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ABSTRACT

Long-Term Effects of Shocks on New Opportunity and Necessity Entrepreneurship*

The dynamics of startup activity are crucial for job creation, innovation, and a competitive economy. Does regional firm formation exhibit hysteresis, such that shocks, including those induced by temporary policy interventions, have permanent effects? Due to the pronounced heterogeneity among new entrepreneurs, it is important to distinguish between those pulled by opportunity and those pushed by necessity. This distinction allows evaluating the long-term effects of policies aimed at stimulating opportunity entrepreneurship versus active labor-market policies supporting self-employment as a way out of unemployment. Based on 84 waves of quarterly microdata from the Spanish Labor Force Survey, we create time series of new opportunity and new necessity entrepreneurship for the 17 Spanish regions. To test whether exogenous shocks have long-run effects on firm formation, we apply a battery of panel data and time series unit root tests accounting for deterministic breaks. We also present results for the different Spanish regions and industrial sectors. We find that hysteresis is more widespread in new opportunity than in new necessity entrepreneurship, implying that shocks and temporary policies are more likely to shift opportunity than necessity entrepreneurship in the long run. Moreover, we document that the global Financial Crisis of 2008 changed the technology of firm formation out of opportunity, but not out of necessity. Our analysis opens the door to further research on the long-term effectiveness of a regional and sectoral policy mix of entrepreneurship promotion and active labor market policies.

JEL Classification: C32, E23, J24, L26, M13

Keywords: self-employment, opportunity entrepreneurship, necessity entrepreneurship, firm formation, hysteresis, stationarity, regions

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1 Introduction

In recent decades, a significant number of advanced economies have undergone profound changes in the composition of their workforce, breaking the downward trend of self-employment participation in the labor force. In some cases, self-employment has even reached record levels in historical perspective (Eurofund, 2017; Yssaad and Ferrao, 2019; Giupponi and Xu, 2020; Boeri et al., 2020; Henley, 2021; OECD, 2021; Bay and Koster, 2022).

Part of the literature suggests that much of the resurgence in self-employment has been driven by push factors and the development of new forms of underemployment (Boeri et al., 2020; Henley, 2023). However, self-employment has also increasingly attracted skilled workers for whom the relative valuation of wage employment and self-employment may have shifted towards the latter (Falco and Haywood, 2016). In other words, the resurgence has not only been linked to joblessness, governments' use of self-employment promotion as part of active labor market policies to combat unemployment, slow economic growth, and low quality of new jobs created—linked to the gig sector and the development of various forms of underemployment, including dependent self-employment—but also to a shifts in the occupational decisions of a large number of skilled professionals who have decided to become entrepreneurs due to a change in the relative reward from the two occupations (Henley, 2021).

This development has been strongly influenced by the weaker protection of wage employment in various countries, along with the growing demand for professional services through digital platforms that reduce the inherent uncertainty of self-employment. Examples of this phenomenon are the increase in transitions to self-employment from wage employment, either directly or through an intermediate transition to hybrid self-employment, and the growing effectiveness of entrepreneurship promotion policies. In conclusion, contrary to the view that self-employment is a sector made up of individuals who have turned to it as a last resort (Rissman, 2006; Baumgartner and Caliendo, 2008) and that push factors alone have been behind the change in employment composition, we cannot rule out that a growing proportion of individuals who have decided to become entrepreneurs despite being wage earners or having job offers have been drawn to it by entrepreneurship promotion policies, reduced entry costs, and other pull factors (Caliendo and Kritikos, 2019). The relative participation of these two types of self-employed individuals, the allocation towards necessity or opportunity-driven entrepreneurship, defined based on their entry motivation, is considered a key factor to understand the impact of entrepreneurship on growth, innovation, and job creation (Åstebro et al., 2011).

The identification of factors that enhance or inhibit each type of entrepreneurship has been a recurring theme in much of the empirical literature (Audretsch et al., 2024). In particular, in the evaluation of entrepreneurship policies, it is important to distinguish between policies designed with the goal of stimulating entrepreneurship and those with the goal of turning unemployment into self-employment

(Millán et al., 2014). These policies are motivated by different objectives, such as contributions to innovation and economic growth or as an alternative to other active labor market policies such as training programs. Thus, governments have devised and implemented portfolios of policies to promote entrepreneurship (or, appropriately, to create incentives to the creation of opportunity entrepreneurs) or to turn unemployment into self-employment (or, appropriately, to support entry into self-employment motivated by a state of necessity). These interventions impose sizeable costs on the taxpayer. For this reason, these policies should be properly monitored and evaluated both in the short and the long term. The distinction between opportunity and necessity entrepreneurship is crucial for such evaluation efforts. For example, in the latter case, the effectiveness of the policy in the medium to long term would not only be marked by survival of the business but also by whether this period of self-employment serves as a stepping-stone for a successful transition to wage employment(Bruce and Schuetze, 2004; Hyytinen and Rouvinen, 2008). Recent studies have evaluated entrepreneurship support policies using administrative data and analyzing various outcomes such as duration of self-employment, transitions into regular employment, income or job satisfaction (Caliendo et al., 2020). In general, this literature appears to point to positive outcomes of startup programs for the unemployed and suggests higher probabilities of business survival among opportunity entrepreneurs (Caliendo and Kritikos, 2019).

