643	9.5956	12.9871	14.3353	9.6833	12.2426	13.3238
		Prob.	0.4446	0.6272	0.3837	0.3408	0.8548	0.6422	0.8869	0.6737	0.5737	0.8826	0.7271	0.6489
	ΔF	Stat.	-5.5797	-3.9531	-9.1629	-4.9643	-6.1600	-4.3760	64.1293	44.6701	97.3031	63.8125	44.0032	97.2850
		Prob.	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0002**	**0.0000**	**0.0000**	**0.0002**	**0.0000**

Table 1B. First Generation of Stationary Panel Unit Root Test. Hadri (2000)

Sample		**G-I**		**G-II**		**G-III**	
Var.		*i*	*t*	*i*	*t*	*i*	*t*
S	Stat.	13.078	6.9427	10.6502	6.5320	7.7054	3.7828
	Prob.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
ΔS	Stat	0.9703	2.9156	1.7120	2.9629	-0.0036	1.4530
	Prob.	**0.1660**	**0.0018**	**0.0434**	**0.0015**	**0.5015**	**0.0731**
Y	Stat.	14.1002	11.4461	10.6404	8.8441	9.8983	5.1219
	Prob.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ΔY	Stat.	5.2432	0.4134	4.1481	0.1249	1.1458	2.1443
	Prob.	**0.0000***	**0.3397**	**0.0000***	**0.4503**	**0.1259**	**0.0160**
F	Stat.	12.4130	5.7762	7.3389	5.3749	8.5603	3.2508
	Prob.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006
ΔF	Stat.	0.1465	3.4734	0.7305	3.4927	-0.1863	1.8870
	Prob.	**0.4418**	**0.0003**	**0.2325**	**0.0002**	**0.5739**	**0.0296**

*segunda dif (se cumple)

[1] Note: Test for unit root in level and in first difference (Δ) Include in test equation: (*i*) individual intercept; (*t*) individual intercept and trend; (*n*) none.

Table 1C. Second Generation of Panel Unit Root Test. Pesaran (2007) CIPS test

Sample		G-I		G-II		G-III	
Var.		*without trend*	*with trend*	*withou t trend*	*with trend*	*without trend*	*with trend*
S	Zt-bar Stat.	-1.304	-0.429	-2.483	-1.472	-0.105	-0.002
	Prob.	0.096	0.334	0.007	0.071	0.458	0.499
ΔS	Zt-bar Stat.	-8.717	-6.927	-7.551	-6.877	-6.020	-4.858
	Prob.	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Y	Zt-bar Stat.	3.774	4.184	3.127	2.389	-1.349	0.391
	Prob.	1.000	1.000	0.999	0.992	0.089	0.652
ΔY	Zt-bar Stat.	-3.756	-3.380	-2.941	-2.187	-5.426	-5.410
	Prob.	**0.000**	**0.000**	**0.002**	**0.014**	**0.000**	**0.000**
F	Zt-bar Stat.	0.838	0.379	-1.375	1.144	1.040	-0.190
	Prob.	0.799	0.647	0.085	0.874	0.851	0.425
ΔF	Zt-bar Stat.	-7.683	-5.333	-6.823	-5.632	-5.060	-3.630
	Prob.	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**

Table 2A. Pedroni (1999, 2004). Residual Cointegration Test

		G-I			G-II			G-III		
Var.		*i*	*t*	*n*	*i*	*t*	*n*	*i*	*t*	*n*
Panel v-Stat.	Stat.	0.9161	2.9450	-1.0167	0.9993	1.3016	-1.1667	0.4068	2.7483	-0.2056
	Prob.	**0.1798**	**0.0016**	**0.8454**	**0.1588**	**0.0965**	**0.8783**	**0.3421**	**0.0030**	**0.5815**
Panel rho-Stat	Stat.	-0.9896	-1.8703	0.1951	-1.5576	-1.4742	0.6852	-0.1427	-1.1680	-0.4934
	Prob.	**0.1612**	**0.0307**	**0.5773**	**0.0597**	**0.0702**	**0.7534**	**0.4433**	**0.1214**	**0.3108**
Panel PP-Stat	Stat.	-3.6286	-8.5583	-1.0853	-3.9344	-7.8045	-0.0659	-1.5799	-4.5938	-1.4751
	Prob.	**0.0001**	**0.0000**	**0.1389**	**0.0000**	**0.0000**	**0.4737**	**0.0571**	**0.0000**	**0.0701**
Panel ADF-Stat	Stat.	-5.1517	-7.4489	-0.9008	-4.1453	-4.3182	0.3199	-3.1866	-5.6040	-1.6669
	Prob.	**0.0000**	**0.0000**	**0.1818**	**0.0000**	**0.0000**	**0.6255**	**0.0007**	**0.0000**	**0.0478**
Group rho-Stat.	Stat.	0.2378	1.4953	1.1566	0.6799	1.5673	2.3018	-0.4307	0.4666	-0.9167
	Prob.	**0.5940**	**0.9326**	**0.8763**	**0.7517**	**0.9415**	**0.9893**	**0.3333**	**0.6796**	**0.1796**
Group PP-Stat.	Stat.	-2.8544	-3.6469	-1.1956	-1.5989	-2.2139	1.2636	-2.5241	-3.0242	-3.3242
	Prob.	**0.0022**	**0.0001**	**0.1159**	**0.0549**	**0.0134**	**0.8968**	**0.0058**	**0.0012**	**0.0004**
Group ADF-Stat.	Stat.	-4.1678	-4.4223	-1.0252	-2.5102	-2.8535	1.8626	-3.4796	-3.4691	-3.7640
	Prob.	**0.0000**	**0.0000**	**0.1526**	**0.0060**	**0.0022**	**0.9687**	**0.0003**	**0.0003**	**0.0001**

Table 2B. Kao (1999). Residual Cointegration Test

	G-I	G-II	G-III
t- Stat.	-0.6109	0.2488	-1.4271
Prob.	**0.2706**	**0.4017**	**0.0768**

Table 2C. Westerlund (2007). Panel Cointegration Tests

		G-I			G-II			G-III		
Var.		*i*	*t*	*n*	*i*	*t*	*n*	*i*	*t*	*n*
Gt Stat.	Z-value	0.006	-0.197	1.197	-0.616	0.086	1.471	0.732	-0.405	0.119
	Prob.	**0.130**	**0.200**	**0.560**	**0.110**	**0.270**	**0.570**	**0.420**	**0.130**	**0.370**
Ga Stat.	Z-value	1.454	2.478	2.404	1.270	1.635	2.097	0.750	1.902	1.246
	Prob.	**0.160**	**0.160**	**0.740**	**0.250**	**0.210**	**0.660**	**0.220**	**0.330**	**0.500**
Pt Stat.	Z-value	1.042	-0.443	0.840	0.903	0.405	1.030	0.615	-1.480	-0.012
	Prob.	**0.370**	**0.090**	**0.670**	**0.380**	**0.240**	**0.660**	**0.460**	**0.080**	**0.400**
Pa Stat.	Z-value	1.072	-0.883	1.016	0.689	-1.195	0.969	0.750	-0.178	0.398
	Prob.	**0.420**	**0.030**	**0.750**	**0.290**	**0.010**	**0.680**	**0.460**	**0.100**	**0.440**

Table 3A. Panel FMOLS results[2]

Var.		G-I c(level)	G-I c@t	G-II c(level)	G-II c@t	G-III c(level)	G-III c@t
Pooled							
Y	Coeff.	-0.6754	-0.5591	-0.4074	-0.5293	-1.1521	-2.8550
	(Std.E)	(0.1762)	(0.1795)	(0.2040)	(0.1512)	(0.5547)	(0.9449)
	Prob.	**0.0002**	**0.0020**	**0.0473**	**0.0006**	**0.0397**	**0.0030**
F	Coeff.	-0.2661	0.091	-0.8644	0.2076	-0.1494	0.0577
	(Std.E)	(0.1168)	(0.1021)	(0.2759)	(0.1400)	(0.1315)	(0.1477)
	Prob.	**0.0235**	**0.3743**	**0.0020**	**0.1401**	**0.2578**	**0.6963**
Grouped							
Y	Coeff.	-1.9940	-3.1229	-2.8681	-3.1894	-0.7920	-3.0315
	(Std.E)	(0.2175)	(0.3742)	(0.2045)	(0.5002)	(0.4333)	(0.5628)
	Prob.	**0.0000**	**0.0000**	**0.0000**	**0.0000**	0.0698	0.0000
F	Coeff.	0.1126	0.1783	0.2113	0.2083	-0.0231	0.1371
	(Std.E)	(0.0947)	(0.0795)	(0.1307)	(0.1215)	(0.1353)	(0.0876)
	Prob.	**0.2353**	**0.0255**	**0.1077**	**0.0884**	**0.8648**	**0.1202**

Table 3B. Dynamic OLS (DOLS) results

Var.		G-I c(level)	G-I c@t	G-II c(level)	G-II c@t	G-III c(level)	G-III c@t
Pooled							
Y	Coeff.	-0.8372	-0.5366	-0.4371	-0.4679	-2.2946	-2.8867
	(Std.E)	(0.2081)	(0.2855)	(0.2953)	(0.2761)	(0.4148)	(1.3434)
	Prob.	**0.0001**	**0.0617**	**0.1415**	**0.0930**	**0.0000**	**0.0347**
F	Coeff.	-0.1116	0.2539	-0.5895	0.3662	-0.0582	0.1975
	(Std.E)	(0.1389)	(0.1641)	(0.4426)	(0.2464)	(0.1073)	(0.2245)
	Prob.	**0.4224**	**0.1235**	**0.1854**	**0.1401**	**0.5888**	**0.3815**
Grouped							
Y	Coeff.	-2.6435	-3.5181	-3.0426	-4.0204	-2.0947	-2.8273
	(Std.E)	(0.5815)	(1.0395)	(0.2399)	(0.9651)	(1.3410)	(2.0817)
	Prob.	**0.0000**	**0.0009**	**0.0000**	**0.0001**	0.1219	0.1782
F	Coeff.	0.5493	0.7864	0.8772	1.1650	0.0985	0.2659
	(Std.E)	(0.2085)	(0.2833)	(0.2533)	(0.3267)	(0.3521)	(0.5007)
	Prob.	**0.0009**	**0.0060**	**0.0007**	**0.0005**	**0.7804**	**0.5969**

[2] Trend specification: *c(level)*: constant (level); *c@t*: linear trend; *n*: none.

Table 4. Panel Granger Causality Test

		Self-Growth hyp.					*Self-Freedom hyp.*					*GDP-Freedom hyp.*			
		S → Y		Y → S			S → F		F → S			Y → F		F → Y	
	k_i	W_i	p_i	W_i	p_i	k_i	W_i	p_i	W_i	p_i	k_i	W_i	p_i	W_i	p_i
Canada	2	0.002	0.999	2.542	0.281	2	2.090	0.352	2.392	0.302	2	1.542	0.463	1.166	0.558
France	2	3.763	0.152	5.635	0.060	2	0.961	0.619	0.244	0.885	2	0.122	0.941	1.376	0.503
Germany	1	0.239	0.625	1.088	0.297	2	1.272	0.529	1.009	0.604	1	0.220	0.639	0.007	0.935
Italy	1	0.157	0.692	2.079	0.149	1	0.293	0.588	0.274	0.601	2	1.556	0.459	5.880	0.053
Japan	1	0.330	0.565	0.246	0.620	2	3.940	0.139	1.289	0.525	1	0.355	0.551	0.000	0.985
United Kingdom	2	2.208	0.332	0.518	0.772	2	0.551	0.759	0.458	0.795	2	11.116	0.004	0.837	0.658
United States	1	3.465	0.063	0.469	0.493	1	0.252	0.616	0.075	0.784	2	11.841	0.003	1.183	0.554
Argentina	1	0.983	0.321	0.040	0.841	2	0.479	0.787	7.860	0.020	2	4.175	0.124	1.486	0.476
Chile	2	4.146	0.126	7.654	0.022	2	3.293	0.193	0.739	0.691	1	3.829	0.050	0.363	0.547
Colombia	2	0.210	0.900	3.004	0.223	1	0.082	0.775	0.222	0.638	1	0.001	0.982	0.337	0.562
Ecuador	1	0.443	0.506	0.002	0.968	2	3.722	0.156	4.998	0.082	2	1.793	0.408	63.379	0.000
Croatia	1	1.839	0.175	0.000	0.986	2	1.204	0.548	3.945	0.139	2	6.668	0.036	2.300	0.317
Hungary	2	0.567	0.753	0.367	0.833	2	9.206	0.010	1.007	0.604	2	0.230	0.891	1.793	0.408
Poland	2	6.564	0.038	5.174	0.075	2	7.491	0.024	1.641	0.440	1	1.198	0.274	0.114	0.736
Romania	2	0.497	0.780	14.776	0.001	1	1.902	0.168	0.005	0.946	1	0.517	0.472	0.017	0.895
Korea R	1	0.116	0.734	0.142	0.707	2	0.161	0.923	6.986	0.030	2	1.564	0.458	2.465	0.292
Malaysia	2	5.701	0.058	0.482	0.786	1	0.343	0.558	4.133	0.042	2	0.791	0.673	1.148	0.563
Sri Lanka	1	0.760	0.383	0.173	0.678	2	5.269	0.072	0.452	0.798	2	2.506	0.286	2.259	0.323
Thailand	1	1.287	0.257	0.069	0.792	1	1.235	0.266	1.015	0.314	2	2.680	0.262	5.580	0.061
Fisher Test G-I		**44.389**		**51.130**			**49.563**		**44.188**			**58.777**		**94.210*****	
CV (1%)		92.029		96.433			88.142		88.009			99.599		90.841	
CV (5%)		70.975		74.925			74.751		71.780			78.322		73.256	
CV (10%)		63.643		66.180			67.165		64.338			68.886		66.140	
Fisher Test G-II		**26.225**		**31.186**			**30.996**		**17.268**			**38.627**		**16.687**	
CV (1%)		64.252		64.689			65.899		56.768			66.286		55.075	
CV (5%)		47.199		52.468			48.918		47.195			47.078		44.398	
CV (10%)		40.532		42.928			42.470		40.969			40.528		39.770	
Fisher Test G-III		**18.164**		**19.944**			**18.566**		**26.921**			**20.150**		**77.523*****	
CV (1%)		44.141		45.826			43.954		49.596			57.369		55.279	
CV (5%)		34.833		34.475			34.725		37.054			41.040		38.687	
CV (10%)		29.866		29.886			30.532		31.110			34.864		32.760	

Notes: The optimum lag lengths is determined by using Akaike's information criterion (AIC)
The symbols *, ** and *** indicates levels of statistical significance at at the 10%, 5% and 1%, respectively

Part III: Exploring convergence

Chapter 5. The export intensity of self-employment: evidence of convergence for 19 OECD countries

Abstract: This paper empirically investigates whether the increasing economic integration across countries leads to convergence in the export intensity of entrepreneurship. This question is explored using a panel of 19 OECD economies over the period 1970-2013. In addition, in order to evaluate the robustness, we compare the results and explore different definitions of convergence: stochastic convergence, time-series β-convergence and convergence clubs. Empirical results point to the existence of stochastic convergence and β-convergence when structural breaks are taken into account. Finally, some evidence is found of convergence clubs.

***Key words*:** Entrepreneurship, Self-employment, Openness, Exports, Stochastic convergence, Time-series β-convergence, Panel data, unit roots, Structural breaks, Convergence clubs.

JEL classification: L26, F41, F16, O47, C23.

5.1. Introduction

After experienced a process of exceptionally strong globalization, the world is witnessing to an upsurge of protectionism. This new trend is threating not only free trade agreements but also the levels of economic integration achieved in some economic areas like the European Union.1 In this framework the less competitive firms and unemployed with low employability, are groups that will treat to lobby and to vote political options that incorporate the concerns of these groups (i.e. protectionist actions like less trade openness and restrictive migration policies. The consequences of this process are a hot policy issue at the time of writing after the great recession, since some industries and large sectors of the population considers globalisation as the ultimate cause of their problems, and advocate by any return to protection for national business and domestic employees against foreign firms and migrant workers. For them, the expected promotion of efficiency and productivity associated to globalisation is not guaranteed if the differences between institutions across countries alter the relative productivity and competitiveness.

The only way to resolve this type of controversies is providing solid economic propositions and empirical findings in order to evaluate the globalisation impact on economic growth, innovation, job creation and entrepreneurship. In this context, the study of the relationship between economic integration and entrepreneurship is particularly interesting, since entrepreneurship is a determinant of economic growth and job creation.

In principle, the relationship between trade openness and entrepreneurship is ambiguous, since one can argue that we can find plausible explanations for expecting both a positive and a negative relationship. On the one hand, economic integration opens new business opportunities and encourages the self-employed firm size, since sales to foreign markets expands the potential demand. From this perspective, more trade openness is a positive factor not only for fostering entrepreneurship but also for enhancing the probability of survival and success.[2] On the other hand, globalization

[1] Indeed, the European Union is a paradigmatic example of this globalization process. The development of a single market, was an additional step over a free trade area, since it is associated to a free trade are not only for products, but also for capital and labour.

[2] There is a related body of literature, the literature on *new venture internationalization and growth*, which provides propositions and empirical findings in favour of an export-led growth hypothesis. This literature hypothesises that when an

increases the intensity of competition the opportunities of jobs and wages in the export sector leading a raise in the number self-employed workers due to the confluence of two phenomena: i) as global competition continuous to intensify some of them, the less competitive ones, could not withstand this competition, thus triggering the shutdown; ii) the greater the exposure to foreign competition, the smaller the fraction of self-employed people as the Díez and Ozdagli's (2011) model suggest.

A second research question is whether more openness influences on the relative distribution of entrepreneurship between productive and unproductive activities, i.e. between the so-called formal and informal self-employment. Holmes and Schmitz (2001) developed a theoretical model à la Grossman & Helpman. In this model multilateral tariff reduction leads both an increase in the equilibrium research and in average productivity. By contrast, a unilateral tariff reduction causes an increase in the equilibrium research but export profits remain the same. Thus a unilateral tariff reduction is less powerful than a multilateral one. Then, lowering tariffs leads to a shift from unproductive to productive entrepreneurial activities. Recently, Saunoris and Sajny (2017) explore the influence of trade openness on informal entrepreneurship, suggesting that economic freedom promotes formal entrepreneurship and inhibits informal entrepreneurship.

However, the key question is to know whether the effect of a higher exposure to international trade, leads, in any case, an optimal reallocation of labour between paid-employment and self-employment and between less productive firms to more productive exporters, and even across countries with positive effects on economic growth, innovation and job creation.

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entrepreneur decides to become an international exporter, this decision may contribute to diversify risk, to achieve optimal scale absorbing excess capacity (Lages and Montgomery, 2004). These decisions, however, are more likelihood among the more productive ones (Bernard and Jensen, 1999; Bernard and Wagner, 1997). Thus, following the results of this branch of literature, more outward-oriented economies will register higher entrepreneurship and economic growth like empirical literature seem to support, when the relationship between the region/country's prevalence of new ventures that are oriented toward exports and its rate of economic growth is analysed (see, e.g. Gonzalez-Pernía and Peña, 2015, Hessels and van Stel, 2011; Almeida Couto et al. 2006; Girma et al., 2004, Moen, 2002, Giles & Williams, 2000).

Thus, the challenge is to provide empirical findings in order to shed light to the debate and attitudes towards openness. To this end it is important to know the effects of more trade openness on the export intensity of self-employment is mutually beneficial, not only for higher-income countries but also for lower-income countries.

One could hypothesise that although the mechanism is different, the effects of increasing economic openness on the export intensity of self-employment are the same for less competitive countries and for the most developed ones. In other words there is a trend to converge in terms of export intensity of self-employment. Developing countries usually have higher informal sectors (marginal entrepreneurs) than developed economies. Then globalization will lead reductions in the self-employment sectors in those countries thanks to the new opportunities of paid-employment. On the other hand, and in the most developed countries, these new business opportunities and the new international division of work may lead a revival in self-employment (a reversal in the trend) and then a reduction in the export intensity of self-employment. On balance, one could expect that a process of convergence in the export-self-employment ratio.[3]

Thus, to analyse whether there is convergence in the export intensity of self-employment, this article explores a sample of annual data formed by 19 OECD economies over the period 1970-2013, with the purpose of researching two concepts of convergence on the ratio of exports by self-employed: *stochastic convergence*, which suggests that the impact of a shock on the relative variable under study is temporary -trend stationary-, and time-series *β-convergence*, which implies that the sample average mean reverts to a common level. Following the Carlino and Mills (1993, 1996 a, b) methodology, we will check the stochastic convergence and time-series β-convergence by applying different approaches for panel data: the Lagrange Multiplier stationarity test without structural breaks proposed by Hadri (2000); the unit root test with structural breaks developed by Car-

[3] The theory of Audretsch and Sanders (2007) offers us a rational for expecting a convergence. And a positive effect of globalisation on developed countries which thanks to the increase of economic integration suffers a shift from the *industrial* to the entrepreneurial" model of production. Developed countries shift their manufacturing process to emerging countries due to the lower production costs. These countries benefit of this process whereas developed countries have de-industrialised and settled down in more technological sectors. Thus, entrepreneurs in developed countries benefit the most from globalisation.

rion-i-Silvestre et al., (2005); and finally, the Phillips and Sul (2007) approach related to convergence club test.