For public policy evaluation, specifically concerning the design of incentive schemes to promote entrepreneurship, it is important to consider not only short-term effects but also long-term effects (Congregado et al., 2012). Short-term effects have been extensively studied in the literature, either through survival analysis in self-employment or through causal analysis, where the effects of a policy are analyzed by distinguishing between a treatment group and a control group. However, these types of studies do not capture the long-term effects because the nature of these studies is based on short-term analysis, often comparing the period shortly before to the period shortly after a policy intervention. This approach prevents the observation of medium- or long-term effects. The works of Caliendo et al. (2020) and Caliendo and Tübbicke (2020), which evaluate effects of startup subsidies for up to five years, are exceptions to this rule.

Thus, very little is known from the literature about what will happen once an entrepreneurship policy is ended. This is very relevant because many policy interventions are temporary, such as the Paycheck Protection Program, the largest support program for small businesses in the United States during the Covid-19 pandemic (Fairlie and Fossen, 2022) or the popular German lump-sum startup subsidies for the unemployed (Caliendo et al., 2012). Does entrepreneurial business creation return to its previous trend or is it altered in the long run due to such temporary interventions? The long-term effectiveness of entrepreneurship policies depends on the answer to this question. The scope of the research question is not limited to policy interventions. It is equally important to understand if shocks to entry into opportunity or necessity entrepreneurship due to other disruptions—e.g., a pandemic, a natural or human-made disaster, or a credit supply shock—have persistent effects once the underlying cause of the shock has disappeared. Understanding the long-run effects is crucial for example to design appropriate recovery policies. The potential phenomenon that shocks have permanent effects on entrepreneurial activity is called hysteresis in entrepreneurship (Congregado et al., 2012). However, prior literature on the hysteresis phenomenon in entrepreneurship does not make the important distinction between opportunity and necessity entrepreneurship. To distinguish between the long-term effects of entrepreneurship policies aimed at opportunity entrepreneurs versus those aimed at necessity entrepreneurs, we must explicitly identify these two groups of entrepreneurs and analyze the hysteresis phenomenon in each group.

Macro-level analysis allows us to overcome the limitation of microdata-based studies by studying long-term effects. The hysteresis phenomenon can be investigated by exploring the macro dynamics of self-employment, in particular whether entrepreneurship evolves as a trend stationary or as a non-stationary time-series process. If entrepreneurship is trend stationary, economic and policy shocks can be regarded as transitory from an aggregate perspective: entrepreneurial activity eventually reverts to its underlying, long-run trend. If, on the other hand, the rate of entrepreneurship is non-stationary, shocks will have permanent effects. By analyzing the underlying statistical properties of the two types of entrepreneurship, involving entrepreneurs who are pushed by necessity or pulled by opportunity, we contribute to understanding how policies and economic shocks propagate over time.

In addition to the literature on policy effects on entrepreneurship, our study also speaks to a body of literature devoted to the analysis of the macro dynamics of self-employment over the business cycle (e.g., Thurik et al., 2008; Faria et al., 2010; Koellinger and Thurik, 2012) and the link between unemployment and self-employment (e.g., Blanchflower, 2000; Berglann et al., 2011). The lack of robust evidence on these relationships remains as a main source of controversy among scholars, summarized in the recession-push and the prosperity-pull hypotheses (Congregado et al., 2012) as well as in the distinction between opportunity and necessity entrepreneurship as two different components of business creation with potentially opposite dynamics over the business cycle (Amit and Muller, 1995; Dawson and Henley, 2012). Most empirical studies on the relationship between self-employment and unemployment only aspire to capture a net effect of the recession-push and the prosperity-pull effects (Congregado et al., 2012). This paper empirically revisits the dynamics of entrepreneurship at the macro level by exploring a new source of heterogeneity: the distinction between two categories of entrepreneurs based on the intentions revealed at entry, that is, between opportunity-based entrepreneurs and necessity-based entrepreneurs (Raynolds et al., 2001; Hessels et al., 2008). Recent literature has provided operational definitions of opportunity and necessity entrepreneurship suitable for available nationally representative data (Fairlie and Fossen, 2020) and has started analyzing the dynamics of opportunity and necessity entrepreneurship over the business cycle (Fossen, 2021; Neymotin, 2021).

With this in mind, and to the best of our knowledge, this paper represents the first attempt to evaluate the long-run effects of shocks to new opportunity and new necessity entrepreneurship at the macro-level. Conceptualizing entrepreneurship as new firm formation, we create a novel database of quarterly time series of new opportunity and new necessity entrepreneurship for the 17 Spanish autonomous regions and by industrial sectors over the period from 2000 to 2020 based on about 12 million individual observations from the Spanish Labor Force Survey. Spain is a suitable case of study since self-employment promotion as an active labor market policy has been intensively applied as a way to combat the high unemployment rate. We apply panel data unit root tests with both homogeneous and heterogeneous alternative hypotheses that are robust to both classical spherical disturbances and potential spatial spillovers, as well as time series unit root tests at the national, regional and sectoral levels allowing for the endogenous detection of up to two deterministic breaks in the data. This enables us to accommodate major disruptions during our observation period such as the Financial Crisis, which peaked with the bankruptcy of Lehman Brothers in September 2008.