Empirical results point to divergence whether multiple structural breaks are unattended; by contrast, considering both cross-section dependence among countries and the presence of multiple structural breaks, the trend analysis reveals signs of stochastic convergence for the majority of individuals and only time-series β-convergence for 11 economies. Findings from convergence club hypothesis show a weak coincidence with results of time-series β- convergence.

The rest of the paper is organized as follows. In the next section, we report some stylized facts and a brief review of previous literature. In section 3, the database and the variables under study are described. In section 4, the empirical strategy is presented, while section 5, presents the results of estimations. Finally, section 6 concludes and provides some policy implications.

5.2. Some stylized facts

The aim of this article is to check if there exist a process of convergence in ratio of exports self-employment across OECD countries. Maybe, to have a look on recent data could be the natural starting point for addressing different aspects related to the convergence issue. In 1970, lower-income OECD countries of our sample in terms of GDP per capita[4] like Italy, Spain, Greece or Portugal, exhibited low ratios of *exports by self-employed*. By contrast, higher-income OECD economies, like Norway or Denmark achieved the higher rates. It is important to note that, in this period, many countries had not yet begun the process of reduction of tariff barriers and adoption of free trade agreements and different forms of economic integration.

However, during the last four decades the OECD economies have witnessed a major globalization process, with increasing integration of markets. As a result the export intensity of self-employment seems to show, in some extent, a trend of convergence. For instance, one can check how, in

[4] Source: World Bank. Indicator name: GDP per capita (constant 2005 US$)

2013, the relative position of like Spain or Portugal was close to the OECD average.

Figure 1. GDP per capita and XSELF in OECD countries, 1970

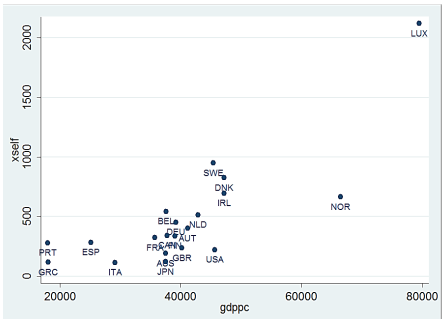

Fig. 2. GDP per capita and XSELF in OECD countries, 2013.

This scenario is consistent with some theories on the evolution of the self-employment rates depending on the stage of economic development. Thus, higher levels of self-employment are a symptom of societies in early stages of development characterized by a large informal sector and small and non-competitive enterprises that have not reached the optimum size to exploit economies of scale and compete in a global market. (Acs, et al., 1994; Porter, 1990, 2002; OECD, 2009; Fiess et al., 2010). However, in high-income countries, formal sector is predominant over informal and is featured by firms which can develop a successful export-oriented strategy and consequently, contribute positively to economic growth (Krueger, 1980).

At the global level, all countries, rich and poor, are betting on trade openness models as a way of increasing productivity, competitiveness and economic growth. However, there are arguments for and against the positive effects of openness on self-employed rates. On the other hand, one could assert that there is a negative and statistically significant relationship between the rate of self-employment and the exporting firms (Díez and Ozdagli 2015) and between self-employment and per capita manufactured exports, finding that export-oriented firms seem to be larger than firms oriented to domestic market. (Pietrobelli et al., 2004). Moreover, empirical results show that more openness decrease the probability of became entrepreneur (Congregado et al., 2014). On the one hand, one could argue that the impact of openness on self-employed is country- and industrial sector-specific (Fugazza and Fiess, 2010).

The core of this controversy lies in understanding whether greater openness reduces export patterns by self-employed or, conversely, has positive effects on this relationship. One argument in favor of openness would be to provide empirical evidence on whether there is a process of convergence among OECD countries in relation to this variable over the last five decades. The study of convergence will give us the clues to know whether the OECD self-employed tends to develop an export-oriented strategy or, by contrast, we are facing a process of divergence among them due to country-specific structural characteristics.

Empirical literature on convergence hypothesis has raised great interest over the last decades and has made an important contribution to different field like economic growth (Sala-i-Martin, 1996b; de la Fuente, 1997; Islam, 2003), international trade and income convergence (Ben-David, 1993, 1996; Gaulier, 2003; Lee, 2009), tourist markets (Nayaran, 2006, 2007; Lean and Smyth, 2008; Tang, 2011); CO2 emissions (Romero-Avila, 2008; Pettersson et al., 2014), among others areas. However, the study of convergence on the relationship between entrepreneurship and trade openness seems to be a field that has not yet been sufficiently explored.

Moreover, the concept of convergence is very wide and involves different interpretations and methodological strategies depending on the use of cross-sectional data (Baumol, 1986; Barro, 1991, Barro and Sala-i-Martin, 1991, 1992, 1995; Mankiw et al., 1992),time series (Carlino and Mills, 1993; Quah, 1993; Bernard and Durlauf, 1996; Evans and Karras, 1996a; Evans, 1998; Li and Papell, 1999) or panel data (Evans and Karras, 1996; Gaulier et al., 1999;s. Fleissig and Straus, 1999, 2001; Funk and Strauss, 2003; Narayan P.K., 2008 a,b;Carrion-i-Silvestre and German-Soto, 2009; Apergis et al., 2012). This paper focuses on the study of stochastic convergence and time-series β-convergence in a panel data framework.

The notion of β-convergence goes back to Baumol (1986) and is related to the existence of a negative relationship between annual growth rates and initial levels of income across countries. This fact permits the author to identify different convergence clubs depending on the level of industrialization by country, forming the poorest countries a divergence club over time. The seminal work of Baumol (1986) is extended by Barro and Sala-i-Martin (1991, 1992, 1995) who introduce the concepts of *absolute or un-*

conditional covergence -countries convergence to the same steady state- and *sigma or conditional convergence* -countries converge to different steady states due to the existence of relevant differences among them and thus, there exist a negative correlation between growth rates and the initial level of income across countries-.

Other kind of convergence studied in literature is named stochastic convergence (Quah, 1990). In this sense and according to Bernard and Durlauf (1995, p.99), there exists stochastic convergence "whether the long-run forecasts of output differences tend to zero as the forecasting horizon increases", that is, the persistence of shocks on per capita income to the average sample is temporary. Thus, testing the convergence hypothesis is equivalent to check if there are evidences of unit roots in our sample. Stochastic convergence is tested by cross-section tests of β-convergence, where a unit root means that the variable under study is affected by permanent shock, which can lead to divergent scenario. However, empirical results from unit root stationarity tests are ambiguous. Some authors find evidence of stochastic convergence (Evans and Karras, 1996; Evans, 1998) while others argue about divergence (Lee et al., 1997).

Carlino and Mills (1993, 1996 a, b) try to provide solutions to the problematic observed in the field of cross-section tests of β-convergence (Quah; 1993; Bernard and Durlauf, 1996; Evans and Karras, 1996), in particular, the difficulties derived from over-rejecting the null of no convergence. For this purpose, the authors examine convergence of per capita income and per capita earnings across eight U.S regions and define a deviation series to be tested by using ADF unit root tests. Rejection of the null of no convergence implies that the relative variable under study is trend stationary, and thus, there exists evidence of stochastic convergence. Likewise, Carlino and Mills (1993) introduce a sufficiency condition of convergence, called time-series β-convergence, which refers to the negative relationship between initial income levels to their compensating differentials and their speed of growth.

In order to test these two kinds of convergence – that is, stochastic convergence and time-series β-convergence- , we will proceed firstly to check different stationarity proofs following Hadri (2000), Carrion-i-Silvestre et al., (2005) and Phillips and Sul (2007) approaches for our panel data. According to Carrion-i-Silvestre and Soto, (2008) one of the main advantages in the use of panel data is that the time series seem to exhibit similar stochastic patterns, especially, in the context of countries subject to common laws. For this end, we can highlight the following works about convergence process in OECD countries considering some recent researches based on macroeconomic variables by using the unit root test for panel data, in particular, the panel Lagrange Multiplier stationarity test proposed by Hadri (2000) and panel stationarity test with multiple breaks developed by Carrion-i-Silvestre et al., (2005).

In this context, Romero-Ávila (2009) investigates stochastic convergence and time-series β-convergence for relative income levels in 19 OECD economies over the period 1870−2003. By applying Carrion-i Silvestre et al., (2005) method, he finds evidence about the existence of a convergence process among industrialized economies over the 20th century which is consistent with previous literature (Li and Papell, 1999; Strazicidh et al., 2004; Dawson and Sen, 2007). The results also show strong evidence of some groups of breaks coinciding with the Great Wars.

Focusing on our variable under study which sets up a relationship between entrepreneurship/self-employed with the share of exports, the literature seems to be more scarcity. Parker, Congregado and Golpe (2012) check hysteresis hypothesis −permanent shocks− on harmonized data of entrepreneurship rates (non-agricultural self-employment) for a panel composed of 23 OECD countries from 1972 to 2006. After applying different panel unit root and stationarity tests without structural breaks (Breitung, 2000; Hadri, 2000; Levin et al., 2002; Im et al., 2003; Maddala and Wu, 1997) they find evidence that supports the hysteresis hypothesis for the variable considered due to the presence of unit roots (Layard et al., 1999). The finding also exhibits at least one structural break in all OECD economies, three for nine of them and up four structural breaks in three OECD countries – France, Germany and USA-. By contrast, the results from using panel stationarity test with multiple structural breaks reveal strong evidence on persistence on data instead of permanent shocks hypothesis.

Related to international trade and its effects on convergence, we can highlight the well-known work of Ben-David (1996). The author studies the influence of international trade to the income convergence for a sample formed of major exporters and importers countries. By grouping countries in function of their trade affiliations, he finds out a significant evidence of income convergence for the wealthier countries than by creating of random groups. Following this approach, Gaulier (2006) replicate the Ben-David (1996) methodology and point out among his main findings that "absolute convergence within trade-based groups does not imply a significant reduction of standard of living differences". On the other hand, this result also suggests that "trade intensity per se does not bring about convergence" and thus, the selection of big countries into a group can bias results.

5.3. Data Description

Our empirical estimates are based on a sample of annual data for 19 OECD economies over the period 1970-2013, a panel data covering a period 44 years. The variable under study is the ratio of exports exports to self-employment, –*XSELF*, hereafter–,where the volume of exports of goods and services is expressed in constant 2005 US$ and the number of self-employed workers is taken from *Labour Force Surveys*. The first indicator -*exports*- has been drawn from World Bank (World Development Indicators) and the second one -*the number of self-employed*- from AMECO database. Self-employment is commonly used in the literature as measure of entrepreneurship (Parker, 2004; Congregado, 2008). Given the limitations existing in the availability of data of self-employment for all OECD economies, the countries finally selected for our study are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, the United Kingdom and the United States. Thus, we work with a balanced panel data of 836 observations (19 countries in 44 periods).

5.4. Methodology

Our empirical strategy is founded on the study of stochastic convergence and time-series β-convergence in the level of exports by self-employed for different OECD economies, following the seminal work of Carlino and Mills (1993, 1996 a, b). In particular, we test whether the time series for all countries are stationary (convergence) or, by contrast, there is evidence of unit roots in the panel (divergence). To this end, different panel techniques are applied. Firstly, we consider the approach proposed by Hadri (2000) which studies stochastic convergence omitting the influence of structural breaks. Secondly, we follow the approach developed by Carrion-i-Silvestre et al., (2005) which completes the convergence analysis taking into account the effects of multiple structural breaks and defines different regimes in order to identify likely differentials across countries and over time by point estimates in our panel, that is, detecting whether there is evidence of time-series β-convergence. Finally, we examine the hypothesis of club-convergence developed by Phillips and Sul (2007) to find out groups of countries which show similar convergence patterns.

5.4.1. LM panel unit root test without structural breaks

Hadri (2000) suggests a residual-based Lagrange Multiplier (LM) test as an extension of the work of Kwiatkowski et al. (1992) -*KPSS*- to panel data. The statistical tests proposed are asymptotically normally distributed and are built under the null hypothesis of stationarity around a deterministic trend/level against the alternative of a unit root, unlike the traditional unit root tests based on the null of non-stationarity.

Focusing only on the analysis of stochastic convergence, the not rejection of the null hypothesis, that is, the no existence of a unit root in the panel, would confirm, in our case, the existence of a process of non-divergence (convergence) in the export patterns by self-employed for all countries .

To this end, and following the econometric strategy of Carlino and Mills (1993), we can write our variable in relative terms as $RY_{i,t} = \ln(Y_{i,t}/\overline{Y}_t)$, where Y_{it} is the variable XSELF for each country $i = 1, \dots, N$ at each annual period $t = 1, \dots, T$; and where $\overline{Y}_t$ is the sample average of our panel data, that is, $\overline{Y}_t = \sum_{i=1}^{N} Y_{i,t}/N$. In our panel, dimension *i*=19 and *T=44* therefore, we work with a balanced panel formed by 836 observations. Following Hadri (2000) work, the variable $RY_{i,t}$ can be defined as follows:

$$RY_{i,t} = \alpha_{i,t} + \beta_i t + \varepsilon_{i,t} \quad (1)$$

$$\alpha_{i,t} = \alpha_{i,t-1} + \upsilon_{i,t} \quad (2)$$

where $\alpha_{i,t}$ is a random walk; $\beta_i t$ is the country-specific linear time trend and $\varepsilon_{i,t}$ and $\upsilon_{i,t}$ are perturbations mutually independent normal distributions, that is, $\varepsilon_{i,t} \sim \text{i.i.d.}(0,\ \sigma^2_{\varepsilon,i})$ and $\upsilon_{i,t} \sim \text{i.i.d.}(0,\ \sigma^2_{\upsilon,i})$, across countries $i = \{1, \dots, N\}$and over time periods $t = \{1, \dots, T\}$.

The null hypothesis of stationarity for all *i* (around a deterministic level or trend) implies that the variance of the errors equals zero, $H_0\colon \sigma^2_{\upsilon,i} = 0$, against the alternative of non-stationarity $\sigma^2_{\upsilon,i} > 0$ for some i. The null hypothesis happens if random walk $\alpha_{i,t} = \alpha_{i,0}$ and it can be obtained substituting equation (2) in (1):

$$RY_{i,t} = \alpha_{i,0} + \beta_i t + e_{i,t} \tag{3}$$

where $e_{i,t} = \sum_{i=1}^{T}(\varepsilon_{i,t} + \upsilon_{i,t})$ and $\alpha_{i,0}$ is the country-specific compensating differentials, which do not vary over time. The test statistic is given by:

$$\eta(\hat{\lambda}) = N^{-1}\sum_{i=1}^{N}(\eta_i(\hat{\lambda}_i)) \tag{4}$$

where $\eta_i(\hat{\lambda}_i) = \widehat{\omega}_i^{-2}T^{-2}\sum_{t=1}^{T}\hat{S}_{i,t}^2$ and $\hat{S}_{i,t}^2 = \sum_{j=1}^{t}\hat{e}_{i.j}$ is the partial sum process of the residuals estimated by OLS in (3). According to Hadri (2000), the standardized way of this test statistic follows a standard normal distribution.

5.4.2. Panel unit root test with multiple structural breaks

Secondly, we will regard the panel stationarity test developed by Carrion-i-Silvestre et al., (2005)-CBL, henceforth-. This test extends the work developed by Hadri (2000) to allow for multiple structural breaks under the same null hypothesis of stationarity. Among the main contributions of this test, we may point out its flexibility when considering the number of breaks for each individual or the positions of each break on time. It allows for the observation of possible endogenous behaviors across countries and over the time. To test CBL, we express again our variable in relative terms, $RY_{i,t}$, and describe the model as the sum of a random walk, a linear time trend for each country *i,* and a stochastic process according to Hadri (2000):

$$RY_{i,t} = \alpha_{i,t} + \beta_i t + \varepsilon_{i,t} \tag{5}$$

$$\alpha_{i,t} = \sum_{k=1}^{m_i}\theta_{i,k}D(T_{b,k}^i)_t + \sum_{k=1}^{m_i}\gamma_{i,k}DU_{i,k,t} + \alpha_{i,t-1} + \upsilon_{i,t} \tag{6}$$

where $\alpha_{i,0} = \alpha_i$ is a country-specific constant; $\beta_i t$ is a country-specific linear time trends; $\upsilon_{i,t} \sim i.i.d.\left(0, \sigma_{\upsilon,i}^2\right)$ and $\varepsilon_{i,t} \sim i.i.d.(0, \sigma_{\varepsilon,i}^2)$, are perturbations for all $i = \{1, \dots, N\}$ and $t = \{1, \dots, T\}$; $DU_{i,k,t}$ and $D(T_{b,k}^i)_t$ are dummy variables related to the changes in level and slope and are denoted as $DU_{i,k,t} = 1$ for $t > T_{b,k}^i$ and 0 otherwise, $D(T_{b,k}^i)_t = 1$ for $T_{b,k}^i + 1$ and 0 otherwise, with $T_{b,k}^i$ presents the *k-th* date of the break for the *i-th* individual, $k = \{1, \dots, m_i\}$, $m_i \geq 1$. When $\sigma_{\upsilon,i}^2 = 0, \forall i = \{1, \dots, N\}$, which occurs when $\alpha_{i,t} = \alpha_{i,0}$, we are under the null hypothesis of stationarity that it can be got by substituting (6) into (5) and re-organized the terms of equations as follows:

$$RY_{i,t} = \alpha_{i,0} + \sum_{k=1}^{m_i} \theta_{i,k} DU_{i,k,t} + \beta_i t + \sum_{k=1}^{m_i} \gamma_{i,k} DT^*_{i,k,t} + e_{i,t} \qquad (7)$$

where $DT^*_{i,k,t} = t - T^i_{b,k}$, for $t > T^i_{b,k}$ and 0 otherwise, $k = \{1, \dots, m_i\}$, $m_i \geq 1$. In (7), the term $\alpha_{i,0}$ shows individual time-invariant effects; $\sum_{k=1}^{m_i} \theta_{i,k} DU_{i,k,t}$ indicates individual-specific structural break effects; $\beta_i t$ is the country-specific linear time trends; $\sum_{k=1}^{m_i} \gamma_{i,k} DT^*_{i,k,t}$ denotes structural breaks effects on each individual´s time trend. For this specification, the non-rejection of the null hypothesis implies a stochastic convergence process for all OECD countries considered while rejection implies that at least one of these countries is not stochastic converging. In order to get robust results, we compute CBL test under assumptions of heterogeneity and homogeneity in the estimations of long-run variances across i, following the same process described above for Hadri (2000) test.

5.4.2.1. Time series $\boldsymbol{\beta}$ − convergence

Given that, the presence of stochastic convergence is not sufficient condition to achieve the concept of β-convergence, we need to consider the contributions provided by Carlino and Mills, 1993; Dawson and Sen, 2007; Tomljanovich and Vogelsang, 2002; or Nieswiadomy and Strazicich (2004), among others, related to the analysis of time series β-convergence. According to its definition, β- convergence requires that the estimations of the intercept and trend coefficients in equation (7) to be statistically significant but opposite in signs for each i country.

Once identified the different regimes in the previous stochastic convergence analyisis, β- convergence would be consistent whether α>0 and β<0 for the pre-break regime. For post-break regimes, beta-convergence requires significance and opposite in sing. For this analysis we will follow the notation defined by Tomljanovich and Vogelsang (2002) and Nieswiadomy and Strazicich (2004), where a C means estimations of intercept and trend coefficients consistent with β-convergence and both are statistically significant at the 10 per cent level or better; a c is used for estimations consistent with beta-convergence but only one coefficient is statistically significant at least the 10 per cent level, a D stands for estimations consistent with divergence and both are statistically significant at the

10 per cent level or better; a d identifies divergence but only when one coefficient is statistically significant; a E shows estimations of intercept and trend coefficients that are statistically insignificant which suggest long-run convergence.

5.4.3. Club-Convergence Analysis

Finally, we will follow the methodology proposed by Phillips and Sul (2007) –PS, henceforth- with the aim of studying the possible existence of club convergence among 19 OECD economies studied. According to the authors, to carry out an adequate investigation about the study of comovement and convergence in presence of heterogeneity, is necessary to apply other kind of convergence tests different from cointegration tests considered until now due to they are not enough to obtain robust results .

One of the most relevant contributions suggested by PS test is the possibility of taking into account both heterogeneity and divergence across individuals and over the time. Through a nonlinear factor model, the PS test allows identify convergence clusters with certain common patterns in their transition behavior a long-run, around the panel average or around a common trend, offering robust results when the series are stationary around a trend or non-stationary.