Our results indicate that hysteresis is more widespread for firm formation out of opportunity than for firm formation out of necessity. This suggests that shocks to firm formation out of opportunity, including those due to temporary policy interventions, are more likely to have long-run effects than shocks on firm formation out of necessity. Moreover, a deterministic structural break in new opportunity entrepreneurship is consistently found in the neighborhood of the 2008 Financial Crisis, but less so for new necessity entrepreneurship. This suggests that the Financial Crisis permanently altered the technology of regional business creation out of opportunity, but not out of necessity. We also document significant heterogeneity in the dynamics across regions and industrial sectors.

The rest of the paper is structured as follows. Section 2 is devoted to the data and discusses alternative strategies for capturing different types of entrepreneurship using Labor Force Surveys. Section 3 explains the econometric approach, whereas Section 4 presents the results. Finally, Section 5 concludes the analysis and discusses implications and avenues for further research.

2 Data

Entrepreneurship is a multifaceted concept, so any single aggregate measure of it is bound to miss some facet of the concept. At the macro-level by far the most common measure is self-employment—see, e.g., Iversen et al. (2007), Congregado (2008) and Ahmad and Hoffmann (2008) for detailed discussions—, since data taken from Labor Force Surveys allow us to analyze comparable long time series of aggregate self-employment. The self-employed include non-employers as well as employers, and there may or may not be additional partners in a partnership business. Our choice of entry into self-employment to measure entrepreneurship does not diminish the scope of empirical findings based on alternative measures focused on firms—see Gartner and Shane (1995) for a discussion—or indicators of nascent entrepreneurs or business ownership such as those provided by the Global Entrepreneurship Monitor and the EIM Compendia database, respectively, as discussed by Marcotte (2013). However, the low frequency and number of available observations for these two indicators' series discourage their use in macroeconometric analysis, whether based on time series or panel data. Using labor force surveys has the advantages of high frequencies and large observation numbers, and in addition, we observe stocks and flows of different types of self-employed individuals and can compare their macro dynamics. The importance of taking into account heterogeneity among the self-employed has been emphasized by the works of Congregado et al. (2012), Fairlie and Fossen (2020), or Neymotin (2021), among others.

Our measurement of entrepreneurship refers to the concept of business creation. Therefore, we measure entry flows into self-employment coming from heterogeneous prior employment states. These flow measures contrast with static measures such as business ownership.

In line with the objectives of the paper, we create a new database of firm formation distinguishing by the motivation that gave rise to entry into self-employment, for Spain and its regions. We use microdata from 84 consecutive quarterly waves of the Spanish Labor Force Survey obtained from the Encuesta de Población Activa with permission from the Instituto Nacional de Estadística. We focus on the period from 2000/Q1 to 2020/Q4 including a total of about twelve millions individual observations.

Following the operationalization suggested by Fairlie and Fossen (2020), we identify newly self-employed individuals motivated by opportunity or necessity (see also Block and Wagner, 2010; Fossen and Büttner, 2013). We define a necessity entrepreneur in quarter t as an individual who switches to self-employment between quarters t and $t+1$, conditional on being observed in quarter t in a non-employment state, i.e., either by being classified as unemployed (actively seeking employment) or as inactive in the labor market. In contrast, we classify an individual as an opportunity entrepreneur in quarter t if he/she experienced a transition to self-employment between quarter t and $t+1$, conditional on being observed in quarter t as a wage and salary employee. The idea is that those who quit their paid jobs to become an entrepreneur have the alternative option of keeping their current job, so they are likely to be pulled into entrepreneurship because they see an opportunity (opportunity entrepreneurs). In contrast, the non-employed do not currently have the alternative of paid employment; in particular, the registered unemployed are actively looking for employment by definition. Therefore, they are likely to be pushed into self-employment due to a lack of alternatives to make a living (necessity entrepreneurs).

Thus, in each wave and region, we count the number of newly self-employed individuals (who were not self-employed in the previous quarter) and classify them as new necessity entrepreneurs if they were non-employed in the previous quarter and as new opportunity entrepreneurs if they were paid employees in the previous quarter. In our main analysis, we do not normalize the numbers of new opportunity and new necessity entrepreneurs to avoid introducing additional variables that might influence the properties of the time series. In alternative estimations, we normalize the number of new opportunity entrepreneurs in a region in quarter t by the number of paid employees in quarter $t-1$ and the number of necessity entrepreneurs in t by the number of non-employed individuals in $t-1$. These normalized measures can be interpreted as entry rates. We find that the results are qualitatively robust to normalization of the series (see Appendix B).

Applying cross-regional sample weights, we create longitudinal aggregates of both types of new self-employed workers for the national and the regional levels. As a result, we obtain a panel consisting of aggregate quarterly time series of new opportunity and new necessity entrepreneurs for the 17 Spanish regions covering 84 quarters during the first two decades of this century.

The upper panels of Figures 1 and 2 show the national time series for opportunity and necessity entrepreneurs, respectively; the lower panels present first differences. In both series, a break in the data in 2004 is apparent visually; due to the size of the break, this is likely due to data collection by the statistical agency (the agency did not reply to our inquiry). In the following, we account for this apparent break in two alternative ways. First, we start the analysis in 2005, after this break (the upper panels of Figures 3 and 4 show the first-differenced shorter series). Second, based on the full data starting in 2000, we use unit root tests allowing for the endogenous detection of two deterministic breaks. We expect these tests to detect the apparent systematic break in 2004 (this serves as a plausibility check), and we allow a potential additional idiosyncratic break at another time in the series. Apart from the 2004 break, no relevant upward or downward time trends are visible in the level or first-differenced series.

3 Methodology

The aim of the analysis is to test for hysteresis in new opportunity and necessity entrepreneurship. Hysteresis means that shocks to firm formation, including those induced by temporary policy interventions, have permanent effects on firm formation. The results will thus inform about the long-run effects of policy and other shocks on regional firm formation activity. In contrast to prior literature, we distinguish between firm formations out of opportunity and necessity, as the hysteresis phenomenon might be different. We run the analysis at the national, regional and sectoral levels in Spain using the quarterly data we created spanning 2000 to 2020.

In statistical terms, investigating hysteresis means testing for unit roots (stochastic trends or non-stationarity) in time series or aggregate panel data. We start with panel data unit root tests to investigate whether there is a unit root in at least one of the 17 Spanish autonomous regions, in none of them, or in all the regions. The panel data unit root tests, however, do not account for known or unknown structural deterministic breaks in the data.[1] Therefore, in the next step, we use the aggregate national level time series for Spain, and then the time series in each region separately, to test for unit roots in the time series data allowing for up to two deterministic breaks.

3.1 Panel Data Unit Root Analysis

We start with the panel data unit root tests using all 17 regions and the full quarterly data from 2000-2020. We employ panel-based versions of augmented Dickey and Fuller (1979) tests (henceforth, ADF). The base model tests are written as:

$$\Delta oppo_{i,t} = c_1 + \rho \, oppo_{i,t-1} + e_{i,t} \tag{1}$$

$$\Delta nec_{i,t} = c_2 + \rho \, nec_{i,t-1} + e_{i,t} \tag{2}$$

where *oppo* denotes our new opportunity entrepreneurship variable, and *nec* our new necessity entrepreneurship variable. If a test rejects the null hypothesis that $\rho = 0$, we conclude that no unit root is present.

Following the algorithmic procedure suggested by Dickey and Pantula (2002), the tests are run in second differences ("transformed first differences") as a first step to test for integration of order 2, $I(2)$.[2] Upon failure to reject the null hypothesis of $I(2)$, we conclude there is a unit root in the original level series, and the test procedure stops. If we reject $I(2)$, the procedure continues with levels for a final test of $I(1)$. Appendix A.1 provides a formal treatment.

Robustness of the panel unit root analysis is assessed through a sequence of ADF-based tests that gradually relax the limiting hypothesis of homogeneous autoregressive behavior of the benchmark AR(1) process, allowing for heterogeneous hypothesis testing. We run three distinct tests: the Levin et al. (2002) test (henceforth LLC); the Im et al. (2003) test (henceforth IPS), and, finally, the Hadri (2000) test. Employing an ADF-based test equation, the first test is augmented with a set of lagged dif-

[1] Although the panel data methodology proposed by Karavias and Tzvalis (2014) entails both unit root analysis and endogenous break retrieval, it has some drawbacks for our application. We use and discuss this approach in Appendix C.

[2] The order of integration is the minimum number of differences required to obtain a stationary series; stationary series (without a unit root) are integrated of order 0.

ferences to account for possible panel autocorrelation. To allow for possible cross-sectional dependence across regions' residuals, we additionally augment each ADF-based panel with its time mean, capturing time-variant heterogeneity across the data. This is equivalent to taking cross-sectional averages in each cross section to account for potential spatial spill-overs across regions.

In the LLC and IPS tests, the null hypothesis is an integrated process, and a rejection of the null leads us to accept the alternative hypothesis of stationarity (homogeneous or heterogeneous, respectively). However, failure to reject the null hypothesis could in principle also be due to a lack of statistical power. To assess robustness, it is therefore logical to reverse the null and alternative hypotheses. The test offering us this possibility, while accounting for possible cross-sectional dependence, is the Hadri (2000) test. Appendix A.2 provides formal details on the LLC, IPS and Hadri tests we employ.

3.2 Time Series Unit Root Analysis

If there are deterministic (and thus, exogenous) changes in a times series, any ADF or ADF-like tests have reduced power to reject the null hypothesis of a unit root (Perron, 1989); in other words, there is a higher likelihood of failing to reject a false unit root null hypothesis. Therefore, we proceed to time series based unit root tests that account for the possibility of deterministic breaks and thereby address this potential issue. We first analyze the aggregate time series at the national level of Spain and then tackle potential heterogeneity by analyzing the time series of each of the 17 autonomous regions and for different industrial sectors separately.