To briefly describe PS methodology, we suppose that our variable under study, XSELF, denoted as Y_{it}, $\forall\, i = 1, \dots, N$and $t = 1, \dots, T$, can be decomposed as:

$$Y_{it} = a_{it} + x_{it} \tag{8}$$

where a_{it} denotes systematic components and x_{it} represents transitory components. In order to separate common and idiosyncratic components which can be mixed in this specification, they transform equation (8) as follows:

$$Y_{it} = \left(\frac{a_{it} + x_{it}}{\mu_t}\right)\mu_t = \delta_{it}\mu_t, \qquad \forall\, i, t \tag{9}$$

where δ_{it} is a time varying idiosyncratic component and μ_t stand for the common trend component. To test the convergence, that is, whether the factor loadings δ_{it} converge to a constant δ, Phillips and Sul (2007) proceed to isolate the idiosyncratic component and eliminate the common component, defining a relative transition parameter, h_{it}:

$$h_{it} = \frac{Y_{it}}{N^{-1}\sum_{i=1}^{N} Y_{it}} = \frac{\delta_{it}}{N^{-1}\sum_{i=1}^{N} \delta_{it}} \tag{10}$$

where h_{it} show the loading coefficient δ_{it} in relation to the panel average at time t. The main properties of h_{it} are: (i) Its cross sectional mean equals unity, (ii) if δ_{it} converge to δ, then the relative transition parameters h_{it} converge to unity and (iii) the cross sectional variance of h_{it} converges to zero in the long-run, that is, $H_{it} = \sigma_t^2 = N^{-1}\sum_{i=1}^{N}(h_{it}-1)^2 \to 0$, as $t \to \infty$. By using a panel semiparametric model for δ_{it}, we can formulate the null hypothesis:

$$\delta_{it} = \delta_i + \frac{\sigma_i \xi_{it}}{L(t)t^{\alpha}}, \ \ t \geq 1, \ \ \sigma_i \geq 0 \ \ \forall\, i \tag{11}$$

where, we assume that $\xi_{it} \sim i.i.d\ (0,1)$ across i, the function $L(t)$ is slowly varying and α is a decay rate. When $\alpha \geq 0$, then δ_{it} converges to δ_i. Therefore, the null and alternative hypotheses of convergence according to PS test are:

$$H_0\colon \delta_i = \delta \quad and \quad \alpha \geq 0$$

$$H_1\colon \delta_i \neq \delta \ \ \forall i, \ \ or \ \ \alpha < 0$$

The regression *t* test of the null hypothesis of convergence can be obtained as:

$$\log(H_1/H_t) - 2\log L(t) = \hat{c} + \hat{b}\log t + u_t \tag{12}$$

where $L(t) = \log(t+1)$; $\hat{b} = 2\hat{\alpha}$, is the fitted coefficient of *log* t, being $\hat{\alpha}$ the OLS estimate of α. This formula (12) starts at certain point $t = [rT]$, where $[rT]$ is the integer part of rT and with $r > 0$. Phillips and Sul (2007) recommend a value of r=0.3 for this end.

The rejection of the null hypothesis only implies that there is not full convergence ($\hat{b} \geq 0$) in the panel but it does not mean that there might not be different convergence-clubs in the sample. For identifying these potential clubs, the authors develop clustering algorithm that resume in four steps. The first step is to order individuals in the panel according to the last observation in it. The second one is to form the core group or subgroup, G_k, choosing the k highest individuals in the panel, for $N > k \geq 2$, and estimating *log(t)* regression to obtain convergence *t*-statistic, t_k, with

$t_k > -1.65$. The third one consists of including to subgroup G_k new members by adding one at a time and estimating again the regression to get the *t*-statistic. If the *t*-statistic is over zero, then the subgroup G_k would be the first convergence club. The final step is to run the *log(t)* regression for all those individuals not selected in the club formed in the previous step. If this set converges, then these individuals form a second convergence-club. The authors suggest repeating steps 1 to 3 in order to find out the existence of more subgroups that can be clustered in the convergence clubs. They also explain that if it is no possible to set up clubs, it would mean that these individuals diverge.

5.5. Results

The empirical findings of our study are presented in Tables 1 to 6 of the Appendix. They summarize the main results of applying the different methodological approaches described above, that is, the panel KPSS stationarity test without structural breaks proposed by Hadri (2000); the Carrion-i-Silvestre et al., (2005) methodology to allow for multiple structural breaks for the study of the time series β- convergence; and the econometric technique developed by Phillips and Sul (2007) about convergence-clubs.

5.5.1. Panel Unit Root Test without structural breaks.

Table 1 shows the panel KPSS test without structural breaks according to Hadri (2000). Panel A in Table 1 includes the results from testing univariate KPSS test for each OECD economies studied. We can reject the null hypothesis of stationarity at the 1 per cent significant level for all countries -Greece, at 10 per cent- with the exceptions of Sweden in which we accept the null. Thus, there is strong evidence of diverging across OECD countries in related to the exports patters by self-employed. Panel B in Table 1 exhibits the results from applying the panel KPSS test under the both assumptions of homogeneity and heterogeneity in the long-run variance estimation. For both cases, we can reject the null hypothesis of joint-stationary at the 1 per cent level, which again suggests a diverging behavior.

5.5.2. Panel Unit Root test with Structural Breaks

Given that the omission of structural breaks in the KPSS test of Hadri (2000) may lead to biased outputs, we carry on our research applying the CBL test which considers the influence of these changes in the panel. The results are presented in Tables 2 and 3 for the convergence analysis without trend and with trend, respectively. Both tables are divided into two panels as in Table 1 and are estimated with a maximum of 3 structural breaks.

Panel A in Table 2 presents a convergence analysis with multiple structural breaks which has been estimated omitting the effects of a trend. Results exhibits the presence of one structural break for Portugal; two breaks for Italy and Sweden; and three breaks for the remaining sixteen economies. The null hypothesis of stationarity can be rejected in eighteen cases, which implies absence of stochastic convergence for all of them, except for Japan and Sweden. Panel B reports the KPSS test taking into account not only the assumptions of asymptotic normality and cross-sectional independence but also allowing for cross-sectional correlation by using the bootstraps critical values. The results show that the null hypothesis of joint stationarity can be rejected at the 1 per cent significance level for the case of cross-sectional independence and asymptotic normality, which suggests divergence in the ratio of exports by self-employed in OECD countries. Considering the bootstraps critical values under cross-sectional dependence, we cannot reject the null hypothesis for both cases of homogeneity and heterogeneity in the long-run variance estimation.

The empirical findings differ from Table 2 if we introduce a trend in our model. Panel A in Table 3 shows now one structural break for Australia, Canada and The Netherlands; two breaks for Austria, Denmark, Greece, Ireland, Japan and Norway; and three breaks for the remaining economies. The non-rejection of null hypothesis implies the existence of stochastic convergence for twelve countries of OECD, except the cases of Belgium, Finland, Germany, Italy, Portugal and the United Kingdom at the 1 per cent significant level, and Canada, at the 10 per cent level. In Panel B, we can reject the null of joint regime-wise trend stationarity for the case of cross-sectional independence but not under the assumption of cross-sectional dependence.

5.5.2.1. Time series β- convergence

In the previous section, we have found evidence of stochastic convergence for twelve OECD economies by applying the KPSS tests with structural breaks and trend (Table 3). Now, to test time series β-convergence, we need to consider differentials across countries and over the time. The output from this analysis is exhibited in Table 4 and 5. These tables provide information about the point estimates of the intercept and trend coefficients estimated for the different convergence regimes identified in the previous stochastic convergence analysis. According to the definition of time series β- convergence, exports by self-employed converge whether the point estimates of parameters are statistically significant and opposite in sign.

Our empirical results indicate for the pre-break regime that point estimates are consistent with β-convergence and are statistically significant at the 10 per cent of significance level or better for twelve OECD countries – Austria, Canada, Finland, France, Germany, Greece, Italy, Japan, the Netherlands and Spain; weak convergence for Ireland and the United Kingdom; and divergence for seven economies -Australia, Belgium, Denmark, Norway, Portugal, Sweden and the United States-. In the post-break regimes, four economies shift from a convergence process to a divergence situation –Austria, Greece, Italy, and Japan- while only four economies leave a divergence process to convergence –Belgium, Portugal, Sweden and the United States-. After the first structural break, it is found signs of convergence in nine OECD countries, while after the second break, only five countries presented convergence in export patterns.

5.5.3. *Club-Convergence Analysis*

Finally, Table 6 shows the results of applying the convergence test. We may observe the formation of five convergence clubs that include the following members: I) Japan and Ireland; II) Denmark, Finland, Greece and Spain; III) Austria, France, Germany, Norway, Portugal, Sweden and the United States; IV) Australia, Belgium, Italy and the Netherlands; V) Canada and the United Kingdom.

These findings suggest that each country included in the same convergence club presents common growth characteristics or are in transition toward a long-run growth senda in the export-oriented strategy developed by self-employed workers. However, the different clubs are heterogeneous across countries and over time. Only the club III shows more individuals with a similar patterns of strong convergence (C) -Germany, Norway, Portugal and the United States- according to the last-break regime related to the analysis of time-series β-convergence presented in Table 5.

5.6. Conclusions and policy implications

In this paper we have investigated the concepts of stochastic convergence, time-series β-convergence and convergence club hypothesis in the relationship between exports and self-employment for a panel data sample of 19 OECD countries from 1970 to 2013. By applying different panel unit root tests, we find that whether the existence of multiple structural breaks are unattended, empirical findings point to divergence across countries; by contrast, there is evidence of stochastic convergence for the majority of OECD economies in the analysis of KPSS tests considering multiple structural breaks with trend. According to Carlino and Mills (1993) and Tomljanovich and Vogelsang (2002), we complete the notion of stochastic convergence by studying of time-series β- convergence. Our results provide signs of time-series β- convergence for eleven OECD economies (in their last-break regime) -Austria, Belgium, Canada, Germany, Greece, Japan, the Netherlands, Norway, Portugal, Spain and the United States- and evidences of divergence for the remaining countries.

In further research, it would be interesting in deepening on the study of entrepreneurial characteristics and openness factors, as the degree of freedom of an economy, for better understanding of why some countries show long-run convergence in terms of exports by self-employed while others diverge, with the aim that policy makers and practitioners might devise policies that contribute to promotion of a competitive entrepreneurship, able to adapt to the requirement of a global market.

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APPENDIX

Table 1. KPSS tests without structural breaks. Stochastic convergence.

A:Univariate tests.

Country	KPSS test
Australia	1.340***
Austria	0.366***
Belgium	9.105***
Canada	8.078***
Denmark	2.500***
Finland	1.398***
France	6.597***
Germany	0.949***
Greece	0.130*
Ireland	11.380***
Italy	1.545***
Japan	1.002***
Netherlands	5.939***
Norway	0.345***
Portugal	0.327***
Spain	2.905***
Sweden	0.090
United Kingdom	5.019***
United States	0.268***

B: Panel KPSS test

			Bootstraps critical values			
	Test	p value	90%	95%	97.5%	99%
$Z(\hat{\lambda})$ (homogeneous)	65.531	0.000	5.074	7.385	8.737	11.197
$Z(\hat{\lambda})$ (heterogeneous)	86.357	0.000	4.777	6.537	7.923	9.388

Notes: The finite critical values for the KPSS test for the specification with trends at the 1%, 5% and 10% levels are 0.213, 0.149, 0.121, respectively, with T=50 (see

Sephton, 1995). $Z(\hat{\lambda})$ homogeneous and $Z(\hat{\lambda})$ heterogeneous denote Hadri's (2000) version of the panel KPSS test for the case of homogeneity and heterogeneity in the panel.***, ** and * imply rejection of the null hypothesis at 1%, 5% and 10%, respectively.

Table 2. KPSS tests with multiple structural breaks (without trend model 1,3). Stochastic convergence.

A: Univariate tests.

Country	Test	m_i	break points	$\hat{T}_{b,1}^{1}$	$\hat{T}_{b,2}^{1}$	$\hat{T}_{b,3}^{1}$	10%	5%	1%
Australia	0.204***	3	6, 12, 29	1976	1982	1999	0.036	0.041	0.051
Austria	0.682***	3	6, 12, 24	1976	1982	1994	0.039	0.045	0.060
Belgium	0.091**	3	14, 23, 29	1984	1993	1999	0.055	0.066	0.097
Canada	0.113***	3	9, 20, 36	1979	1990	2006	0.038	0.043	0.054
Denmark	0.055**	3	10, 18, 35	1980	1988	2005	0.041	0.047	0.061
Finland	0.041**	3	7, 23, 29	1977	1993	1999	0.036	0.041	0.049
France	0.071***	3	7, 22, 38	1977	1992	2008	0.036	0.040	0.049
Germany	0.063***	3	6, 23, 37	1976	1993	2007	0.036	0.040	0.050
Greece	0.090***	3	6, 20, 29	1976	1990	1999	0.033	0.036	0.044
Ireland	0.135***	3	8, 15, 25	1978	1985	1995	0.040	0.045	0.058
Italy	0.068**	2	13, 29	1983	1999	-	0.053	0.062	0.085
Japan	0.046	3	6, 12, 36	1976	1982	2006	0.048	0.057	0.078
Netherlands	0.073***	3	7, 13, 24	1977	1983	1994	0.040	0.046	0.059
Norway	0.078***	3	6, 20, 34	1976	1990	2004	0.032	0.035	0.042
Portugal	0.099**	1	13	1983	-	-	0.082	0.096	0.128
Spain	0.057***	3	7, 13, 24	1977	1983	1994	0.040	0.046	0.059
Sweden	0.037	2	21, 33	1991	2003	-	0.098	0.125	0.186
United Kingdom	0.068**	3	11, 18, 38	1981	1988	2008	0.049	0.057	0.076
United States	0.076**	3	12, 31, 38	1982	2001	2008	0.051	0.060	0.081

B: Panel KPSS test

	Cross-sectional independence		Bootstraps critical values *cross-sectional dependence*			
	Test	p value	90%	95%	97.5%	99%
$Z(\hat{\lambda})$ (homogeneous)	5.018	0.000	7.384	8.974	10.744	13.050
$Z(\hat{\lambda})$ (heterogeneous)	7.691	0.000	8.410	9.490	10.561	12.405

Notes: The specification contains country-specific intercepts and linear trends. $Z(\hat{\lambda})$ homogeneous and $Z(\hat{\lambda})$ heterogeneous denote the CBL tests (Carrion-i-Silvestre et al., (2005) for the case of homogeneity and heterogeneity in the panel The bootstrap estimations were based on 20,000 replications. A maximum of $m_i = 3$ structural breaks have been estimated following the LWZ information criteria.***, ** and * imply rejection of the null hypothesis at 1%, 5% and 10%, respectively.

Table 3. KPSS tests with multiple structural breaks (with trend model 2, 4). Stochastic convergence.

A: Univariate tests.

Country	Test	m_i	break points	$\hat{T}^1_{b,1}$	$\hat{T}^1_{b,2}$	$\hat{T}^1_{b,3}$	10%	5%	1%
Australia	0.051	1	10	1980	-	-	0.085	0.100	0.138
Austria	0.029	2	10, 23	1980	1993	-	0.049	0.057	0.072
Belgium	0.128***	3	6, 18, 29	1976	1988	1999	0.032	0.035	0.042
Canada	0.093*	1	14	1984	-	-	0.082	0.096	0.129
Denmark	0.035	2	10, 22	1980	1992	-	0.051	0.058	0.075
Finland	0.082***	3	7, 23, 38	1977	1993	2008	0.036	0.041	0.050
France	0.030	3	6, 16, 30	1976	1986	2000	0.032	0.035	0.042
Germany	0.101***	3	13, 20, 26	1983	1990	1996	0.054	0.065	0.091
Greece	0.027	2	12, 29	1982	1999	-	0.051	0.059	0.077
Ireland	0.032	2	6, 34	1976	2004	-	0.060	0.070	0.098
Italy	0.180***	3	10, 23, 35	1980	1993	2005	0.038	0.044	0.058
Japan	0.027	2	14, 33	1984	2003	-	0.059	0.070	0.097
Netherlands	0.045	1	29	1999	-	-	0.169	0.220	0.339
Norway	0.032	2	20, 28	1990	1998	-	0.091	0.116	0.172
Portugal	0.166***	3	6, 19, 31	1976	1989	2001	0.031	0.034	0.040
Spain	0.027	3	18, 27, 36	1988	1997	2006	0.077	0.098	0.147
Sweden	0.023	3	17, 23, 33	1987	1993	2003	0.070	0.089	0.132
United Kingdom	0.056***	3	7, 21, 27	1977	1991	1997	0.037	0.041	0.051
United States	0.043	3	13, 27, 34	1983	1997	2004	0.049	0.059	0.084

B: Panel KPSS test

	Cross-sectional independence		Bootstraps critical values *cross-sectional dependence*			
	Test	p value	90%	95 %	97.5 %	99 %
$Z(\hat{\lambda})$ (homogeneous)	6.354	0.000	13.976	15.579	17.311	19.620

$Z(\hat{\lambda})$ (heterogeneous)	14.642	0.000	32.408	35.141	38.255	41.487

Notes: The specification contains country-specific intercepts and linear trends. $Z(\hat{\lambda})$ homogeneous and $Z(\hat{\lambda})$ heterogeneous denote the CBL tests (Carrion-i-Silvestre et al., (2005) for the case of homogeneity and heterogeneity in the panel. The bootstrap estimations were based on 20,000 replications. A maximum of $m_i = 3$ structural breaks have been estimated following the LWZ information criteria.***, ** and * imply rejection of the null hypothesis at 1%, 5% and 10%, respectively.

Table 4 . Estimates of Parameters for the Different Convergence Regimes. Time-series β-convergence

	Pre-break Regime 1		*Post-break Regime 2*			*Post-break Regime 3*			*Post-break Regime 4*			
Country	$\hat{\alpha}_i$	$\hat{\beta}_i$	$\hat{T}^1_{b,1}$	$\hat{\gamma}_{i,1}$	$\hat{\theta}_{i,1}$	$\hat{T}^1_{b,2}$	$\hat{\gamma}_{i,2}$	$\hat{\theta}_{i,2}$	$\hat{T}^1_{b,3}$	$\hat{\gamma}_{i,3}$	$\hat{\theta}_{i,3}$	R^2
Australia	-0.387*** (-14.260)	-0.051*** (-11.079)	1980	-0.892*** (-54.504)	-0.005*** (-5.785)	-			-			0.932
Austria	-0.294*** (-22.175)	0.032*** (14.099)	1980	0.026** (2.122)	0.003 (1.546)	1993	-0.033*** (-3.232)	8.9E-05 (0.0978)	-			0.935
Belgium	0.767*** (73.509)	0.009*** (3.075)	1976	0.785*** (94.347)	-0.018*** (-13.838)	1988	0.604*** (69.890)	-0.027*** (-18.403)	1999	0.351*** (45.236)	-0.001 (-1.473)	0.994
Canada	0.722*** (36.395)	-0.032*** (-13.203)	1984	0.299*** (20.530)	-0.020*** (-22.667)	-			-			0.981
Denmark	0.252*** (9.751)	0.002 (0.493)	1980	0.537*** (21.582)	0.020*** (5.300)	1992	0.687*** (35.624)	0.007*** (4.540)	-			0.960
Finland	-0.604*** (-19.755)	0.014* (1.878)	1977	-0.321*** (-14.216)	0.002 (0.744)	1993	-0.125*** (-5.386)	0.017*** (6.072)	2008	-0.038 (-1.036)	-0.019 (-1.285)	0.959
France	-0.699*** (-59.499)	0.039*** (12.005)	1976	-0.432*** (-42.611)	0.006*** (3.345)	1986	-0.394*** (-44.990)	0.026*** (22.924)	2000	-0.067*** (-7.452)	-0.020*** (-15.950)	0.991
Germany	-0.072*** (-5.221)	0.023*** (12.854)	1983	0.187*** (10.100)	-0.005 (-1.056)	1990	0.093*** (4.732)	-0.058*** (-8.885)	1996	-0.199*** (-15.763)	0.009*** (7.236)	0.967
Greece	-2.639*** (-64.489)	0.059*** (10.268)	1982	-2.215*** (-61.091)	-0.012*** (-3.013)	1999	-2.192*** (-55.360)	0.002 (0.502)	-			0.785
Ireland	-0.692*** (-22.246)	0.005 (0.529)	1976	-0.549*** (-32.679)	0.044*** (41.387)	2004	0.530*** (18.910)	0.027*** (4.598)	-			0.992
Italy	-0.983*** (-44.128)	0.008** (2.056)	1980	-1.029*** (-49.721)	-0.009*** (-3.376)	1993	-1.023*** (-47.706)	-0.041*** (-12.373)	2005	-1.412*** (-55.375)	-0.009 (-1.515)	0.966
Japan	-2.342*** (-83.753)	0.045*** (13.211)	1984	-1.679*** (-66.912)	-0.005** (-1.968)	2003	-1.539*** (-46.027)	0.023*** (3.745)	-			0.958
Netherlands	0.631*** (79.607)	-0.017*** (-37.043)	1999	0.210*** (18.636)	-0.005*** (-3.385)	-			-			0.982
Norway	0.828*** (62.228)	0.010*** (8.975)	1990	1.175*** (57.667)	0.009** (1.871)	1998	1.151*** (74.187)	-0.021*** (-11.433)	-			0.946
Portugal	-1.466*** (-38.456)	-0.078*** (-7.415)	1976	-1.955*** (-66.690)	0.051*** (12.242)	1989	-1.389*** (-45.745)	-0.027*** (-5.736)	2001	-1.705*** (-56.132)	0.037*** (8.064)	0.915
Spain	-1.659*** (-93.430)	0.029*** (17.104)	1988	-1.309*** (-52.932)	0.040*** (7.739)	1997	-0.979*** (-39.625)	-0.012** (-2.336)	2006	-1.054*** (-38.451)	0.029*** (3.817)	0.972
Sweden	0.874*** (54.713)	0.003 (1.669)	1987	0.952*** (37.270)	-0.051*** (-6.068)	1993	0.694*** (33.464)	0.014*** (3.514)	2003	0.911*** (43.916)	0.005 (1.227)	0.853
United Kingdom	0.355*** (15.766)	-0.008 (-1.432)	1977	0.251*** (14.205)	-0.061*** (-26.597)	1991	-0.463*** (-18.335)	0.025*** (3.013)	1997	-0.359*** (-21.547)	-0.018*** (-9.731)	0.991
United States	-0.450*** (-20.671)	-0.019*** (-6.566)	1983	-0.801*** (-36.788)	0.015*** (5.144)	1997	-0.667*** (-22.800)	-0.038*** (-4.615)	2004	-0.825*** (-31.251)	0.041*** (7.431)	0.884

Notes: Figures in parenthesis below the point estimates of the intercept and trend coefficients estimated are t statistics. ***, ** and * imply rejection of the null of a statistically insignificant coefficient at the 1, 5 and 10 per cent significance levels.

Table 5. Summary of empirical Results related to Time-series β-convergence

	Pre-break Regime 1	*Post-break Regime 2*	*Post-break Regime 3*	*Post-break Regime 4*
Australia	D	1980 D		
Austria	C	1980 d	1993 c	
Belgium	D	1976 C	1988 C	1999 c
Canada	C	1984 C		
Denmark	d	1980 D	1992 D	
Finland	C	1977 c	1993 C	2008 d
France	C	1976 C	1986 C	2000 D
Germany	C	1983 c	1990 C	1996 C
Greece	C	1982 D	1999 c	
Ireland	c	1976 C	2004 D	
Italy	C	1980 D	1993 D	2005 d
Japan	C	1984 D	2003 C	
Netherlands	C	1999 C		
Norway	D	1990 D	1998 C	
Portugal	D	1976 C	1989 D	2001 C
Spain	C	1988 C	1997 D	2006 C
Sweden	d	1987 C	1993 D	2003 d
United Kingdom	c	1977 C	1991 C	1997 D
United States	D	1983 C	1997 D	2004 C

Notes: C (converging); c (weak converging); D (diverging); d (weak diverging)

Table 6. *Convergence club test*

	b-coef	*t-stat*	*cl ubs*	*OECD countries*
const logt	-2.644 -0.787	-1.225 -1.052	I	*Ireland, Japan*
const logt	-1.186 -0.027	-1.072 -0.071	II	*Denmark, Finland, Greece, Spain*
const logt	-3.284 0.180	-5.976 0.946	III	*Austria, France, Germany, Norway, Portugal, Sweden, United States*
const logt	-3.774 0.835	-4.097 2.614	IV	*Australia, Belgium, Italy, Netherlands*
const logt	-4.450 1.461	-1.311 1.241	V	*Canada, United Kingdom*

Notes: The clubs have been obtained by means of the algorithm suggested by Phillips and Sul (2007) in which the groups are formed by countries showing similar convergence speeds to the panel average. The parameter Log t is twice the convergence speed of each club to the panel average. The statistic t-stat is the convergence test sta-

Chapter 6. Convergencia en el esfuerzo inversor en I+D+i de las regiones españolas

Este trabajo trata de contrastar la hipótesis de convergencia estocástica para el gasto total en I+D+i de las comunidades autónomas españolas así como el peso relativo de sus componentes público y privado durante el período 1987–2013, haciendo uso del test de estacionariedad con cambio estructural para datos de panel propuesto por Carrión, del Barrio y López-Bazo (2005). En el período analizado la hipótesis de convergencia es aceptada tanto al considerar el esfuerzo inversor en I+D+i total como cuando examinamos este esfuerzo en función de su naturaleza pública o privada. Por tanto, ya sea como consecuencia de la adecuación de las políticas o de las fuerzas que operan en los mercados y que determinan la configuración de los tejidos empresariales regionales, los resultados parecen apuntar hacia una mayor cohesión, en términos de esfuerzo innovador de los diferentes territorios, lo que debería traducirse en unos efectos favorables sobre la reducción de los desequilibrios, reforzándose así la cohesión territorial.

6.1. Introducción

Con independencia de su eficiencia y adecuación, una de las recetas que se desprenden de las proposiciones teóricas y empíricas de la literatura de crecimiento económico[1] –revisadas exhaustivamente en los trabajos de

[1] La literatura empírica acerca de la relación entre el crecimiento y la innovación sugiere que los procesos de innovación realizan una contribución significativa al crecimiento. Además, esta literatura aporta evidencia acerca de las externalidades que caracterizan estos procesos, incluyendo el papel de la investigación financiada con recursos públicos y sobre las posibles barreras a la difusión internacional de la tecnología que pueden obstaculizar el cath up tecnológico y la tendencia a converger por lo que los esfuerzos de inversión domésticos se tornan en cruciales para eliminar las diferencias.

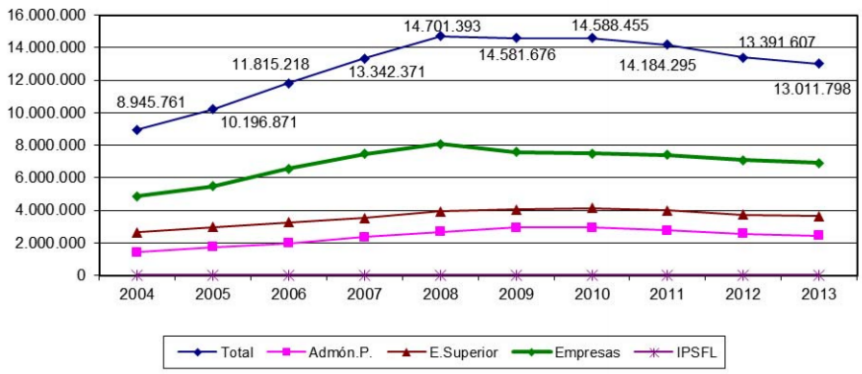
De la Fuente, 1997; Cameron, 1998; Temple 1999– es que apostar por la investigación y la innovación es un pilar clave sobre el que asentar cualquier estrategia de desarrollo, ya sea a través de la intervención pública directa o a través de la ayuda a los proyectos privados innovadores. En efecto, las estrategias de desarrollo regionales, nacionales y comunitarias no son ajenas a estas prescripciones, de manera que resulta habitual encontrar objetivos explícitos de los sectores público y privado en términos de esfuerzo inversor –cuantificado como porcentaje del gasto en I+D+i con respecto al PIB– como forma de promover el crecimiento de un determinado territorio.

No obstante, existe un importante desequilibrio en favor de la iniciativa privada que suele ser interpretado en clave positiva, esto es, en términos de la capacidad del tejido empresarial de contribuir directamente al crecimiento, al tratar de capturar las oportunidades de beneficio más innovadoras que generan mayor valor añadido y que repercuten, en mayor medida, en la creación de empleo (Congregado et al., 2008). Ahora bien, en aquellos casos en los que este esfuerzo inversor por parte del sector privado sea pequeño, bien por su carácter imitador o rutinario, el sector público puede intentar incentivar la innovación, promover la incorporación de nuevos empresarios de carácter innovador al tejido empresarial, e incluso optar por la intervención pública directa en la materia, a partir de la promoción básica y aplicada que se difunda por el tejido empresarial existente. A estos efectos, y aunque la participación del sector público en el proceso de innovación pueda ser visto desde la perspectiva de la complementariedad, no podemos descartar el hecho de que su aparición provoque efectos de crowding out con los consiguientes efectos negativos sobre la participación del sector privado en la inversión nacional en I+D+i.

Con este objetivo, el presente artículo analiza las estadísticas regionales de gasto en I+D+i durante el período 1987-2013 para comprobar si las diferencias en el potencial innovador entre las regiones tienden a acentuarse o a amortiguarse, cuestión clave si tenemos en cuenta las implicaciones de este potencial sobre el crecimiento, la productividad y el empleo, y por ende, sobre la cohesión económica y social de las regiones españolas. De este modo, si queremos evaluar el grado en el que los territorios que partían de posiciones relativamente más atrasadas han ido corrigiendo el gap inversor, cabe preguntarse: ¿ha permitido la descentralización regional unida a las estrategias singulares promovidas por los gobiernos regionales en el ejercicio de su autonomía la corrección de los desequilibrios territoriales existentes?, y en caso afirmativo, ¿sólo se ha corregido el diferencial correspondiente al gasto público o también la evolución del gasto privado ha seguido unas pautas de eliminación de esas diferencias, gracias a las políticas de promoción del tejido empresarial innovador?

Advertirá el lector que esta cuestión es especialmente importante para la economía española en el momento actual debido a la drástica caída del gasto público en general y del gasto público en I+D+i en particular, motivada por la crisis económica y la consecuente búsqueda de estabilidad presupuestaria, lo que ha provocado cambios en la participación relativa de ambos sectores.

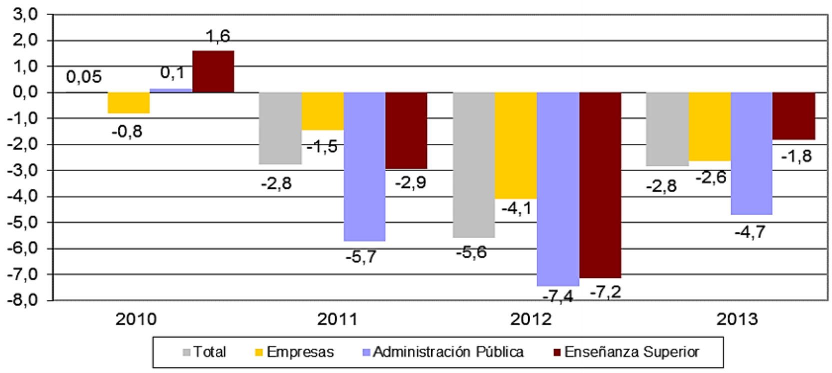
Gráfico 1a. Evolución del Gasto en I+D (miles de euros)



Fuente: INE
Nota: Instituciones Privadas SinFines de Lucro (IPSFL)

Si analizamos estos datos por sectores, tanto el gasto público como el gasto privado experimentaron una disminución del 4,7% y del 2,6% respectivamente, respecto al año anterior, confirmando la evolución decreciente que mantienen desde el inicio de la crisis (Cuadro 1b). Asimismo, la I+D interna fue financiada prioritariamente por el sector privado –empresas (un 46,3%)– y por el sector público –la Administración Pública (un 41,6%)–.

Gráfico 1b. Tasas de variación del gasto en I+D interna en el periodo 2010-2013. (% PIB base 2010)



A nivel regional se detecta una distribución asimétrica del esfuerzo inversor entre las distintas comunidades autónomas, siendo las autonomías que tradicionalmente han presentado mayores porcentajes de gasto con respecto a la media nacional: País Vasco (2,09% del PIB, en 2013), Navarra (1,79%), Madrid (1,75%) y Cataluña (1,50%), observándose igualmente un proceso de ralentización en estos últimos años.

No parece osado aventurar que esta pérdida de capacidad inversora hará más difícil alcanzar el objetivo del 3% de gasto en I+D+i sobre el PIB, fijado para el conjunto de la Unión Europea en 2020, siendo del 2% el objetivo proyectado para España, según la Estrategia Española de Ciencia y Tecnología de Innovación (ver Cuadro 1), objetivo que deberá ir vinculado a una nueva estrategia competitiva y de excelencia de su tejido empresarial que sea capaz de captar mercados y actividades de alto valor añadido.

Cuadro 1. Indicadores de la Estrategia Española de Ciencia y Tecnología y de Innovación

INDICADORES DE ESFUERZO	2010	2016	2020
Gasto en I+D sobre el Producto Interior Bruto (%)	1.39%	1.48%	**2.00%**
Gastos I+D sector privado sobre el Producto Interior Bruto (%)	0.60%	0.73%	1.20%
Ratio entre financiación privada y pública del gasto en I+D	0.86	1.06	1.70
% De la financiación del gasto en I+D procedente del extranjero	5.70%	9.60%	15.00%

Fuente: INE

En el entorno europeo, la estrategia española de supeditación del gasto de inversión en I+D+i, con respecto a las necesidades impuestas por la evolución de la deuda y de la propia economía española, no es una estrategia compartida con otras economías. Más bien al contrario, la intensidad de la contracción del gasto en I+D en España, es un caso aislado en el entorno europeo, donde los países han intentado minimizar el impacto de la crisis sobre este sector. Como prueba de esta afirmación y según datos de Eurostat, basta citar el ejemplo de una economía como la alemana en la que el gasto en I+D (en relación al PIB) creció un 7,69% entre 2009 y 2013, frente a la economía española que registró una tasa de variación media del gasto en I+D del -8,1% durante ese mismo periodo. Fruto de este proceso, la I+D financiada por el sector privado ya supera a la financiada por el sector público en España.

De todo ello se desprende una aparente adecuación del esfuerzo inversor a los pesos relativos de ambos sectores en las economías más desarrolladas, lo que obedece, en cambio, a una brusca caída del esfuerzo público sin que ello suponga que el sector privado ha sido capaz de tomar el testigo de la I+D+i pública. En este sentido, el hecho de que el peso del sector privado alcance al público puede ser el resultado de causas muy diversas: desde la evolución del tejido empresarial desde posiciones más rutinarias hacia un tejido empresarial más dinámico e innovador, hasta venir motivado por el repliegue de la inversión pública en la materia, debido a la subordinación de las políticas de innovación e I+D a ámbitos en los que el equilibrio presupuestario obliga a reasignaciones al menos transitorias de los gastos.

En este contexto, trataremos de evaluar si las desigualdades de la distribución regional del gasto privado en I+D+i tienden a desaparecer gracias a la propia fuerza de los mercados o si por el contrario tan sólo desaparecen gracias a la intervención pública, esto es, a la introducción de incentivos y políticas públicas directas. En otros términos, este artículo trata de explorar si el esfuerzo inversor en I+D+i tiende a converger y si el origen de las fuentes de financiación pública y privada responden a un mismo patrón.

Para efectuar este análisis consideramos el concepto de convergencia de Quah (1990). En particular, y aplicado a nuestro caso de estudio, diremos que la convergencia estocástica en el gasto en I+D+i hace referencia al supuesto en el que una perturbación, en la relación entre el esfuerzo en I+D+i de una región con respecto a la media, es transitoria, es decir, que cualquier shock en el diferencial del gasto en I+D+i de una región sobre la media total (lo que llamaremos gasto relativo) tiene un efecto transitorio, y, con ello, no permanente. Por tanto, basta con testar si dicho diferencial (del gasto en I+D+i de cada región sobre la media) es estacionario, esto es, carece de raíz unitaria[2].

Para contrastar esta hipótesis y dada la naturaleza de la base de datos sobre la que se apoyan nuestras aplicaciones empíricas –datos de panel– utilizaremos los tests de estacionariedad con cambio estructural propuestos por Carrión, del Barrio y López Bazo (2005) –en adelante, CBL– de raíces unitarias para datos de panel–. Así, cuando exista evidencia de convergencia estocástica, el gasto relativo en I+D+i será estacionario (inexistencia de raíz unitaria), mientras que en el caso de que el gasto relativo no sea estacionario (existencia de raíz unitaria) el efecto de cualquier shock o perturbación sobre dicho gasto se convertiría en permanente, esto es, se genera-

[2] Recordemos que la existencia de una raíz unitaria supone que la serie, tiene entre otras características, memoria infinita, y por tanto, cualquier cambio en ella tendría carácter permanente y no transitorio como sería el caso cuando la serie fuera estacionaria (no existencia de raíz unitaria).

ría un proceso de divergencia.

De este modo, el presente artículo se enmarca en los trabajos empíricos sobre convergencia, en particular sobre convergencia estocástica, permitiendo la existencia de cambio estructural con el fin de estudiar si las diferencias en el gasto en I+D regional, se han ido difuminando o no.

Para llevar a cabo esta tarea, el resto del artículo se estructura como sigue. En el siguiente apartado se revisa, de manera sucinta, la literatura previa acerca de la relación entre emprendimiento, innovación y convergencia, en un intento de proporcionar al lector las claves necesarias para poder poner en perspectiva el interés potencial de nuestros resultados. El tercer apartado describe el panel de datos regional que servirá de base para nuestras aplicaciones empíricas y la estrategia econométrica utilizada para llevar a cabo el análisis de convergencia que constituye el núcleo de este trabajo. El cuarto apartado se reserva para presentar los resultados de la aplicación de los contrastes de raíces unitarias para datos de panel incluyendo aquellos que permiten la posibilidad de cambio estructural. Avancemos en este punto que aunque hay evidencia de cambio estructural en las tres series consideradas, los resultados apuntan hacia la idea de que la convergencia en términos del esfuerzo inversor en I+D+i tanto por parte del sector público como el sector privado ha sido la tendencia dominante entre las regiones españolas en el período 1987-2013.

6.2. Emprendimiento, innovación y convergencia

La relación entre el emprendimiento y la innovación es y ha sido una de las relaciones más intensamente exploradas dentro de la denominada literatura del emprendimiento/autoempleo. Como bien es sabido, la innovación es una de las facetas que define el desempeño de la función empresarial (Schumpeter, 1912; O'kean, 2000; O'kean y Menudo, 2008; Iversen et al., 2008) y conocer las claves que determinan el que un tejido empresarial sea innovador es y ha sido uno de los grandes retos a los que se enfrenta el análisis del emprendimiento dado los favorables efectos de la innovación sobre el crecimiento.

En este sentido, y aunque existe una extensa literatura tanto teórica como empírica, acerca de los efectos de la I+D+i sobre el *crecimiento económico* –Romer (1990), Grossman y Helpman (1991), Aghion y Howitt (1992, 2007), Barro y Sala-i-Martin (1995), Young (1998), Jones (1995, 1998)–, *la productividad* –Griliches (1979), Mansfield (1980), Griliches y Lichtenberg (1984), Jaffe (1986), Mairesse y Sassenou (1991), Mairesse y Mohnen (1995), Mohnen (1996), Hall y Mairesse (1995), Guellec y van Pottelsberghe de la Potterie (2004)–, e incluso sobre las *externalidades* de los procesos de innovación –Griliches (1992), Nadiri (1993), Bernstein y Mohnen (1994), Coe y Helpman (1995), Keller (1998), Coe y Hoffmaister (1999), Xu y Wang (1999), Wei et al. (2001), Falvey et al. (2002, 2004), Madsen (2007), Coe, Helpman y Hoffmaister (2009)–, las contribuciones referidas al papel del sector del conocimiento, de la innovación y al propio emprendimiento como uno de los determinantes fundamentales en el proceso de crecimiento, pese a su interés, han sido más escasa. Por ello, el estudio de los sistemas regionales de innovación y de la propia calidad y configuración de los tejidos empresariales regionales así como de los elementos que los configuran han pasado al primer plano de interés en este campo (Cornett y Ingstrup, 2010).

Para el caso español, Calvo (2002) examina la convergencia sigma[3] en el gasto en innovación por persona ocupada en el período 1994–2000, obteniendo evidencia en favor de la convergencia –aunque protagonizada por los sectores de tecnología alta–, en línea con algunos trabajos previos como los de Castillo y Jimeno (1998), Coronado y Acosta (1999) o Calvo (2000b).

Más recientemente Villaverde y Maza (2010) analizan de forma no paramétrica la distribución regional del gasto en I+D+i para el período 1997–2008, proporcionando evidencia de la alta desigualdad entre las re-

[3] El *coeficiente sigma* es una medida de dispersión que muestra cómo varía en el tiempo la desviación estándar del logaritmo neperiano del gasto en innovación para las 17 comunidades autónomas. Calvo (2002), p.36-37.

giones españolas con cierto grado de persistencia, desde 2004. A la reconsideración de estos resultados a la luz de las nuevas tendencias marcadas por la crisis, junto al uso de técnicas alternativas para detectar estos cambios, dedicamos el resto del trabajo.

6.3. Datos y marco empírico

Una vez planteados los objetivos y anclado el contenido de este trabajo en el contexto de la literatura previa, dedicamos este apartado a presentar los elementos que sirven de base a las aplicaciones empíricas sobre el fenómeno de la convergencia regional en términos de esfuerzo inversor en I+D+i.

6.3.1. Datos

En nuestro análisis empírico utilizamos datos anuales de gasto en I+D+i (total, público y privado) referidos a las 17 Comunidades Autónomas (en adelante, CC.AA) durante el periodo 1987–2013, los cuales han sido tomados de dos fuentes distintas. Para el periodo 1987–2007 se ha utilizado la base de datos regional (BDMORES) publicada por el Ministerio de Hacienda y Administraciones Públicas. Debido a la no actualización de dicha base desde diciembre de 2011, se ha hecho uso, para el periodo restante 2008–2013, de los datos procedentes del Observatorio Español de I+D+i (ICONO), que depende del Ministerio de Economía y Competitividad.

Es necesario señalar que, durante este periodo, ha habido cambios metodológicos importantes en la obtención de las series, en especial, en lo relativo al gasto público y privado, y por tanto, al total. Es por ello que, si bien, existen datos disponibles desde 1980 para las 17 CC.AA se ha optado por rechazarlos debido a la presencia de varios valores anómalos en algunas de ellas.

En el cuadro 2 se observa como la evolución del esfuerzo inversor tanto total como público y privado ha seguido una senda creciente para el total de las 17 CC.AA durante el periodo objeto de estudio. Se puede apreciar como País Vasco, Navarra, Madrid y Cataluña son las regiones españolas con un mayor esfuerzo inversor, siendo destacable, en particular, el caso del País Vasco cuando hablamos del esfuerzo inversor privado, muy superior al resto de las CC.AA. En relación al esfuerzo inversor público, este es mayor especialmente en Madrid, Cataluña y Andalucía; posiblemente, y recordando que este esfuerzo incluye tanto las Administraciones Públicas como la enseñanza superior, la existencia de un gran número de universidades en dichos territorios supone un alza importante de dicho esfuerzo.