As mentioned before, visual inspection of the time series revealed an evident systematic and deterministic break in 2004 (Figures 1 and 2). We deal with this in two alternative ways: first, by starting the analysis in 2005, avoiding this break altogether, and second, by allowing for the endogenous detection of this break based on the full time series.

In the first approach, based on the data from 2005-2020, we begin the national time series analysis with the ADF test and the Kwiatkowski et al. (1992) test (henceforth KPSS). The latter test flips the null and alternative hypotheses of the ADF test and corresponds to the Hadri (2000) test for panel data discussed above. These tests do not account for deterministic breaks and are presented for comparison only for the national series, but not for the regional and sectoral analyses.

As the quarterly time series spanning 2005-2020 is still long, it seems more realistic to assume that there may be an additional deterministic break. Therefore, we run the Perron and Vogelsang (1992a,b) test (henceforth PV), which can detect one deterministic break from 2005 to 2020. The test appears adequate to our set-up as it considers a break in both the null of unit root and the alternative hypothesis of stationarity.[3] An alternative test could be the recursive endogenous break-detecting methodology for testing the presence of a unit root by Zivot and Andrews (1992). However, its exclusion of a break in the null hypothesis represents a limiting factor that the PV test overcomes.

In the second approach, we extend the sample to the entire 2000-2020 period to make full use of the information available. To account for the apparent 2004 break, we resort to an alternative test that can detect two potential deterministic breaks in levels, the Clemente et al. (1998) test (henceforth CMR). The CMR test should be able to detect the systematic 2004 break and a potential additional non-systematic but nevertheless deterministic break in our time series.[4]

The ability of the CMR test to detect the apparent systematic 2004 break endogenously serves as a plausibility check. We shall consider the series integrated of order 1 or higher only if such property has not been rejected by a given test, and the 2004 break is detected as statistically different from 0 and estimated endogenously with good precision. Given the nature of the CMR test, results from this test will be considered conclusive evidence of the order of integration of the series.

The number of lags in our time series models is decided parametrically by a general to specific methodology based on a maximum number of lags selected by the decision rule popularized by Schwert (1987, 1989). This parametric solution allows us to distance ourselves from possible ambiguities in decisions based on information criteria.

4 Results

4.1 Panel Data Results

The results of the tests based on the complete panel data of Spain's 17 regions appear in Table 1 for both new opportunity entrepreneurs (*oppo*) and new necessity entrepreneurs (*nec*). The table shows the LLC, IPS and Hadri tests. Following the Dickey and Pantula (2002) approach, first differences are tested first. If the null hypothesis, which implies a unit root, is not rejected, the test procedure stops. If the null hypothesis based on first differences is rejected, the procedure continues to testing levels.

We begin with the homogeneous hypothesis test, the LLC. Specified with an intercept, demeaned and lagged as suggested by the Bayesian information criteria, this first generation panel unit root test would lead us to conclude that variance stationarity is a common property shared by all autonomous regions in Spain. However, a limitation of first generation homogenous tests is that the alternative

[3]We use the additive outlier model test equation (Perron, 1989; Perron and Vogelsang, 1992a; Perron, 1997), which is suitable for sudden changes in the mean. An alternative model test equation, the innovative outlier model, would instead be more suitable for gradual changes, as the test equation embodies a contemporaneous deterministic change in both an intercept and a trend.

[4]The works of Lee and Strazicich (2003) and Narayan and Popp (2010) on a Lagrangian Multiplier test for unit root detection and an alternative criterion for break detection, respectively, represent alternative ways to test for unit roots while allowing the possibility of a sudden change in the exogenous part of the model. However, they do not offer additional advantages that would be relevant for our analysis.

hypothesis of homogenous stationarity in the test based on levels may not be realistic: Stationarity might only be a dominating statistical property across the whole panel, but not be a property shared by every autonomous region.

In order to clarify this, we employ two additional tests, the IPS and the Hadri tests, commonly known as second generation (heterogeneous in alternative) tests. The IPS test has been specified with a cross sectional average augmented, non-trending test equation with spherical disturbances controlled by a lag order decided by the Bayesian information criterion. Results of the IPS show a rejection of any integrated process in both the first and second step regression, leading us to accept the fact that some of the regional series might indeed be stationary.

Finally, to act as a natural robustness check for the last test, a Hadri-type test was specified with a constant only in its deterministic components, as the visual analysis of the first differenced series did not bring up any relevant upward or downward time trend. The number of necessary lags, as for the other tests, was decided though the Bayesian information criterion. As the test compares a homogeneous $I(d)$ against a heterogeneous $I(d+1)$ alternative, the results show that the test clearly does not reject the $I(1 \text{ or } 0)$ hypothesis in the first step regressions and then rejects the null of homogeneous stationarity. This gives us final evidence that at least one of the regional series follows an integrated process of order one.

The results from the second generation tests are consistent, as they both point to heterogeneity across the regions: at least one series is stationary and at least one has a unit root. This is true for both new opportunity and new necessity entrepreneurs. These results call for testing region by region separately to understand the heterogeneity detected in the panel unit root tests. Before we do this, we first analyze the time series at the national level of Spain to check for potential deterministic breaks.