Cuadro 2. Evolución del esfuerzo inversor en I+D+i (total y por fuente) en las Comunidades Autónomas españolas (porcentaje con respecto al PIB)

	Total			**Público**			**Privado**		
Comuni-	**1987**	**2000**	**2013**	**1987**	**2000**	**2013**	**1987**	**2000**	**2013**
Andalucía	0.41	0.63	1.04	0.26	0.42	0.66	0.15	0.21	0.38
Aragón	0.53	0.68	0.90	0.30	0.29	0.41	0.24	0.39	0.49
Asturias	0.40	0.81	0.86	0.23	0.40	0.41	0.17	0.41	0.45
Baleares	0.14	0.22	0.33	0.06	0.19	0.29	0.09	0.03	0.04
Canarias	0.21	0.47	0.50	0.19	0.37	0.39	0.02	0.10	0.11
Cantabria	0.35	0.42	0.91	0.30	0.31	0.59	0.05	0.12	0.32
Castilla y	0.27	0.64	0.99	0.20	0.37	0.43	0.07	0.27	0.56
Castilla-La	0.24	0.56	0.53	0.03	0.20	0.22	0.21	0.36	0.31
Cataluña	0.68	1.05	1.50	0.19	0.33	0.65	0.49	0.71	0.85
Comunidad	0.26	0.69	1.02	0.17	0.40	0.61	0.09	0.30	0.41
Extremadu-	0.32	0.54	0.76	0.22	0.39	0.60	0.11	0.14	0.16
Galicia	0.24	0.64	0.86	0.17	0.43	0.47	0.07	0.21	0.39
Madrid	1.35	1.56	1.75	0.58	0.70	0.76	0.76	0.86	0.99
Murcia	0.39	0.69	0.84	0.29	0.39	0.51	0.10	0.30	0.33
Navarra	0.30	0.86	1.79	0.00	0.30	0.56	0.30	0.57	1.23
País Vasco	0.89	1.15	2.09	0.16	0.25	0.52	0.73	0.90	1.57
La Rioja	0.07	0.57	0.79	0.05	0.22	0.40	0.02	0.35	0.39
ESPAÑA	0.58	0.91	1.24	0.33	0.46	0.58	0.25	0.35	0.66

Fuente: Ministerio de Economía y Competitividad. Observatorio Español de I+D+i. Los datos de contabilidad regional proceden de la base de datos BDMORES del Ministerio de Hacienda y Administraciones Públicas.

6.3.2. Estrategia econométrica

El análisis de la convergencia a través de los contrastes de raíces unitarias ha sido un enfoque intensamente utilizado en los últimos años. En esta línea, nuestra estrategia de análisis empírico pasa por el uso de contrastes de raíces unitarias para datos de panel como forma de analizar el fenómeno de la convergencia estocástica. Siguiendo la estrategia de Carlino y Mills (1993), primero definimos el gasto relativo en I+D+i de cada región G_{it}computando el logaritmo del tipo de gasto en I+D+i considerado –total, público o privado–, expresado en porcentaje de su PIB, de la región *i* en el momento *t*, con respecto a la media de las observaciones individuales (región) en cada período de tiempo. De esta forma, nuestra variable queda definida como:

$$G_{it} = ln(G_{it}/\bar{G}_t) \qquad (2)$$

En los gráficos 2a, 2b y 2c podemos observar la evolución del esfuerzo inversor relativo total, privado y público durante el período 1987–2013. En los tres casos, especialmente en el público y en el total, se muestra como existe un cierto proceso de convergencia del gasto relativo para las 17 CC.AA. Sin embargo, a pesar de este análisis gráfico preliminar es necesario un análisis más complejo para contrastar si existe dicho proceso de convergencia en los tres tipos de gastos.

Gráfico 2a: Evolución del esfuerzo inversor relativo en I+D+i total, regiones españolas, 1987-2013.

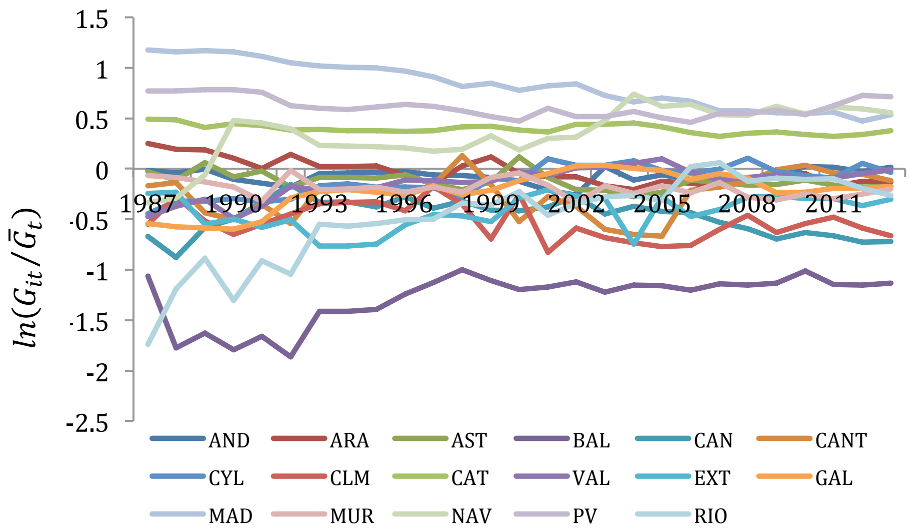


Gráfico 2b: Evolución del esfuerzo inversor relativo en I+D+i privado, regiones españolas, 1987-2013.

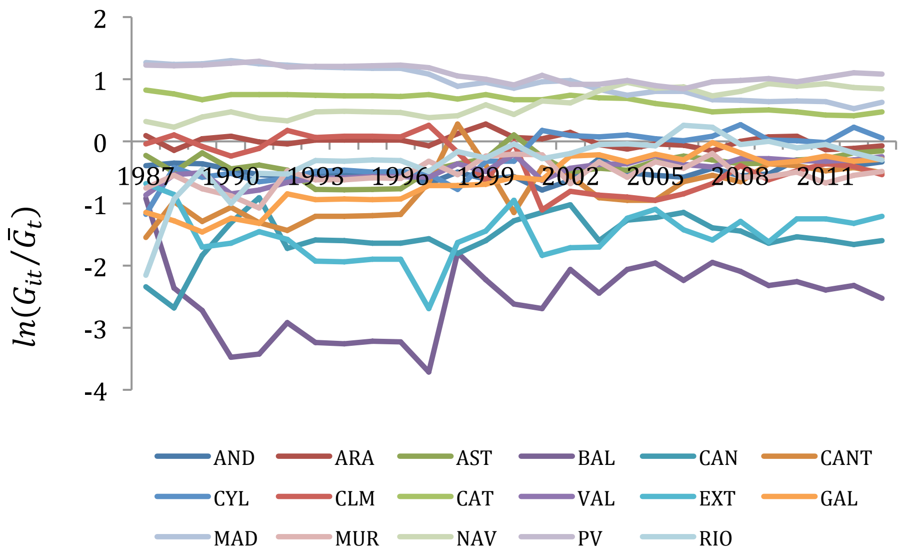
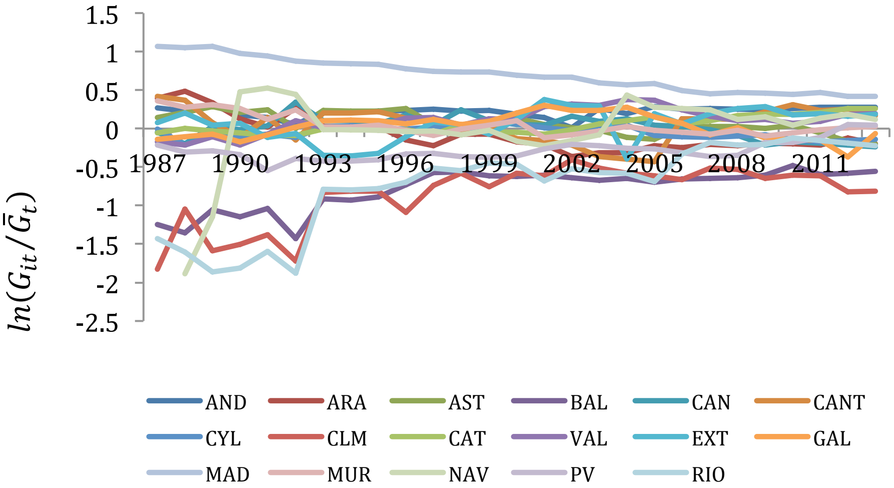


Gráfico 2c: Evolución del esfuerzo inversor relativo en I+D+i público, regiones españolas, 1987-2013.



Como bien es sabido, el concepto de convergencia estocástica implica que el gasto relativo es estacionario, es decir, rechaza la hipótesis de existencia de raíz unitaria haciendo uso de las aproximaciones de búsqueda de raíces unitarias para datos de panel –dada la naturaleza de la base de datos sobre la que se fundamentan nuestras estimaciones– el enfoque adoptado permite detectar la presencia de éstas, incluso en el contexto de múltiples cambios estructurales, aunque para poner en valor estos últimos, se presentarán los resultados derivados de estos tests de raíces unitarias con y sin cambio estructural.

Siguiendo esta estrategia, el primer paso es llevar a cabo el test de estacionariedad de Kwiatkowski et al. (1992) –KPSS –y el de Hadri (2000), definido como una media de los tests univariantes KPSS. Sin embargo, y como bien es sabido, los métodos de inferencia pueden reportar sesgo si se ignora la existencia de cambio estructural cuando éste está presente en los datos, lo cual es bastante probable si consideramos un período de tiempo tan largo, más de tres décadas, donde resulta altamente probable que los cambios en el marco de acción política y en la propia dinámica seguida por los tejidos empresariales regionales, hayan generado cambios sustanciales en la trayectoria dinámica de las variables de esfuerzo inversor en I+D+i de las regiones españolas.

Por estas razones también empleamos la prueba del panel de CBL. Esta prueba nos permite incorporar un cambio estructural potencial en la función de tendencia, evitando el sesgo potencial de aceptar la hipótesis nula de no convergencia en presencia de cambios estructurales.

6.4. Resultados

Siguiendo con la propuesta anteriormente descrita, comenzaremos estudiando la convergencia estocástica. En primer lugar, este análisis se realiza mediante contrastes de raíces unitarias para datos de panel convencionales –test de Hadri–. Sin embargo, este test tiende a rechazar la hipótesis nula de presencia de raíces unitarias, en el caso en el que existan cambios estructurales.

Por esta razón, se completa el estudio con la extensión de este contraste, propuesto por CBL. En el contexto de nuestro análisis, esta aproximación ha de permitirnos controlar tanto la heterogeneidad como la existencia de cambio estructural múltiple, esto es, de un número distinto de cambios de régimen para cada una de las regiones españolas.

Cuadro 3. KPSS test sin cambios estructurales

Panel A. Comunidad Au-			
	Total	**Público**	**Privado**
Andalucía	0.117	0.173**	0.156***
Aragón	0.486***	0.833***	0.120
Asturias	0.390***	0.202**	0.213***
Baleares	2.051***	0.421***	0.277***
Canarias	0.173**	0.074	0.234***
Cantabria	0.078	0.094	0.417***
Castilla y León	0.570***	0.080	0.401***
Castilla La Mancha	0.193**	0.395***	0.149**
Cataluña	0.826***	0.411***	0.487***

Comunidad Valenciana	1.073***		0.241***		0.361***	
Extremadura	0.261**		0.269***		0.164**	
Galicia	0.327***		0.085		0.759***	
Madrid	1.840***		6.194***		1.067***	
Murcia	0.527***		0.739***		0.634***	
Navarra	0.569***		3.154***		0.569***	
País Vasco	0.155**		0.132*		0.304***	
La Rioja	0.910***		0.485***		0.860***	
Panel B: Panel KPSS test						
	Test	p-	90%	95%	97.5%	99%
$Z(\hat{\lambda})_{Homogeneous}$	11.856	0.000	4.4725	5.967	7.136	9.288
$Z(\hat{\lambda})_{Heterogeneous}$	12.456	0.000	6.1461	7.935	9.188	12.210
Panel B: Panel KPSS test PÚBLICO						
	Test	p-	90%	95%	97.5%	99%
$Z(\hat{\lambda})_{Homogeneous}$	13.336	0.000	6.481	11.745	16.430	21.244
$Z(\hat{\lambda})_{Heterogeneous}$	11.213	0.000	6.351	8.080	10.303	12.589
Panel B: Panel KPSS test PRIVADO						
	Test	p-	90%	95%	97.5%	99%
$Z(\hat{\lambda})_{Homogeneous}$	5.828	0.000	4.060	5.442	6.524	8.231
$Z(\hat{\lambda})_{Heterogeneous}$	7.060	0.000	6.454	8.237	9.072	10.144

Notas: Los valores críticos para el KPSS para la especificación con tendencia al 1%, 5% y 10% son 0.213, 0.149, 0.121, respectivamente, para T=50 (véase Sephton, 1995). Igualmente los dos Z son los valores de un estadístico de multiplicadores de Lagrange para el contraste KPSS de Hadri (2000), concretamente para los casos de homogeneidad y heterogeneidad en la estimación de la varianza a largo plazo. ***,** y * denotan el rechazo de la hipótesis nula al 1%, 5% y 10%, respectivamente.

En el cuadro 3 presentamos los resultados del contraste estacionario de panel propuesto por Hadri (2000). El panel A se muestran los resultados de los contrastes univariantes KPSS. Entre las 17 CC.AA podemos destacar que, prácticamente, en todas y para cualquier sector de ejecución

–público y privado–, podemos rechazar la hipótesis nula de estacionariedad (al 10%, 5% o 1% de significatividad). Es decir, el contraste univariante KPSS muestra la existencia de divergencia en el gasto en I+D relativo en el total de las 17 CC.AA, exceptuando los casos de Andalucía y Cantabria, en el caso del gasto en I+D total, Canarias, Cantabria, Castilla-León y Galicia, en el caso del gasto público en I+D, y finalmente Aragón cuando se trata del gasto privado en I+D.

El panel B del cuadro 3 se muestra los resultados del contraste de estacionariedad de Hadri (2000) para el caso de "independencia de corte transversal[4]" y normalidad asintótica así como los valores críticos obtenidos mediante bootstrap permitiendo "correlación de corte transversal". Por motivos de robustez, se ha utilizado el contraste de Hadri suponiendo homogeneidad y heterogeneidad en la varianza a largo plazo. Como podemos observar, los resultados nos llevan a poder rechazar la hipótesis nula de estacionariedad conjunta en todos los casos a un nivel de significatividad del 1% para el caso de "independencia de corte transversal" y normalidad asintótica. Estos resultados permanecen inalterados cuando los comparamos con el contraste de Hadri haciendo uso de los valores críticos proporcionados vía bootstrap. Como se puede observar, en todos los casos podemos rechazar la hipótesis nula al 5% de significatividad independientemente del supuesto de homogeneidad o heterogeneidad en la estimación de la varianza a largo plazo (excepto en el caso del supuesto de heterogeneidad en la varianza a largo plazo en el caso del gasto en I+D privado que sería al 10% de significatividad).

A la luz de estos resultados, podemos afirmar la existencia de divergencia en el gasto de I+D para cualquier sector de ejecución en las 17 CC.AA. Sin embargo, estos resultados nos podrían llevar a conclusiones erróneas si no tuviéramos en cuenta la existencia de cambios estructura-

[4] La independencia de corte transversal implica la ausencia de correlación entre las unidades observacionales (CC.AA en nuestro trabajo) para cada periodo.

les[5]. En base a ello vamos a hacer uso de la metodología propuesta por CBL que, como ya hemos advertido anteriormente, es una extensión del contraste de estacionariedad de Hadri permitiendo cambios estructurales.

El test CBL, supone la existencia de un proceso generador de datos que, bajo la hipótesis nula de estacionariedad en varianza, se puede especificar como:

$$G_{i,t} = \alpha_i + \sum_{k=1}^{m_i} \theta_{i,k} DU_{i,k,t} + \beta_i t + \sum_{k=1}^{m_i} \gamma_{i,k} DT^*_{i,k,t} + \varepsilon_{i,t} \quad \ldots\ldots(3)$$

siendo $DU_{i,k,t}$ y $DT^*_{i,k,t}$, dos variables ficticias introducidas para capturar los cambios en nivel y pendiente, respectivamente, de forma que la variable $DU_{i,k,t} = 1$ para todo $t > T^i_{b,k}$ y 0 en caso contrario, donde $T^i_{b,k}$ denota el cambio k-ésimo para el individuo i-ésimo, donde $k = 1,\ldots,m_i$, $m_i \geq 1$. Por su parte, $DT^*_{i,k,t} = t - T^i_{b,k}$, para todo $t > T^i_{b,k}$ y 0, en caso contrario. Finalmente el término de error $\varepsilon_{i,t}$ se supone independiente entre regiones.

En este punto, deberíamos hacer notar que este proceso generador de datos incluye: a) efectos individuales–cambios estructurales o cambios en media, b) efectos temporales si $\beta_i \neq 0$ y c) efectos de cambio estructural temporal si $\gamma_{i,k} \neq 0$ –que se dan cuando hay cambios en la tendencia de una región. Añadir que esta especificación es lo suficientemente general como para permitir heterogeneidad individual, tendencias diferentes en cada región y cambios en la pendiente de cada región. Para testar la hipótesis nula de estacionariedad, el estadístico del contraste CBL requiere el cómputo del siguiente estadístico:

[5] Se entiende por cambio estructural como cualquier cambio en la serie temporal (en nuestro caso el gasto relativo en I+D+i) que afecta al comportamiento a largo plazo de dicha serie, provocando que los parámetros de la serie sean variantes con el tiempo.

$$LM\left(\hat{\lambda}\right) = N^{-1}\sum_{i=1}^{N}\left(\hat{\psi}_i^{-2}T^{-2}\sum_{t=1}^{T}\hat{S}_{i,t}^2\right)$$

(4)

donde $LM\left(\hat{\lambda}_i\right) = \hat{\psi}_i^{-2}T^{-2}\sum_{t=1}^{T}\hat{S}_{i,t}^2$ es el test KPSS para la región i-ésima, y $\hat{S}_{i,t} = \sum_{j=1}^{t}\hat{\varepsilon}_{i,j}$ es la suma obtenida de la suma de los residuos tras la estimación de la ecuación 3 por mínimos cuadrados. Finalmente, $\hat{\psi}_i^2$ es la estimación consistente de la varianza a largo plazo de los residuos $\varepsilon_{i,t}$.

Dado que este contraste no es independiente del lugar en el que se ubiquen los cambios (λ_i), se ha de usar el procedimiento sugerido por Bai y Perron (1998), esto es minimizar la suma de los cuadrados de los residuos para determinar esta localización de los cambios, para cada región. Tras fechar estos cambios para todos los posibles $m_i \leq m^{\max}$ para cada región –siendo m y $m^{\max}$ el número de cambios y el máximo número de cambios, respectivamente– debemos seleccionar el número apropiado de cambios. Para determinar este número, se usa el criterio de información de Schwarz modificado tal y como sugieren Liu, Wu y Zidek (1997) cuyo estadístico se calcula a través de la siguiente expresión:

$$Z\left(\hat{\lambda}\right) = \frac{\sqrt{N}\left[\eta\left(\hat{\lambda}\right) - \bar{\xi}\right]}{\bar{\varsigma}} \xrightarrow{d} N(0,1)$$

(5)

donde $\bar{\varsigma}^2$ y $\bar{\xi}$ son la media y la varianzade $LM_i\left(\hat{\lambda}_i\right)$. Como el estadístico $Z\left(\hat{\lambda}\right)$ parte del supuesto de independencia entre las observaciones individuales, hemos de computar la distribución del test por bootstraping siguiendo a Maddala yWu (1999).

Los cuadros 4a, 4b y 4c muestran los resultados de dicho contraste para los tres tipos de gastos utilizados en este artículo. El panel A de los tres cuadros muestra los resultados de los contrastes univariantes KPSS permitiendo la existencia de cambios estructurales tal como el contraste está planteado.

Es necesario señalar, que para controlar la posible existencia de sesgo en muestras finitas como es nuestro caso, se han calculado los valores críticos para los contrastes KPSS individuales haciendo simulaciones de Monte Carlo usando 20000 replicaciones. Podemos observar que, básicamente la mayoría de las CC.AA, independientemente del tipo de gasto, presentan al menos un cambio estructural en la función de gasto en I+D relativo. Así, teniendo en cuenta las excepciones en el caso de Aragón, Baleares, Canarias, Cataluña, Comunidad Valenciana, Madrid, Navarra y La Rioja (en el gasto total en I+D); de Asturias, Baleares, Castilla-León, Cataluña, Comunidad Valenciana, Extremadura, y Navarra (en el caso de gasto privado en I+D) y Andalucía, Canarias, Cantabria, Castilla-León, Murcia y Navarra (en el caso de gasto en I+D público), no rechazamos la hipótesis nula de estacionariedad.

El panel B, por su parte, muestra los resultados del test de Hadri (2000) para el caso de independencia entre las observaciones individuales así como los valores críticos obtenidos por bootstraping. En el caso de asumir en el contraste de estacionariedad KPSS los supuestos de normalidad asintótica e “independencia de corte transversal”, obtenemos que, tanto en el caso del gasto en I+D total como en el caso del gasto en I+D privado y público, si se puede rechazar al 99% de significatividad dicha hipótesis nula de estacionariedad, teniendo evidencia de divergencia en dichos gastos de I+D.

Sin embargo, estas conclusiones podrían ser erróneas imponiendo el supuesto de “dependencia de corte transversal” y haciendo uso de los valores críticos obtenidos mediante bootstrap. Se puede observar que bajo este supuesto, en todos los casos no podemos rechazar la hipótesis nula de estacionariedad (y, por tanto, de convergencia). En consecuencia, se demuestra que la asunción del supuesto de “independencia de corte transversal” puede llevarnos a rechazar de forma espúrea la hipótesis nula.

De acuerdo con estos resultados, y para los tres casos estudiados, no puede rechazarse la hipótesis nula de estacionariedad, por lo que puede afirmarse que existe un proceso de convergencia. Es decir, los resultados muestran que no tener en cuenta la existencia de cambios estructurales puede llevarnos a conclusiones erróneas (rechazo de la hipótesis nula que nos lleve a un proceso de divergencia). Los resultados confirman que controlar la existencia de cambios estructurales se muestra vital para poder concluir adecuadamente acerca de los procesos de convergencia.

Respecto al número de cambios estructurales detectados se observa que, para los tres casos analizados, su número es similar (alrededor de 30). Sin embargo, parece ser que su distribución en el tiempo es distinta en cuanto al origen en el esfuerzo inversor. En relación al gasto en I+D+i total, se aprecia como un tercio de estos cambios estructurales se concentran a principios de los años 90, pudiendo interpretarse su origen en la crisis económica que tuvo lugar en la economía española en el año 1993, mientras que alrededor de otro tercio tienen lugar a principios de este siglo (años 2000, 2001 y 2002), periodo que coincide con el IV Plan Nacional de I+D+i 2000-2003.

Centrándonos en el caso público y privado detectamos un gran número de cambios estructurales a principios de los años 90, coincidiendo con la situación analizada para el gasto I+D+i total, pero también es cierto que parece haber un desplazamiento de los cambios estructurales hacia mediados de la primera década del presente siglo. El origen de estos cambios podría estar vinculado al inicio de la crisis actual. Así, en el caso del gasto privado, cinco comunidades autónomas (Andalucía, Castilla-La Mancha, Cataluña, Madrid y País Vasco) evidencian cambios estructurales a partir del año 2005 , mientras que en el caso público existen seis comunidades autónomas (Canarias, Cantabria, Cataluña, Galicia, País Vasco y La Rioja) que muestran cambios a partir del año 2005[6].

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[6]Es necesario señalar que la ausencia de cambios estructurales a partir del año 2009 para cualquier CC.AA. no implica la no existencia de estos. El motivo

Cuadro 4a: Contraste KPSS con cambios estructurales. Esfuerzo inversor relativo total.

Panel A: Test univariante

Región	Estadístico	m_i	$\hat{T}^1_{b,1}$	$\hat{T}^1_{b,2}$	10%	5%	1%
Andalucía	0.060	2	1998	2002	0.122	0.145	0.192
Aragón	0.592***	2	1990	2000	0.124	0.148	0.202
Asturias	0.083	1	2001		0.158	0.192	0.266
Baleares	0.924***	1	1995		0.185	0.237	0.335
Canarias	0.275**	2	1990	2006	0.149	0.193	0.277
Cantabria	0.070	2	1999	2005	0.115	0.142	0.198
Castilla y León	0.124*	2	1992	2000	0.117	0.140	0.195
Castilla la Mancha	0.158*	1	2000		0.157	0.187	0.251
Cataluña	0.165*	2	1990	2006	0.138	0.174	0.256
Comunidad Valenciana	0.188**	2	1991	1999	0.126	0.157	0.222
Extremadura	0.099	2	1992	1996	0.162	0.209	0.306
Galicia	0.089	2	1991	1999	0.126	0.156	0.224
Madrid	0.130**	2	1996	2003	0.103	0.118	0.150
Murcia	0.079	1	2001		0.159	0.192	0.266
Navarra	0.736***	2	1990	2002	0.122	0.146	0.192
País Vasco	0.171	2	1991	1999	0.181	0.229	0.350
La Rioja	0.399***	2	1992	2002	0.116	0.14	0.203

de esta cuestión, se debe a que la metodología utilizada en el trabajo impide contrastar la existencia de cambios estructurales a partir de dicho año, por lo que solo es posible contrastar de estos hasta ese año.

					3	
Panel B: Contraste KPSS de panel						
	Independencia de corte transversal		Valores críticos bootstraps *Dependencia de corte transversal*			
	Estadístico	p-value	90%	95%	97.5%	99%
$Z(\hat{\lambda})$ (homogéneo)	5.734	0.000	7.353	8.463	9.750	11.254
$Z(\hat{\lambda})$ (heterogéneo)	15.634	0.000	15.880	18.656	21.473	24.495

Nota: La especificación en que se basan estos resultados incluye constantes diferentes para cada región y tendencia lineal. $Z(\hat{\lambda})$(homogéneo) y $Z(\hat{\lambda})$ (heterogéneo) son los estadísticos del contraste de CBL. La distribución bootstrap para $Z(\hat{\lambda})$ está basada en 20,000 réplicas. El número de cambios ha sido determinado haciendo uso del criterio de información LWZ para un máximo de 2 cambios estructurales $m_i = 2$ ***, ** y * indican rechazo de la hipótesis nula al 1%, 5% y 10%, respectivamente.

Cuadro 4b: Contraste KPSS con cambios estructurales. Esfuerzo inversor relativo privado.

Panel A: Test univariante

Región	Estadístico	m_i	$\hat{T}^1_{b,1}$	$\hat{T}^1_{b,2}$	10%	5%	1%
Andalucía	0.077	2	1990	2009	0.198	0.255	0.382
Aragón	0.116*	2	1997	2002	0.114	0.135	0.177
Asturias	0.257**	2	1992	1996	0.163	0.210	0.313
Baleares	0.437***	2	1990	1997	0.149	0.189	0.274
Canarias	0.098	1	1990		0.268	0.348	0.525
Cantabria	0.077	1	1996		0.175	0.218	0.315
Castilla y León	0.402***	1	2000		0.157	0.188	0.258
Castilla la Mancha	0.060	2	2000	2006	0.124	0.154	0.221
Cataluña	0.140*	2	1999	2005	0.115	0.142	0.196
Comunidad Valenciana	0.210**	1	1997		0.167	0.204	0.292
Extremadura	0.372***	2	1992	1997	0.149	0.192	0.279
Galicia	0.096	2	1991	2001	0.117	0.138	0.186
Madrid	0.105	2	1987	2006	0.103	0.121	0.159
Murcia	0.068	1	1991		0.251	0.324	0.490
Navarra	0.225***	2	1998	2002	0.123	0.146	0.196
País Vasco	0.102	2	1997	2008	0.114	0.134	0.176
La Rioja	0.161	1	1990		0.267	0.344	0.519

Panel B Contraste KPSS de panel

	Independencia de corte transversal		Valores críticos bootstraps *Dependencia de corte transversal*			
	Estadístico	p-value	90%	95%	97.5%	99%
$Z(\hat{\lambda})$ (homogéneo)	4.389***	0.000	7.671	9.131	10.829	13.450
$Z(\hat{\lambda})$ (heterogéneo)	6.292***	0.000	14.363	16.044	17.690	20.726

Nota: La especificación en que se basan estos resultados incluye constantes diferentes para cada región y tendencia lineal. $Z(\hat{\lambda})$(homogéneo) y $Z(\hat{\lambda})$ (heterogéneo) son los estadísticos del contraste de CBL. La distribución bootstrap para $Z(\hat{\lambda})$está basada en 20,000 réplicas.

El número de cambios ha sido determinado haciendo uso del criterio de información LWZ para un máximo de 2 cambios estructurales $m_i = 2$. ***, ** y * indican rechazo de la hipótesis nula al 1%, 5% y 10%, respectivamente.

Cuadro 4c: Contraste KPSS con cambios estructurales. Esfuerzo inversor relativo público.

Panel A: Test univariante

Región	Estadístico	m_i	$\hat{T}^1_{b,1}$	$\hat{T}^1_{b,2}$	10%	5%	1%
Andalucía	0.223*	1	2004		0.180	0.231	0.343
Aragón	0.140	2	1990	1995	0.179	0.229	0.338
Asturias	0.093	1	1996		0.175	0.217	0.316
Baleares	0.151	2	1992	1996	0.166	0.211	0.316
Canarias	0.269**	2	1990	2006	0.165	0.209	0.305
Cantabria	0.790***	2	1999	2005	0.115	0.140	0.197
Castilla y León	0.266***	2	1992	2004	0.109	0.130	0.177
Castilla la Mancha	0.136	2	1992	1996	0.163	0.207	0.317
Cataluña	0.065	2	2002	2007	0.148	0.189	0.287
Comunidad Valenciana	0.078	2	1991	2000	0.120	0.145	0.201
Extremadura	0.079	2	1992	1996	0.167	0.212	0.317
Galicia	0.103	2	1992	2006	0.123	0.154	0.223
Madrid	0.120*	2	1991	2002	0.114	0.134	0.178
Murcia	0.379**	1	1992		0.232	0.300	0.443
Navarra	0.941***	1	1990		0.270	0.351	0.542
País Vasco	0.224	1	2008		0.250	0.321	0.485
La Rioja	0.087	2	1992	2005	0.114	0.137	0.195

Panel B. Contraste KPSS de panel

	Independencia de corte transversal		Valores críticos bootstraps *Dependencia de corte transversal*			
	Estadístico	p-value	90%	95%	97.5%	99%
$Z(\hat{\lambda})$ (homogéneo)	10.440***	0.000	2.367	19.105	26.945	33.928
$Z(\hat{\lambda})$ (heterogéneo)	7.894***	0.000	1.742	13.702	16.125	18.594

Nota: La especificación en que se basan estos resultados incluye constantes diferentes para cada región y tendencia lineal. $Z(\hat{\lambda})$(homogéneo) y $Z(\hat{\lambda})$ (heterogéneo) son los estadísticos del contraste de CBL. La distribución bootstrap para $Z(\hat{\lambda})$ está basada en 20,000 réplicas. El número de cambios ha sido determinado haciendo uso del criterio de información LWZ para un máximo de 2 cambios estructurales $m_i = 2$. ***, ** y * indican rechazo de la hipótesis nula al 1%, 5% y 10%, respectivamente.

6.5. Conclusiones

Este trabajo ha analizado la evolución del gasto relativo en I+D+i y de sus componentes público y privado en las 17 regiones españolas durante el periodo 1987-2013, desde la perspectiva de la convergencia, haciendo uso del test de estacionariedad con cambio estructural para datos de panel propuesto por Carrión, del Barrio y López-Bazo (2005). Abordar esta cuestión es importante, no sólo para contrastar si han existido estrategias diferenciadas entre los gobiernos autonómicos sino para saber si los tejidos empresariales de los diferentes territorios han sido capaces de aprovechar las oportunidades y avanzar en la cohesión territorial.

El análisis empírico desarrollado ha tratado de dar respuesta a las cuestiones que se plantean en la introducción de este artículo, por un lado, si el esfuerzo inversor en I+D+i tiende a converger y por otro, si el origen de las fuentes de financiación pública y privada siguen un comportamiento similar. En relación a la primera cuestión, nuestros resultados muestran cómo las estimaciones realizadas bajo el supuesto de *independencia entre las regiones* puede llevarnos a conclusiones erróneas acerca del proceso de convergencia real producido entre las CC.AA. Por el contrario, si consideramos los cambios estructurales producidos en la función de gasto en I+D relativo, los resultados parecen apuntar hacia la convergencia en el esfuerzo inversor en todas las CC.AA. Respecto a la segunda cuestión, resulta igualmente significativo en ese proceso tanto el esfuerzo inversor realizado por el sector público como el generado por el sector privado, sin que se aprecien diferencias entre ambos.

A pesar de este proceso de convergencia entre las distintas regiones españolas no debemos olvidar la aún amplia brecha existente entre ellas, por lo que, una de las vías de actuación de la acción pública debería estar encaminda en intentar acortar estas distancias. Finalmente, se ha puesto de manifiesto la existencia e importancia de los cambios estructurales en los distintos procesos de convergencia, lo cual nos abriría una nueva línea de estudio susceptible de ser incorporada a la agenda de investigación futura, teniendo presente el posible impacto de la crisis económica en este proceso.

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tistic and is a simple one-sided t-test with a critical value of -1.65 (see Phillips and Sul, 2007 for further details).

Table 7. Time-series β-convergence and convergence-club. Summary of Tables 5 and 6.

Convergence club

Time-series β- convergence	*Last-break Regime*	I	II	III	IV	V
	C	*Japan*	*Spain*	*Germany Norway Portugal United States*	*Netherlands*	*Canada*
	c		*Greece*	*Austria*	*Belgium*	
	D	*Ireland*	*Denmark*	*France*	*Australia*	*United Kingdom*
	d		*Finland*	*Sweden*	*Italy*	

Note: C (converging); c (weak converging); D (diverging); d (weak diverging)

Part IV: Exploring the PPP hypothesis

Chapter 7: Long memory and mean reversion in real exchange rates in Latin America

This paper examines the long-run PPP hypothesis for twelve Latin American real exchange rates (REERs) using fractional integration techniques. The empirical results, applying parametric approaches, provide evidence of mean reversion in the REERs in the cases of Nicaragua, Belize, Costa Rica, Guyana and Paraguay, and lack of it for the remaining seven countries. Employing semiparametric methods the evidence of mean reversion covers the following countries: Belize, the Dominican Republic, Ecuador and Mexico. Thus, only for Belize and Guyana do we obtain consistent evidence of mean reversion in the real exchange rates. At the other extreme, lack of mean reversion, and thus, lack of PPP is obtained with both methods in Bolivia, Brazil, Colombia and Venezuela. For the remaining six countries, the results are ambiguous. The results for the PPP theory in Belize and Guyana may show the importance of promoting policies based on exchange rate flexibility and economic liberalization to reach a long-run stability scenario that lead to greater international competitiveness and lower external vulnerability.

7.1. Introduction

The validity of the Purchasing Power Parity (PPP) hypothesis has been one of the more debated issues in the area of international economics not only for its relevance in the determination of the exchange rate (Dornbusch, 1987; Dornbusch and Frankel, 1988; Fraser et al., 1991) but also for its policy implications (Liu, 1992). Initially introduced by M. De Azpilcueta in 1556 and, later, by the contributions of economists like Thornton (1802), Wheatley (1807) and Cassel (1918), the PPP theory suggests that the equilibrium exchange rate between two currencies is given by the ratio of the two countries' relative price levels, domestic and foreign prices, (absolute PPP) or, in a relative version of PPP, by the countries' relative inflation rates.

Nowadays, there seems to be a widespread consensus that PPP does hold in the long run but not in the short-run (Frenkel, 1981; McNown and Wallace, 1989) in spite of the existence of short-run deviations from PPP. Nevertheless, this hypothesis is considered controversial due to the lack of consistent results, even though, in recent decades, there has been further expansion in this regard. According to Froot and Rogoff (1995), before the decade of the 80s, the majority of empirical studies (the stage-one tests) were subject to little theoretical and econometric development that prevented making a distinction between temporary disturbances to PPP and the long-run real effects, thereby not showing strong support in favour of this theory (Corbae and Ouliaris, 1988; Enders, 1988). Under the null hypothesis of simple PPP, evidence was only found for a long-run PPP equilibrium in tests based on data from hyperinflationary economies (e.g. Frenkel, 1978). From the 80s, the credibility of these previous works was questioned. The stage-two tests (e.g. Hakkio, 1984, Meese and Rogoff 1988) assume as null that the real exchange rate is non-stationarity (follows a random-walk) against the alternative that PPP holds in the long-run.

Testing the stationarity of individual series is thus, the first step to examine the validity of the PPP hypothesis and thereby avoid possible spurious results. Nevertheless, this null hypothesis was also questioned (Roll, 1979) as well as the power of the unit root tests with respect to the data sets. Finally, Froot and Rogoff (1995) suggest a set of stage-three tests based on cointegration techniques that, despite their growing development in recent years, seem to offer, once again, inconclusive results just as in the stage-two tests (Kim, 1990; Fisher and Park, 1991). Focusing on standard cointegration techniques (Engle and Granger, 1987; Johansen, 1988, 1991, 1996; Johansen and Juselius, 1990), and applied on nominal and real exchange rates, we can find different results depending on the econometric methods employed, the frequency of data or the income level of countries, with the investigations devoted to the least developed countries being scarcer (LDCs). For these countries and, in particular, for Latin America, we find evidence supporting the PPP hypothesis in Holmes (2008), Divino et al. (2009) and Bahmani-Oskooee et al. (2013) and conflicting evidence can be found in Bahmani-Oskooee (1993, 1995), Holmes (2001), Breitung and Candelon (2005) and Alba and Papell (2007).

Concerning fractional differentiation, the evidence is even more scarce. Only a few studies show long memory properties in Latin America's exchange rates such as Soofi (1998), Alves et al. (2001), Holmes (2002) and Gil-Alana (2008) among others. In connection to these previous works, and applying fractional integration techniques, the present paper tests the REERs in twelve Latin American countries in order to provide empirical evidence for the PPP hypothesis. The contribution of this work is double edged: On the one hand, we aim to shed some light with regard to this hypothesis from a fractional integration approach and, on the other hand, fill the gap existing in the literature given that the majority of studies are focused on developed countries.

The remainder of this paper is structured as follows. Section 2 presents a brief review of the PPP literature in Latin American countries. Section 3 describes the methodology employed and Section 4 reports and discusses the empirical results. Lastly, Section 5 concludes the paper.

7.2. Purchasing Power Parity in Latin America

The empirical studies on the PPP hypothesis in Latin American countries have offered mixed results. On the one hand, we can distinguish a first set of works based on conventional unit root and cointegration tests such as the Dickey and Fuller -ADF- (1979) or Johansen (1988) tests that provide evidence both supporting PPP (Mikkelsen´s, 1989; McNown and Wallace's, 1989; Liu, 1992; Mahdavi and Zhou, 1994; Conejo and Shields, 1993) and rejecting it (Bahmani-Oskooee, 1993, 1995). In this light, Zhou (1997) re-examines Bahmani-Oskooe (1993) and Mahdavi and Zhou's (1994) works, and concludes that the ADFs tests used in these previous investigations are not adequate to identify the order of integration of variables affected by break points, as suggested by Perron (1989), Christiano (1992), Banerjee et al. (1992) and Zivot and Andrews (1992). Nowadays, the findings for the PPP hypothesis seem to be more robust due to the advance in econometrics techniques for panel data. However, these results should be analyzed with caution (Taylor and Sarno, 1998). For instance, in a recent paper, Alba and Papell (2007) examine a sample of 84 developed and developing countries comparing the results of the ADF test with those using the panel data unit root tests suggested by Levin, Lin, and Chu (2002) and Im, Pesaran and Shin (2003). Their results show that tests based on the whole panel do not provide conclusive results about PPP, whereas if the sample is grouped by regions, PPP holds for panels of European and Latin American countries, which confirms Holmes' (2001) results. However, taking into account possible structural breaks, Breitung and Candelon (2005) find absence of PPP for South and Latin American countries. Recently, Bahmani-Oskooee et al. (2013) tested the validity of PPP in fifteen Latin American countries. Using a sequential panel selection method (Chortareas and Kapetanios, 2009) and the panel KSS unit root tests with a Fourier function (Ucar and Omay, 2009) which allows for structural breaks, the authors find strong support in favor of PPP in the majority of the Latin American countries under consideration. Similar results are obtained by He et al. (2014) -except for Honduras-, which is, in turn, consistent with Cheng et al. (2008) and Divino et al. (2009), in contrast with Bahmani-Oskooee et al. (2008, 2009) and Lu et al. (2010).

On the other hand, the analysis of the long-run PPP hypothesis from a fractional framework has not been widely addressed in the literature. Most of studies focus on a small sample of developed countries (Cheung, 1993; Cheung and Lai, 1993; Pan and Liu, 1999; Gil-Alana, 2000; Caporale and Gil-Alana, 2004), so it is more difficult to find evidence for LCDs and, in particular, for Latin American countries. Focusing on LDCs, we can point out, for instance, the studies of Masih and Masih (1995) for Taiwan; Chou and Shih (1997) for Asian newly industrialized countries; Soofi (1998) for a selected member of OPEC; Choudhry (1999) for Eastern Europe, or more recently, Caporale and Gil-Alana (2015) for South Africa. Specifically for Latin American countries, we find the work of Alves et al. (2001) that test PPP in Brazil for the historical period 1855-1996. Comparing both fractional and conventional cointegration approaches, their results only provide evidence for relative PPP in the long-run. Moreover, Holmes (2002) evaluates a sample of thirty LDCs in which it is found that eight countries show mean-reverting real exchange rates (of which three are Latin American countries -Guatemala, Suriname and Venezuela). Finally, in another paper on fractional integration, Caporale and Gil-Alana (2010) investigate PPP in seventeen Latin American countries during the monthly period 1970:01 - 2008:05. Using the least-squares I(d) procedure proposed by Gil-Alana (2008) which takes into account possible structural breaks in the series, they do not find support for PPP in the majority of the cases. Only Argentina shows evidence of mean reversion when a single structural break is included. In this paper, we attempt to follow this last work in order to analyze the real exchange rates of twelve Latin American economies from a fractional integrated approach.