4.2 National Level Tests

The panel data unit root tests reported above do not account for deterministic breaks in the data. Therefore, we next analyze the national time series for Spain.

Given the presence of at least one integrated process in one or more of the regions that form part of the national aggregate, as detected above, we expect both the necessity and opportunity groups in the national aggregate series to exhibit an order of integration equal to one or higher. Although theoretically a unit root in one series could cancel out by linearly combining the series with another series, in a linear combination of multiple $I(0)$ with multiple $I(1)$ series this is rarely the case, as the derived series is usually integrated of the higher order. Thus, if we confirm the presence of a unit root in the national time series accounting for deterministic breaks, this would increase confidence in the result from above that at least one region exhibits a unit root.

Table 2 shows the linear ADF test and its reversed linear hypothesis alternative, the KPSS test, as well as the PV and CMR tests allowing for one and two determinstic breaks, respectively. All tests are expressed in levels. The first three tests are estimated dropping data points before the 2004 break apparent from visual inspection, while the nonlinear CMR considers all the available information ranging from 2000 to 2020 and allows for the identification of the additional break in 2004.

Our results overall confirm the presence of a unit root in the national series for both new opportunity entrepreneurs (upper panel) and new necessity entrepreneurs (lower panel): The null hypothesis of the ADF of an $I(1)$ process is not rejected, and consistently, the KPSS rejects the $I(0)$ null. For opportunity entrepreneurs, the PV (using data from 2005-2020) detects a deterministic break in the first quarter of 2008, during the Financial Crisis, while it detects a break in 2015q3 for necessity entrepreneurs (see the dashed vertical lines in Figures 3 and 4; the lower panels of these figures also show the breakpoint t-statistics). When we extend the period of analysis, the CMR detects the same breaks and additionally the 2004q1 break as expected from the visual inspection (Figures 1 and 2). All the breaks are identified with good statistical precision. The CMR does not reject an $I(1)$ process for both new opportunity and necessity entrepreneurs, whereas the PV rejects it for new necessity, but not for new opportunity entrepreneurs. Thus, the PV test for new necessity entrepreneurs is the only test not pointing to a unit root. However, the CMR may be preferable, as it is based on the longer time series; furthermore, in our robustness check using a normalized measure of new necessity entrepreneurs, the PV test does not reject an $I(1)$ process, in line with the CMR result (see Table D2 in Appendix D). In any case, we find stronger and more consistent evidence of a unit root for new opportunity than for new necessity entrepreneurship.

The findings are consistent with the presence of a unit root in at least one Spanish region, even when accounting for deterministic breaks, at least for new opportunity entrepreneurship. This justifies the need for a deeper, regional analysis.

4.3 Regional Analysis: One Break, 2005-2020

How heterogeneous are the dynamics of new opportunity and necessity entrepreneurship at the regional level, concerning the presence of unit roots and the timings of breaks? Was firm formation in the different regions similarly impacted by the Financial Crisis? To answer these questions, we conduct tests separately for each of the 17 Spanish regions.

Analogously to our test procedure at the national level, we first analyze the shorter time series starting in 2005, avoiding the break in the data in 2004. In the next subsection, we will consider the full time series. Here, we use the PV model, choosing a specification that fits in both the null hypothesis and the alternative one deterministic change in the mean of the data generating process of the series. Our objective, as we look at a test capable of retrieving a potential break date endogenously, is to detect an idiosyncratic shift in the mean that might have occurred after 2004.[5]

Table 3 shows the results for new opportunity entrepreneurs and Table 4 for new necessity entrepreneurs. We find that a deterministic break is detected in all regions for new opportunity entrepreneurs, and in almost all cases, the break is in the neighborhood of the Financial Crisis, with break dates ranging from 2006q3 to 2009q4 (Galicia and La Rioja are the only exceptions). In the case of the new necessity entrepreneurs, a break is statistically significant in 11 out of the 17 regions and in most of these cases dated between 2013 and 2017 (Extremadura and the Basque Country are the only exceptions). The findings concerning the break dates are overall similar to the results of the PV tests at the national level, but reveal regional heterogeneity. Overall, these results suggest that the Financial Crisis changed the technology of firm formation out of opportunity in most regions, but not the technology of firm formation out of necessity.

In terms of inference, we confirm that the introduction of a change-in-level break dummy in the test equation increases the rejection rate of the null of unit root when compared to a linear ADF specification. Again following the Dickey and Pantula (2002) approach, we test the null hypothesis of $I(2)$ first; if we fail to reject $I(2)$, the procedure stops, and we conclude that there is a unit root. If we reject $I(2)$, we proceed to testing $I(1)$, and conclude that there is a unit root if we fail to reject $I(1)$. For the new opportunity entrepreneurs, we detected the presence of at least a unit root in the majority of regions, namely, in 11 out of the 17 regions: Aragon, Asturias, Balearic islands, Cantabria, Castile and Leon, Castile and la Mancha, Catalonia, the Valencian Community, Extremadura, Region of Murcia, and the Basque Country. In the case of the new necessity entrepreneurs, we are able to find at least a unit root in only a minority of regions, namely in the following 7: Andalucia, Aragon, Balearic Islands, Castile and Leon, the Valencian Community, Galicia, and Community of Madrid. Thus, the hysteresis phenomenon is more widespread among new opportunity than among new necessity entrepreneurs.