7.3. Econometric Methodology.

In this section, we introduce the statistical model of fractional integration on which this article is based on. A general specification for this model is given by the following expression:

$$y_t = \alpha + \beta t + x_t; \qquad (1 - L)^d x_t = u_t, \quad t = 1, 2, \ldots, \tag{1}$$

where y_t is the observed time series, that is, the Latin American REERs, in logs; α and β are the coefficients corresponding to the intercept and a linear time trend, respectively; x_t is assumed to be a fractional *I(d)* process, being *d* the order of integration which can take any real value*; L* is the standard lag operator; and u_t is the regression residuals, which can be specified under different I(0) modeling assumptions. Regarding this point, we can use both parametric and semiparametric methodologies. When applying parametric methods, we consider first the case of: (i) a white noise process, (the corresponding results are reported in Table 1); then, we allow for weak autocorrelation, imposing (ii) a seasonal AR(1) model (in Table 2), and (iii) a more general non-parametric form, which is an approximation to ARMA models, using the Bloomfield (1973) exponential spectral model. Using semiparametric methods, we do not need to impose any specific form for the error term u_t in (1), though in this case we need to establish the bandwidth numbers to be used in the estimation (see Table 4).

More specifically, when estimating d with parametric methods, we use the Whittle function in the frequency domain (Dahlhaus, 1989), applying also a Lagrange Multiplier (LM) test developed by Robinson (1994) that is valid for any real value of *d*, including thus nonstationary regions (d ≥ 0.5). For the semiparametric method, we use a "local" Whittle method, also in the frequency domain (Robinson, 1995). This method requires d to be in the stationary region. Because of this, the estimation results are carried out based on the first differenced data, then adding 1 to the estimated values.

Taking into account that we allow for fractional differentiation, the series may not only be stationary, if $d = 0$ or non-stationary, if $d = 1$, according to a "narrow" definition of stationarity, but also, covariance stationary with long memory and mean reverting behavior, if *d* is any real value belonging to the interval (0, 0.5), or non-stationary but mean reverting, if *d* is a real value on the interval [0.5, 1). Thus, the fractional approach will allow us to expand the conventional analysis, uncovering the long memory and mean-reverting properties of each time series.

7.4. Data and empirical results.

The dataset used for this study are REERs of twelve Latin American economies (Belize, Bolivia, Brazil, Colombia, Costa Rica, Dominican Republic, Ecuador, Guyana, Mexico, Nicaragua, Paraguay, and Venezuela) over the period 1990Q1-2016Q1, quarterly. REER data is based on the Consumer Price Index (CPI) and are extracted from the International Financial Statistics (IFS) -International Monetary Fund (IMF)-. In its own dataset portal, REER is defined as '*the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs. An increase in REER implies that exports become more exp*ensive and imports *become cheaper; therefore, an increase indicates a loss in trade competitiveness*'.

The results of fractional integration using parametric techniques are reported across Tables 1-3. For all of them we consider the following cases: i) no deterministic terms, ii) an intercept, and iii) an intercept with a linear time trend.[1]

Table 1: Estimates of *d* and 95% bands for the case of white noise errors

	No Regressors	An intercept	A linear time trend
Belize	0.97 (0.86, 1.14)	**0.99 (0.78, 1.31)**	0.99 (0.77, 1.31)
Bolivia	1.02 (0.92, 1.17)	**1.25 (1.11, 1.45)**	1.25 (1.11, 1.45)
Brazil	0.90 (0.75, 1.13)	**1.03 (0.90, 1.24)**	1.03 (0.90, 1.24)
Colombia	0.90 (0.77, 1.08)	**1.13 (1.00, 1.29)**	1.13 (1.00, 1.29)
Costa Rica	0.97 (0.85, 1.14)	**1.07 (0.93, 1.30)**	1.07 (0.92, 1.31)
Dominican Rep.	0.96 (0.83, 1.14)	**1.46 (1.22, 1.73)**	1.46 (1.22, 1.74)
Ecuador	1.06 (0.94, 1.23)	**1.33 (1.14, 1.57)**	1.33 (1.14, 1.57)

[1] In other words, we impose $\alpha = \beta = 0$ in (1) in case i); α unknown and $\beta = 0$ in (1) in case ii), and both α, β unknown in case iii).

Guyana	0.79 (0.68, 0.95)	**1.03 (0.77, 1.32)**	1.03 (0.83, 1.30)
Mexico	0.94 (0.82, 1.10)	**0.98 (0.83, 1.16)**	0.98 (0.83, 1.16)
Nicaragua	0.89 (0.80, 1.01)	**0.79 (0.44, 0.96)**	0.82 (0.67, 0.96)
Paraguay	1.06 (0.93, 1.26)	**1.04 (0.87, 1.30)**	1.04 (0.88, 1.30)
Venezuela	1.78 (1.69, 1.90)	**1.83 (1.72, 1.97)**	1.83 (1.72, 1.97)

Note*:* In bold, the most appropriate models for the deterministic components

Table 1 refers to the case of white noise errors. Along with the estimates of d we also report the confidence intervals of the non-rejection values of d using Robinson's (1994) parametric approach. The model with an intercept seems to be the most adequate in all cases (marked in bold in the table), that is, there is no need for a time trend in any single case. Focusing on the estimation of *d*, we observe that Nicaragua is the only country showing evidence of mean reversion (*d* is statistically significantly smaller than 1, in the sense that the upper bound in the interval is smaller than 1); for Belize, Brazil, Costa Rica, Guyana, Mexico and Paraguay, the unit root null (*d = 1*) cannot be rejected, while for Bolivia, Colombia, Dominican Republic, Ecuador and Venezuela statistical evidence is found of *d* being significantly above 1.

Table 2: Estimates of d and 95% bands for the case of seasonal AR(1) errors

	No Regressors	An intercept	A linear time trend
Belize	0.95 (0.65, 1.14)	**0.99 (0.78, 1.29)**	0.99 (0.77, 1.29)
Bolivia	0.96 (0.77, 1.14)	**1.25 (1.11, 1.46)**	1.25 (1.11, 1.46)
Brazil	0.91 (0.76, 1.11)	**1.04 (0.89, 1.24)**	1.04 (0.89, 1.24)
Colombia	0.90 (0.73, 1.08)	**1.11 (0.97, 1.29)**	1.11 (0.97, 1.29)
Costa Rica	0.99 (0.85, 1.15)	**1.08 (0.95, 1.29)**	1.08 (0.95, 1.29)
Dominican Rep.	0.98 (0.83, 1.15)	**1.41 (1.22, 1.67)**	1.41 (1.22, 1.68)
Ecuador	1.05 (0.91, 1.22)	**1.33 (1.15, 1.57)**	1.33 (1.15, 1.58)
Guyana	0.77 (0.60, 0.94)	**1.03 (0.77, 1.32)**	1.03 (0.85, 1.30)
Mexico	0.93 (0.77, 1.10)	**0.98 (0.83, 1.16)**	0.98 (0.83, 1.17)

Nicaragua	0.87 (0.63, 1.03)	0.57 (0.44, 0.96)	**0.66 (0.41, 0.95)**
Paraguay	1.07 (0.91, 1.26)	**1.03 (0.87, 1.30)**	1.03 (0.87, 1.28)
Venezuela	1.74 (1.62, 1.87)	**1.80 (1.72, 1.97)**	1.80 (1.67, 1.96)

Note*:* In bold, the most appropriate models for the deterministic components

Table 2 presents the results for seasonal AR(1) errors.[2] A time trend is only required for Nicaragua, a country that also presents some evidence of mean reversion ($d < 1$). (Note that the interval excludes the unit root case, $d = 1$). For Belize and Mexico, though the estimates of d are smaller than 1, the unit root null hypothesis ($d = 1$) cannot be rejected. This hypothesis cannot be rejected for Brazil, Colombia, Costa Rica, Guyana and Paraguay either. For the remaining countries (Bolivia, Dominican Rep., Ecuador and Venezuela) the results are very similar to those reported in Table 1.

Table 3: Estimates of *d* and 95% for the case of autocorrelated (Bloomfield) errors

	No Regressors	An intercept	A linear time trend
Belize	0.91 (0.71, 1.16)	0.50 (0.37, 0.67)	**0.34 (0.12, 0.63)**
Bolivia	1.03 (0.85, 1.24)	1.00 (0.79, 1.26)	**1.00 (0.80, 1.25)**
Brazil	0.62 (0.42, 0.90)	**0.73 (0.48, 1.01)**	0.75 (0.53, 1.01)
Colombia	0.73 (0.51, 0.98)	**1.00 (0.73, 1.27)**	1.00 (0.74, 1.27)
Costa Rica	0.89 (0.70, 1.15)	0.78 (0.64, 0.96)	**0.75 (0.58, 0.95)**
Dominican Rep.	0.87 (0.63, 1.22)	0.67 (0.33, 1.41)	**0.68 (0.27, 1.43)**
Ecuador	0.97 (0.74, 1.25)	0.69 (0.31, 1.17)	**0.72 (0.37, 1.17)**
Guyana	0.78 (0.57, 1.06)	0.57 (0.38, 0.97)	**0.67 (0.45, 0.99)**
Mexico	0.87 (0.60, 1.17)	**0.72 (0.39, 1.19)**	0.72 (0.39, 1.20)
Nicaragua	**1.18 (0.94, 1.47)**	1.08 (0.77, 1.43)	1.08 (0.76, 1.42)
Paraguay	0.87 (0.69, 1.12)	0.77 (0.62, 1.00)	**0.76 (0.61, 0.99)**

[2] Though the data are seasonally adjusted, based on its quarterly nature we allow for the model: $u_t = \delta u_{t-1} + \varepsilon_t$, with white noise ε_t.

Venezuela	2.04 (1.72, 2.21)	**1.86 (1.47, 2.12)**	1.86 (1.39, 2.12)

Note*:* In bold, the most appropriate models for the deterministic components

In Table 3, the errors are assumed to follow the Bloomfield (1973) exponential spectral model. This approach is interesting in that it does not impose a specified model on u_t but approximate highly parameterized ARMA structures The empirical results show that the time trend is now required in many cases (Belize, Bolivia, Costa Rica, Dominican Rep., Ecuador, Guyana and Paraguay). For the remaining countries (Brazil, Colombia, Mexico and Venezuela), an intercept seems to be sufficient. Evidence is found of mean reversion and thus, transitory shocks ($d < 1$) in the cases of Belize, Costa Rica, Guyana and Paraguay. On the other hand, evidence of unit roots ($d = 1$) is obtained for Bolivia, Brazil, Colombia, Dominican Republic, Ecuador, Mexico and Nicaragua; finally, evidence of d > 1 is obtained only for Venezuela. Thus, we observe that the results are very sensitive to the specification of the error term, and mean reversion is found in the case of Nicaragua with white noise and seasonal AR errors, and for Belize, Costa Rica, Guyana and Paraguay with Bloomfield-type autocorrelated disturbances.

Due to the disparity of the results depending on the specification of the error term, u_t, we also conduct a semiparametric approach, in Table 4 for different bandwidth values. The choice of the bandwidth is still an unresolved issue in most of the semiparametric methods of fractional integration. We have presented values for m = 5, 6, 7, … 15. This table shows evidence of mean reversion in the cases of Belize, Dominican Rep., Ecuador, Guyana and Mexico.

Table 4: Estimates of *d* based on a semiparametric approach

m	5	6	7	8	9	10	11	12	13	14	15
Belize	0.840	0.683	**0.645**	**0.589**	**0.605**	**0.647**	**0.659**	**0.690**	**0.744**	**0.768**	**0.705**
Bolivia	1.283	1.500	1.427	1.119	1.192	1.284	1.311	1.080	1.142	1.163	1.176
Brazil	1.500	1.238	1.402	1.286	1.410	1.318	1.217	1.275	1.171	1.075	1.064
Colombia	1.469	1.500	1.500	1.272	1.304	1.132	1.207	1.135	1.180	1.194	1.198
Costa Rica	1.500	1.196	1.118	1.143	0.961	0.894	0.890	0.911	0.928	0.966	0.994
Dom. Rep.	**0.244**	**0.132**	**0.177**	**0.184**	**0.292**	**0.312**	**0.388**	**0.421**	**0.492**	**0.500**	**0.500**

Ecuador	**0.600**	**0.536**	**0.500**	**0.624**	**0.693**	0.762	0.802	0.841	0.927	0.978	1.059
Guyana	1.104	0.741	**0.680**	**0.641**	**0.667**	**0.721**	0.785	0.795	0.804	0.827	0.803
Mexico	**0.161**	**0.181**	**0.355**	**0.433**	**0.464**	**0.587**	**0.655**	**0.757**	0.835	0.868	0.920
Nicaragua	1.133	1.167	1.179	1.319	1.332	1.250	1.323	1.378	1.418	1.469	1.500
Paraguay	1.134	1.105	1.155	0.992	0.951	0.932	0.928	0.894	0.897	0.937	0.866
Venezuela	1.099	1.188	1.182	1.215	1.217	1.279	1.322	1.380	1.384	1.338	1.329
Lower 5%	0.632	0.664	0.689	0.709	0.725	0.739	0.752	0.762	0.771	0.780	0.787
Upper 5%	1.367	1.335	1.310	1.290	1.274	1.260	1,247	1.237	1.228	1,219	1.212

Note: In bold, evidence of mean reversion at the 5% level.

7.5. Summary and conclusions

The long memory and mean-reverting properties of twelve Latin American real exchange rate series have been examined in this paper using both parametric and semiparametric fractional integration techniques. From a parametric approach, and modelling the errors as a white noise or a seasonal AR(1) process, evidence of mean reversion is found only for the case of Nicaragua ($d < 1$). However, allowing for a more general non-parametric autocorrelated structure, using the exponential spectral approach of Bloomfield (1973), the results reveal: i) mean reversion in Belize, Costa Rica, Guyana and Paraguay; ii) unit roots ($d = 1$) in Bolivia, Brazil, Colombia, Dominican Republic., Ecuador, Mexico and Nicaragua; and iii) an order of integration higher than 1 ($d > 1$) for Venezuela. Due to the disparity of the results with the parametric methods, we also employ a semiparametric approach (Robinson, 1995), and signs of mean reversion were obtained in the cases of Belize and Guyana -which is consistent with results obtained by applying Bloomfield (1973) errors-, as well as, in the Dominican Republic, Ecuador and Mexico.

Thus, as an overall conclusion, we can say that only for Belize and Guyana did we obtain consistent evidence of mean reversion in the real exchange rates using all parametric, semiparametric and even non-parametric techniques, and, on the other extreme, lack of mean reversion, and thus, lack of PPP is confirmed for Bolivia, Brazil, Colombia and Venezuela. For the remaining six countries (Costa Rica, Dominican Republic, Ecuador, Mexico, Nicaragua and Paraguay), the results are ambiguous.

The application of policies geared towards exchange rate flexibility in Guyana may have mitigated the vulnerability of this country to the possible external shocks caused recently by the global financial crisis. Despite all this, its economy is still strongly dependent on oil imports and the prices of a few commodities on which its exports are based, as pointed out the recent IMF report.[3] In the case of Belize, the real effective exchange rate underwent a gradual depreciation process until 2007 that enabled it to approach its equilibrium level. Nevertheless, the application of an unsustainable policy mix during the crisis period has lead to a moderate overvaluation[4]**,** which suggests the need to promote policies which foster economic liberalization and competitiveness.

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Part V: Concluding remarks

Chapter 8. Conclusions and future research agenda

In Chapter 2, we have presented an empirical study of a selected set of determinants of self-employment using a panel data set of 21 different income level economies over the period 1995-2013. By applying both static and dynamic perspectives, our findings seem to point out towards a relative robustness in the effects of growth, openness and innovation on self-employment as well as the existence of differences between clusters obtained by applying multivariate analysis techniques. Indeed, we find that the variables FDI and LSCI have negative impact on LSELF for the G-7 (G-I) while for the less advanced economies (G-II), both variables have a positive sign being only LSCI significant at the 1% level for this last cluster. For LTRD, the results show an ambiguous behavior for the clusters G-III and G-IV. This results should help us to a better understanding about the nature of the relationship between economic development and self-employment.

Chapter 3 has analysed the Granger causality relationship between self-employment -as a proxy of entrepreneurship- and trade openness for a panel data of 20 OECD countries over 1960-2014. Depending on the direction of the causality, two hypotheses have been defined in our specification: i) the trade-led self-employment hypothesis –competitiveness hypothesis- and, ii) the self-employment-led trade hypothesis –growth/scale hypothesis-. A set of time-series and panel data tests were applied in order to detect Granger causality following the approaches by Toda and Yamamoto (1995) Kónya (2006) and Hatemi-J (2012). Empirical results show that the effect of Granger causality is heterogeneous and country-specific and thus, there is not a unique pattern able to describe these links across OCED economies. For the competitiveness hypothesis, we found evidence of Granger causality in 10 out of 20 OECD economies –Australia, Belgium, Canada, Denmark, France, Germany, Italy, Netherlands, Sweden and the United States–, which may be related with the dynamic effects that trade openness may have on entrepreneurship and new ventures in terms of specialization, knowledge transfer or scale effects. For the growth/scale hypothesis, we find evidence of Granger-causality in 15 out of 20 OECD countries —Austria, Australia, Belgium, Canada, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden and the United Kingdom–, considering the three approaches mentioned. This may indicate that the benefits derived from scale economies in a global market may be related with the capability of entrepreneurs to develop a export-oriented strategy with the aim of being more competitive and able to take advantage of new international business opportunities. In this sense, may occur a "feedback" effect between entrepreneurial activity and trade openness as we observed in France and Canada, where it is found bidirectional Granger causality. All these results seem to suggest the promotion of self-employment by the policymakers on the basis of an export-oriented strategy in order to contribute not only to improve trade openness but also the competitiveness and productivity of entrepreneurial networks.

Chapter 4 has studied the long-run relationship between the self-employment rate -as a proxy of entrepreneurship-, the GDP per capita -as a measure of labor productivity- and the index of economic freedom -as proxy of the degree of openness of an economy-, for a sample of 19 OECD and no-OECD countries over the period 1995-2013. Using the panel unit root test of Pesaran (2007) which allows for the cross-sectional dependence of the series, the results are consistent with obtained by applying a set of the first generation panel unit root tests based on the cross-sectional independence. Focusing on the cointegration analysis, the Pedroni's (1999, 2004) test finds evidences of cointegration for all samples. By contrast, the Kao's (1999) tests only suggest a long-run relationship between variables for G-III while Westerlund's (2007) shows weak signs for G-I and G-II. On the other hand, using FMOLS and DOLS estimators, we find a negative and significant relationship between Y and S, both for whole panel and each group mentioned (van Stel et al., 2005; Harbi et al., 2011) while estimations for the effects of F on S seems to be positive but not significant in the majority of cases. Finally, by applying the panel Granger causality approach suggested by XXX(2011) we find evidence of bidirectional Granger causality between S and Y in Poland and according to the results for the Fisher test statistic, causal links from F to Y in G-I and G-III. The findings in this paper suggest important policy implications. In general, countries stand to benefit from policies that support economic freedom; however, less competitive entrepreneurs will treat to lobby obstaculising economic growth and entrepreneurship.

In Chapter 5, we have addressed the concepts of stochastic convergence, time-series β-convergence and convergence club hypothesis in the relationship between exports and self-employment for a panel data sample of 19 OECD countries from 1970 to 2013. By applying different panel unit root tests, we find that whether the existence of multiple structural breaks are unattended, empirical findings point to divergence across countries; by contrast, there is evidence of stochastic convergence for the majority of OECD economies in the analysis of KPSS tests considering multiple structural breaks with trend. According to Carlino and Mills (1993) and Tomljanovich and Vogelsang (2002), we complete the notion of stochastic convergence by studying of time-series β- convergence. Our results provide signs of time-series β- convergence for eleven OECD economies (in their last-break regime) -Austria, Belgium, Canada, Germany, Greece, Japan, the Netherlands, Norway, Portugal, Spain and the United States- and evidences of divergence for the remaining countries. In further research, it would be interesting in deepening on the study of entrepreneurial characteristics and openness factors, as the degree of freedom of an economy, for better understanding of why some countries show long-run convergence in terms of exports by self-employed while others diverge, with the aim that policy makers and practitioners might devise policies that contribute to promotion of a competitive entrepreneurship, able to adapt to the requirement of a global market.

Chapter 6 has analyzed the evolution of the relative expenditure in R&D and their public and private components across 17 Spanish regions over the period 1987-2013. The empirical findings obtained by using Carrion et al., (2005) techniques show that only taking into account the possible structural changes, the results seem to point to a converge process across the regions studies, being both the investment effort carried out by the public sector and the private sector being equally significant.

In Chapter 7, the long memory and mean-reverting properties of twelve Latin American real exchange rate series have been examined using both parametric and semiparametric fractional integration techniques. From a parametric approach, and modelling the errors as a white noise or a seasonal AR(1) process, evidence of mean reversion is found only for the case of Nicaragua ($d < 1$). However, allowing for a more general non-parametric autocorrelated structure, using the exponential spectral approach of Bloomfield (1973), the results reveal: i) mean reversion in Belize, Costa Rica, Guyana and Paraguay; ii) unit roots (d = 1) in Bolivia, Brazil, Colombia, Dominican Republic., Ecuador, Mexico and Nicaragua; and iii) an order of integration higher than 1 (d> 1) for Venezuela. Due to the disparity of the results with the parametric methods, we also employ a semiparametric approach (Robinson, 1995), and signs of mean reversion were obtained in the cases of Belize and Guyana -which is consistent with results obtained by applying Bloomfield (1973) errors-, as well as, in the Dominican Republic, Ecuador and Mexico. Thus, as an overall conclusion, we can say that only for Belize and Guyana did we obtain consistent evidence of mean reversion in the real exchange rates using all parametric, semiparametric and even non-parametric techniques, and, on the other extreme, lack of mean reversion, and thus, lack of PPP is confirmed for Bolivia, Brazil, Colombia and Venezuela. For the remaining six countries (Costa Rica, Dominican Republic, Ecuador, Mexico, Nicaragua and Paraguay), the results are ambiguous. The application of policies geared towards exchange rate flexibility in Guyana may have mitigated the vulnerability of this country to the possible external shocks caused recently by the global financial crisis. Despite all this, its economy is still strongly dependent on oil imports and the prices of a few commodities on which its exports are based, as pointed out the recent IMF report.[3] In the case of Belize, the real effective exchange rate underwent a gradual depreciation process until 2007 that enabled it to approach its equilibrium level. Nevertheless, the application of an unsustainable policy mix during the crisis period has lead to a moderate overvaluation[4]**,** which suggests the need to promote policies which foster economic liberalization and competitiveness.

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[3] Guyana: Staff Statement Discussions for the 2016 Article IV Consultation. IMF. March 11, 2016.

[4]Belize: 2016 Article IV Consultation. IMF Country Report No. 16/334. October 2016.

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Summary

The interplay between entrepreneurship and globalization and economic freedom backs into at the heart of the debate about self-employment contributions to the economic development of modern economies. After experienced a process of exceptionally strong globalization, the world is witnessing to an upsurge of protectionism. This new trend is threating not only free trade agreements but also the levels of economic integration achieved in some economic areas like the European Union.

In this framework the less competitive firms and unemployed with low employability, are groups that will treat to lobby and to vote political options that incorporate the concerns of these groups (i.e. protectionist actions like less trade openness and restrictive migration policies. The consequences of this process are a hot policy issue at the time of writing after the great recession, since some industries and large sectors of the population considers globalisation as the ultimate cause of their problems, and advocate by any return to protection for national business and domestic employees against foreign firms and migrant workers. For them, the expected promotion of efficiency and productivity associated to globalisation is not guaranteed if the differences between institutions across countries alter the relative productivity and competitiveness.

Thus, one could argue that the entrepreneurship ecosystem i.e. the institutional framework for business is the main determinant of the capacity of contribution of entrepreneurship to economic growth, job creation and innovation. Therefore, the economic freedom in its different dimensions, such as the rule of law, the regulatory efficiency and in especial business freedom and labor market institutions, the degree of integration into the global economy –i.e. the openness to trade– and the weight of the public sector on the overall economy might be considered as key factors, for determining whether a society is an entrepreneurial one or not

The only way to resolve this type of controversies is providing solid economic propositions and empirical findings in order to evaluate the

globalisation impact on economic growth, innovation, job creation and entrepreneurship. In this context, the study of the relationship between economic integration and entrepreneurship is particularly interesting, since entrepreneurship is a determinant of economic growth and job creation.

In principle, the relationship between globalization, economic freedom and entrepreneurship is ambiguous, since one can argue that we can find plausible explanations for expecting both a positive and a negative relationship.

Starting with the relation between entrepreneurship and economic integration, we all agree in that economic integration opens new business opportunities and encourages the self-employed firm size, since sales to foreign markets expands the potential demand.

From this perspective, more trade openness is a positive factor not only for fostering entrepreneurship but also for enhancing the probability of survival and success. On the other hand, globalization increases the intensity of competition the opportunities of jobs and wages in the export sector leading a raise in the number self-employed workers due to the confluence of two phenomena: i) as global competition continuous to intensify some of them, the less competitive ones, could not withstand this competition, thus triggering the shutdown; ii) the greater the exposure to foreign competition, the smaller the fraction of self-employed people as the Díez and Ozdagli's (2011) model suggest. In addition we should also consider whether more openness influences on the relative distribution of entrepreneurship between productive and unproductive activities, i.e. between the so-called formal and informal self-employment.

However, the key question is to know whether the effect of a higher exposure to international trade, leads, in any case, an optimal reallocation of labour between paid-employment and self-employment and between less productive firms to more productive exporters, and even across countries with positive effects on economic growth, innovation and job creation.

Thus, the challenge is to provide empirical findings in order to shed light to the debate and attitudes towards globalization. To this end it is important to know the effects of more trade openness on the export intensity of self-employment is mutually beneficial, not only for higher-income countries but also for lower-income countries. In order to address these questions this dissertation also includes a second research question. In particular it presents an inquiry about the reasons of why the effects of globalization on national self-employed sectors should be analyzed not only in quantitative terms but also in qualitative ones. In particular we will treat to provide empirical findings for supporting the theoretical view of the effects of globalization on national entrepreneurial systems, provided by Acd and Sanders (2007). For them, globalization does not destroy self-employment but encourage the *entrepreneurial* model of production (Acs and Sanders, 2007. The shift away from large corporations and towards smaller entrepreneurial activity (Acs and Audretsch, 1993; van Stel, 2006) with the associated reduction in the average self-employed firm size, as well as the new business opportunities in the service sector for entrepreneurship thanks to the improvements in the Information and Communication Technologies (ICT) are the two potential factors behind this surprising performance of the self-employment rate. Audretsch and Sanders (2007) reinforce this idea suggesting that globalization and the development of the ICT sector are leading a new international division of work, the advanced economies endowed with high skilled workers are specialized in early stages of the product life cycle introducing innovations in products or process, while the less developed economies endowed with low skilled workers are specialized in the off-shored production stage.

In sum, this dissertation will treat to analyse the triangle entrepreneurship, globalization economic freedom, for providing a better understanding how and why the contribution of a national self-employed sector on economic growth, innovation and job creation can show different intensities.

Resumen en castellano

La relación entre el emprendimiento, la globalización y la libertad económica ha vuelto a situarse en el centro del debate acerca de la contribución de la globalización sobre el desarrollo económico de las economías modernas. Tras experimentar décadas de una excepcionalmente fuerte globalización, el mundo está asistiendo a un resurgimiento del proteccionismo. Esta tendencia no solo está afectando a los acuerdos de libre comercio sino también a la integración económica que se había alcanzado en algunas áreas como la de la Unión Europea.

En este contexto, las empresas menos competitivas y los desempleados con menor empleabilidad, son grupos que tratan de ejercer su poder de influencia sobre las instituciones y votar a opciones políticas que incorporen las preocupaciones de estos grupos (por ejemplo acciones proteccionistas o de endurecimiento de la política migratoria. La consecuencias de este proceso son una de las cuestiones calientes de la agenda de actuación política en el momento actual tras la Gran Recesión, dado que algunas industrias y grupos de población culpan a la globalización de ser la causa última de sus problemas y presionan para provocar una vuelta al proteccionismo y a la contención de los flujos migratorios, Para ellos, la expansión de la eficiencia y productividad que parecía prometerse como asociada a la globalización parece no estar garantizada si las diferencias entre las instituciones de as diferentes naciones alteran la productividad y competitividad relativa.

Así, podríamos argumentar que el ecosistema empresarial, esto es, el conjunto de instituciones para el desarrollo de los negocios es el principal determinante no solo de la contribución del entrepreneurship al crecimiento económico sino también a la creación de empleo e innovación. Por tanto la libertad económica en sus diferentes dimensiones (tales como el imperio de la ley, la eficiencia regulatoria, y en especial la libertad de empresa, las instituciones del Mercado de trabajo y el grado de integración de la economía (grado de apertura comercial) y el peso de l sector público, pueden ser considerados factores clave para determinar si una sociedad es “empresarial” o no.

La única forma de resolver este tipo de controversias es proporcionar sólidas proposiciones y hallazgos empíricos para evaluar los efectos de la globalización sobre el crecimiento económico, la innovación, la creación del empleo y el entrepreneurship. En este contexto, el estudio de la relación entre la integración económica y el entrepreneurship es especialmente interesante, dado que el entrepreneurship es un determinante principal del desarrollo económico.

En principio, la relación entre la globalización, la libertad económica y el entrepreneurship es ambigua, dado que podríamos encontrar explicaciones tanto para esperar relaciones bidireccionales y de diferente signo. Por un lado, y con respecto a la relación entre el entrepreneurship y la integración económica, podríamos suponer que la integración abre nuevas oportunidades de beneficio, propicia el aumento de las escalas gracias a la extensión de la demanda potencial que emerge gracias a la entrada en nuevos mercados.

Desde esta perspectiva, más apertura es un factor positive no solo para promocionar el entrepreneurship sino también para aumentar la probabilidad de supervivencia y éxito. Por otra parte la globalización, aumenta la intensidad de la competencia pero también las oportunidades de empleo asalariado en el sector exportador hacienda que aumenten las transiciones desde el autoempleo al empleo asalariado., al menos entre los empresarios marginales. Así a medida que la competencia global se intensifica, las empresas y empresarios más ineficientes cerrarán. Por otra parte a medida que aumenta la exposición a la competencia internacional, un menor número de ocupados eran autoempleados, tal y como el modelo de Díez and Ozdagli sugiere. Además, deberíamos considerar cómo todo este proceso afecta a la productividad del autoempleo es decir, a la distribución relativa del entrepreneurship entre autoempleo formal e informal.

Sin embargo, la cuestión clave pasa por conocer si el efecto de una mayor exposición al comercio internacional, genera una reasignación óptima del trabajo entre el empleo y el autoempleo y entre las empresas menos productivas y las más productivas que contribuya al crecimiento económico la innovación y el empleo.

Por tanto, el reto es proporcional evidencia empírica que arroje nueva luz acerca a este debate y a las actitudes hacia la globalización. Para lograr este objetivo, es importante no solo conocer los efectos de una mayor apertura sobre la intensidad exportadora del autoempleo sino también conocer si este proceso es mutuamente beneficioso tanto para los países más y menos desarrollaodos. . Para abordar estas cuestiones esta tesis aborda una segunda cuestión de investigación. Una indagación sobre las razón del porqué los efectos de la globalización sobre el sector empresarial se abordan solo de manera cuantitativa y no también de forma cualitativa. En concreto, trataremos de proporcionar nueva evidencia empírica sobre la base de la aportación teórica de Acs and Sanders (2007). Para ellos la globalización no solo no destruye autoempleo sino que promoeve el modelo de producción *entrepreneurial*, con una trabnsición desde grandes corporaciones a pequeñas configuraciones empresariales (Acs and Audretsch, 1993; van Stel, 2006) lo que se traduce en una reducción del tamaño medio gracias a las nuevas oportunidades en el sector servicio que ha aparecido gracias al desarrollo de las Tecnologías de la Información y Comunicación (ICT), dos factores que probablemente se encuentren detrás de la sorprendente evolución de las tasas de autoempleo en los países más desarrollados.. Audretsch and Sanders (2007) refuerzan esta idea al sugerir que la globalización y el desarrollo del sector ICT han supuesto una nueva división internacional del trabajo en la que las economías más avanzadas son ahora *entrepreneurial driven*, con más trabajadores de altos skills especializados en los procesos de innovación mientras que los países menos desarrollados y emergentes y con trabajadores menos cualificados se especializan en las etapas de la producción que han sido *off-shored*.

En definitiva, esta tesis tratará de analizar el triángulo entre entrepreneurship, globalización y libertad económica para ofrecer una mejor comprensión del cómo y el porqué de la contribución del sector empresarial nacional al crecimiento, la innovación y el empleo con diferente intensidad y características.

Conclusiones

En el capítulo 2 hemos presentado un estudio empírico de un conjunto seleccionado de determinantes del empleo por cuenta propia utilizando un conjunto de datos de panel de 21 economías de diferentes niveles de ingresos durante el período 1995-2013. Aplicando perspectivas tanto estáticas como dinámicas, nuestros hallazgos parecen apuntar hacia una relativa robustez en los efectos del crecimiento, la apertura y la innovación sobre las tasas de autoempleo, detectando diferencias entre los clusters obtenidos a través de técnicas de análisis multivariante. De hecho, se encuentra que las variables FDI y LSCI tienen un impacto negativo sobre LSELF para el G-7 (GI) mientras que para las economías menos avanzadas (G-II), ambas variables mantienen una relación directa, siendo sólo significativa la variable LSCI al nivel del 1% . Para este último grupo, se observa además un comportamiento ambiguo de la variable LTRD para los grupos G-III y G-IV. Estos resultados deberían ayudarnos a comprender mejor la naturaleza de la relación entre el desarrollo económico y el autoempleo.

En el capítulo 3 se ha analizado la relación de causalidad de Granger entre el autoempleo como un indicador de la iniciativa empresarial y la apertura comercial, para una muestra de datos de panel formada por 20 economías de la OCDE durante el periodo 1960-2014. Dependiendo de la dirección de la causalidad, se han definido dos hipótesis en nuestra especificación: i) la hipótesis de la autoevaluación basada en el comercio: hipótesis de la competitividad; y ii) la hipótesis comercial del autoempleo: hipótesis de crecimiento / escala. Para este fin, aplicamos un conjunto de pruebas de series de tiempo y de datos de panel para detectar la causalidad de Granger siguiendo los enfoques de Toda y Yamamoto (1995), Kónya (2006) y Hatemi-J (2012). Los resultados empíricos muestran que el efecto de la causalidad de Granger es heterogéneo y específico de cada país y, por lo tanto, no existe un patrón único capaz de describir estos vínculos a través de las economías de la OCED. Para la hipótesis de la competitividad, encontramos evidencia de la causalidad de Granger en 10 de las 20 economías de la OCDE analizadas -Australia, Bélgica, Canadá, Dinamarca, Francia, Alemania, Italia, Países Bajos, Suecia y Estados Unidos- que pueden estar relacionadas con los efectos dinámicos que la apertura comercial puede tener sobre el espíritu empresarial y los nuevos emprendimientos en términos de especialización, transferencia de conocimiento o efectos de escala. Para la segunda hipótesis, encontramos evidencia de la causalidad Granger en 15 de los 20 países de la OCDE - Austria, Australia, Bélgica, Canadá, Finlandia, Francia, Alemania, Italia, Japón, Noruega, Países Bajos, Portugal, Suecia Y el Reino Unido-, considerando los tres enfoques mencionados. Esto puede indicar que los beneficios derivados de las economías de escala en un mercado global pueden estar relacionados con la capacidad de los empresarios para desarrollar una estrategia orientada a la exportación con el objetivo de ser más competitivos y aprovechar las nuevas oportunidades de negocios internacionales. En este sentido, puede producirse un efecto de "retroalimentación" entre la actividad empresarial y la apertura comercial como lo observamos en Francia y Canadá, donde se encuentra la causalidad bidireccional de Granger. Todos estos resultados parecen sugerir la promoción del autoempleo por parte de los responsables políticos en base a una estrategia orientada a la exportación, a fin de contribuir no sólo a mejorar la apertura comercial sino también a la competitividad y productividad de las redes empresariales.

El capítulo 4 ha investigado la relación de largo plazo entre la tasa de autoempleo -como aproximación del espíritu emprendedor-, el PIB per cápita -como medida de la productividad laboral- y el índice de libertad económica- como indicador del grado de apertura de una economía-, para una muestra heterogénea formada por países miembros y no miembros de la OCDE durante el período 1995-2013. Utilizando la prueba de raíz unitaria de panel de Pesaran (2007) que permite la dependencia transversal de las series, se encuentran evidencias consistentes con los resultados obtenidos aplicando un conjunto de pruebas de raíz unitaria de panel de primera generación basadas en la independencia transversal. Centrándose en el análisis de cointegración, la prueba de Pedroni (1999, 2004) muestra evidencias de cointegración para todas las muestras. Por el contrario, las pruebas de Kao (1999) sólo sugieren una relación a largo plazo entre las variables para G-III mientras que Westerlund (2007) muestra signos débiles para G-I y G-II. Por otro lado, utilizando estimadores FMOLS y DOLS, encontramos una relación negativa y significativa entre Y y S, tanto para el panel completo como para cada grupo mencionado (van Stel et al., 2005; Harbi et al., 2011), mientras que las estimaciones de los efectos de F en S parecen ser positivos pero no significativos en la mayoría de los casos. Por último, aplicando el criterio de causalidad de Granger encontramos evidencia de la causalidad bidireccional de Granger entre S y Y en Polonia y de acuerdo con los resultados del estadístico de Fisher, las relaciones causales de F a Y en GI y G- III. Los hallazgos en este documento sugieren implicaciones políticas importantes. En general, los países se benefician de las políticas que apoyan la libertad económica. No obstante, los empresarios menos competitivos tratarán de ejercer presión sobre la obstaculización del crecimiento económico y el espíritu empresarial.

En el capítulo 5 hemos abordado los conceptos de convergencia estocástica, convergencia temporal y clubs de convergencia en la relación entre las exportaciones y el autoempleo para una muestra de datos de panel integrada por 19 países de la OCDE durante 1970 -2013. Aplicando diferentes pruebas de raíces unitarias para datos de panel, se observa que si no se tiene en cuenta las múltiples rupturas estructurales, los hallazgos empíricos apuntan hacia la divergencia entre los países. Por el contrario, los resultados muestran indicios de convergencia estocástica para la mayoría de las economías de la OCDE en el análisis de las pruebas de KPSS considerando múltiples rupturas estructurales con tendencia. Según Carlino y Mills (1993) y Tomljanovich y Vogelsang (2002), se completa la noción de convergencia estocástica mediante el estudio de la serie temporal β-convergencia. Nuestros resultados proporcionan signos de convergencia de la serie-β para once economías de la OCDE (en su régimen de última ruptura) -Austria, Bélgica, Canadá, Alemania, Grecia, Japón, Holanda, Noruega, Portugal, España y Estados Unidos- y evidencias de divergencia para los restantes países. En investigaciones posteriores sería interesante profundizar en el estudio de las características empresariales y los factores de apertura, como el grado de libertad de una economía, para comprender mejor por qué algunos países muestran convergencia a largo plazo en términos de exportaciones por autoempleados mientras que otras divergen, con el objetivo de que los formuladores de políticas y los profesionales puedan idear políticas que contribuyan a la promoción de un espíritu empresarial competitivo capaz de adaptarse a la exigencia de un mercado global.

El capítulo 6 ha analizado la evolución del gasto relativo en I+D+i y de sus componentes público y privado en las 17 regiones españolas durante el periodo 1987-2013, desde la perspectiva de la convergencia, haciendo uso del test de estacionariedad con cambio estructural para datos de panel propuesto por Carrión, del Barrio y López-Bazo (2005). El análisis empírico desarrollado ha tratado de dar respuesta, por un lado, a si el esfuerzo inversor en I+D+i tiende a converger y por otro, si el origen de las fuentes de financiación pública y privada siguen un comportamiento similar. En relación a la primera cuestión, nuestros resultados muestran cómo las estimaciones realizadas bajo el supuesto de *independencia entre las regiones* puede llevarnos a conclusiones erróneas acerca del proceso de convergencia real producido entre las CC.AA. Por el contrario, si consideramos los cambios estructurales producidos en la función de gasto en I+D relativo, los resultados parecen apuntar hacia la convergencia. Respecto a la segunda cuestión, resulta igualmente significativo en ese proceso tanto el esfuerzo inversor realizado por el sector público como el generado por el sector privado, sin que se aprecien diferencias entre ambos.

Finalmente, el capítulo 7 ha evaluado las propiedades de memoria larga y reversión a la media de doce series de tipos de cambio reales latinoamericanos utilizando técnicas de integración fraccional paramétricas y semiparamétricas. Desde un enfoque paramétrico y modelando los errores como un ruido blanco o un proceso estacional AR (1), la evidencia de reversión a la media se encuentra sólo para el caso de Nicaragua (d <1). Sin embargo, teniendo en cuenta una estructura autocorrelacionada no paramétrica más general, utilizando el enfoque espectral exponencial de Bloomfiel (1973), los resultados revelan: i) la reversión media en Belice, Costa Rica, Guyana y Paraguay; ii) raíces unitarias (d = 1) en Bolivia, Brasil, Colombia, República Dominicana, Ecuador, México y Nicaragua; y iii) un orden de integración superior a 1 (d> 1) para Venezuela. Debido a la disparidad de los resultados con los métodos paramétricos, también se empleó un enfoque semiparamétrico (Robinson, 1995) y se obtuvieron signos de reversión a la media en los casos de Belice y Guyana -que es consistente con los resultados obtenidos aplicando Bloomfiel (1973)), así como, en la República Dominicana, Ecuador y México. Por lo tanto, como conclusión general, podemos decir que sólo para Belice y Guyana obtuvimos evidencia consistente de reversión a la media en los tipos de cambio reales usando todas las técnicas paramétricas, semiparamétricas e incluso no paramétricas y, por el otro extremo, falta de reversión a la media, y por lo tanto, la falta de confirmación de la teoría PPP para Bolivia, Brasil, Colombia y Venezuela. Para los seis países restantes (Costa Rica, República Dominicana, Ecuador, México, Nicaragua y Paraguay), los resultados son ambiguos. La aplicación de políticas orientadas a la flexibilidad del tipo de cambio en Guyana puede haber mitigado la vulnerabilidad de este país a las posibles perturbaciones externas causadas recientemente por la crisis financiera mundial. A pesar de todo, su economía sigue dependiendo en gran medida de las importaciones de petróleo y de los precios de algunos productos básicos en los que se basan sus exportaciones, como se señaló en el reciente informe del FMI. En el caso de Belice, hasta el 2007 que le permitió acercarse a su nivel de equilibrio. Sin embargo, la aplicación de una combinación de políticas insostenibles durante el período de crisis ha llevado a una moderada sobrevaluación, lo que sugiere la necesidad de promover políticas que fomenten la liberalización económica y la competitividad.