4.4 Regional Analysis: Two Breaks, 2000-2020

We now extend the regional time series to the full period spanning 2000-2020, thus including the apparent data break in 2004. As done at the national level, we again use the CMR test that is able to endogenously detect two breaks. This allows the expected detection of the systematic break in 2004 and of an additional idiosyncratic break after 2004, as in the previous section, a break after 2004 was also detected in most regions. Allowing the test to detect the break in 2004 endogenously rather than imposing it serves as a plausibility check of the results. The advantage of using the entire observation

[5] As before, visual inference on the series led us to fit a constant, and we decide the relevant lag order based on the same general to specific methodology we employed in the previous section, where a simple linear model was chosen as the alternative one.

period is that we make use of the full information available.

We first conducted tests for all regions with a null hypothesis stating an $I(2)$ process, following the same procedure as before. The $I(2)$ null hypothesis was rejected in all these tests, prompting us to proceed to tests with a null hypothesis of $I(1)$; we only show the results from the latter tests in the tables for brevity.[6]

The results in Tables 5 and 6 show that the first endogenously retrieved break date points precisely at the first quarter of 2004 in most regions, both for opportunity and necessity entrepreneurs. This is consistent with the visual inspection of the series and increases confidence in the tests. The second break is identified in the neighborhood of the 2008 Financial Crisis for almost all regions in the case of new opportunity entrepreneurs. Concerning new necessity entrepreneurs, a second break is statistically significant in 10 of the 17 regions, and it is between 2005 and 2006 in half of these 10 regions and between 2014 and 2016 in the other half. Thus, as in the tests only including 2005-2020, we find that the technology of new opportunity entrepreneurship was much more consistently shifted by the Financial Crisis than that of new necessity entrepreneurship.

Concerning the unit root tests, in the case of the new opportunity entrepreneurs, the tests could not reject the unit root null against the stationary alternative at the 5% percent significance level for 11 of the 17 regions: Aragon, Asturias, Cantabria, Castile and Leon, Castile-La Mancha, Catalonia, Valencia, Galicia, Murcia, Navarre, and Basque Country (see also Figure 5). For new necessity entrepreneurs, the null hypothesis of a unit root is not rejected for 11 partially different regions: Aragon, Balearic Islands, Canary Islands, Castile and Leon, Castile-La Mancha, Catalonia, Extremadura, Galicia, Madrid, Murcia, and Basque Country (Figure 6). Considering the results of the PV and the CMR tests based on the shorter and longer periods together, we see that a clear hysteresis phenomenon is consistently detected in most regions for new opportunity entrepreneurship, but not as consistently for new necessity entrepreneurship. It has also become evident that there is pronounced heterogeneity between regions.

4.5 Sectoral Analysis

We finally test for unit root behavior and deterministic breaks at the level of industrial sectors. We distinguish between agriculture, manufacturing industry, construction, low-skill services, and high-skill services. Understanding how the hysteresis phenomenon differs between sectors has implications for the long-run impacts of sector-specific shocks and temporary policies that may not only be targeted at specific regions, but also at specific sectors. This informs the design of a specific geographical and sectoral policy mix.

[6] Starting from a maximum lag length, as before, we use a top-down approach, reducing sequentially the lag order until the last lag of each test equation ends up being statistically significant.

Analogously to the regional analysis, we perform PV tests with one endogenous break based on the 2005-2020 data and CMR tests with two endogenous breaks based on the 2000-2020 data to accommodate the apparent data break in 2004. Tables 7 and 8 show the PV and CMR results for new opportunity entrepreneurs, and Tables 9 and 10 for new necessity entrepreneurs, respectively.

The results from all test show that the break dates are highly significant in most sectors. The CMR test detects the systematic break in the first quarter of 2004 precisely in all sectors for both types of entrepreneurs. The break after 2004 is mostly consistently identified across the PV and CMR tests. Concerning new opportunity entrepreneurs, this break occurs around the Financial Crisis for all sectors (except high-skill services when using the CMR, which does not identify a statistically significant second break in this sector). Among new necessity entrepreneurs, this break occurs between 2007 and 2008 only for agriculture and manufacturing, but later for the three other sectors. The result that the Financial Crisis more consistently altered opportunity firm formation is similar to the findings from the regional analysis.

To interpret the unit root tests, we again follow the Dickey and Pantula (2002) procedure of going from the test of $I(2)$ to the test of $I(1)$. We find unit roots in most sectors for new opportunity entrepreneurship (3 out of 5 sectors based on the PV test and all 5 based on the CMR test), but in fewer sectors for necessity entrepreneurs (2 based on the PV test and 3 based on the CMR test). Thus, the results show that new opportunity entrepreneurship exhibits hysteresis more widely across sectors than new necessity entrepreneurship.

5 Conclusions

Our econometric analysis based on comprehensive panel data from Spain over the first two decades of the 21^{st} century reveals three main results. First, hysteresis is more widespread in new opportunity entrepreneurship than in new necessity entrepreneurship across regions and sectors. This means that a shock to new firm formation out of opportunity, for example due to a temporary entrepreneurship promotion policy, is more likely to have long-term effects than a shock to firm formation out of necessity.

This result implies that a temporary stimulus to opportunity business creation may result in more opportunity business creation in the long run even after the stimulus is withdrawn. This finding is encouraging for entrepreneurship promotion policies. On the flip side of the coin, our results also imply that negative shocks to firm formation out of opportunity, for example due to a credit crunch, are also likely to continue decreasing firm formation out of opportunity long after the credit shortage has been resolved. This may imply that policy interventions may be justified to aid the recovery after a negative shock. As we did not find hysteresis to be as widespread in firm formation out of necessity, active labor market policies supporting the transition from unemployment to self-employment are less likely to have continued effects on entry into self-employment after the policy is terminated.

A possible explanation for the hysteresis phenomenon in business creation out of opportunity is that opportunity entrepreneurship in a region or sector triggers further opportunity entrepreneurship in the same region or sector, for example due to network effects, role models, business relationships among startups, or clusters. Researchers have long recognized the regional embeddedness of entrepreneurship (Fritsch and Storey, 2014; Fossen and Martin, 2018). High levels of new business formation seem to be very persistent within certain regions over time (e.g., Fritsch and Mueller, 2007; Andersson and Koster, 2011; Fritsch and Wyrwich, 2014, 2017). The ability of regions to generate a high startup rate is sometimes called entrepreneurship capital (Audretsch et al., 2008). The strong persistency of entrepreneurship capital suggests that regional entrepreneurship culture may be an important part of it, including intangible components such as regional cultural norms and values that shape attitudes toward entrepreneurship (Fritsch and Wyrwich, 2017). Entrepreneurship culture is also an important element of entrepreneurial ecosystems (Wurth et al., 2022, 2023). Given our results, it seems possible that a positive shock to opportunity business creation may permanently increase a region's entrepreneurship culture. Our results call for important further research on the micro-foundations of our findings.

The second main result from our empirical analysis is that new opportunity entrepreneurship consistently exhibits a deterministic structural break around the global Financial Crisis peaking in 2008, but new necessity entrepreneurship less so. This suggests that the Financial Crisis changed the regional and sectoral technology of firm formation out of necessity, but not out of necessity, in the sense of altering the deterministic trend. This may be due to a changing nature of business opportunities at the time of the Financial Crisis; again, subsequent research on the micro-foundations is necessary. In any case, this is another indication that the distinction between opportunity and necessity entrepreneurship is important.

Finally, the third main result is that there is strong heterogeneity across regions and sectors concerning both the hysteresis phenomenon and the timing of structural breaks. This finding implies that the policy portfolio required to foster entrepreneurship should always take into account the wide amount of heterogeneity existing across regions and sectors. In some regions and sectors, temporary policies targeted at one of the entrepreneurial groups will be more likely to have long-run effects than in others.

Our results open the door to further research related to the long-term effectiveness of a regional and sectoral policy mix of entrepreneurship promotion and active labor market policies. Our work is naturally limited by the size of the time dimension of the data and its frequency. Future studies related to the topic should aim to analyze series with an even longer time span and a higher frequency, possibly accommodating causality-oriented frameworks, in an attempt to take into account both variation and trends (short and log run behavior) of different types of entrepreneurial flows.

Glossary

ADF: Augmented Dickey and Fuller (1979) test

CMR: Clemente et al. (1998) test

Hadri: Hadri (2000) test

$I(x)$: Integrated of order x (the minimum number of differences required to obtain a stationary series; stationary series are integrated of order 0)

IPS: Im et al. (2003) test

KPSS: Kwiatkowski et al. (1992) test

LLC: Levin et al. (2002) test

nec: Number of new necessity entrepreneurs (= quarterly entries into self-employment from non-employment)

oppo: Number of new opportunity entrepreneurs (= quarterly entries into self-employment from paid employment)

PV: Perron and Vogelsang (1992a,b) test

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Tables

Table 1: Panel Data Unit Root Test Results

Variable	*Test*	H_0	H_a	*Statistic*	*Decision*
(I)	(II)	(III)	(IV)	(V)	(VI)
$\Delta oppo_t$	LLC	Hom. I(2) process	Hom. I(1 or 0)	-42.03***	
$oppo_t$	LLC	Hom. Unit Root	Hom. Stationarity	-17.27***	Hom. Stationarity
Δnec_t	LLC	Hom. I(2) process	Hom. I(1 or 0)	-43.17***	
nec_t	LLC	Hom. Unit Root	Hom. Stationarity	-15.93***	Hom. Stationarity
$\Delta oppo_t$	IPS	Hom. I(2) process	Het. I(1 or 0)	-45.47***	
$oppo_t$	IPS	Hom. Unit Root	Het. Stationarity	-18.08****	Het. Stationarity
Δnec_t	IPS	Hom. I(2) process	Het. I(1 or 0)	-46.70***	
nec_t	IPS	Hom. Unit Root	Het. Stationarity	16.38***	Het. Stationarity
$\Delta oppo_t$	Hadri	Hom. I(1 or 0)	Het. I(2) process	-4.26	
$oppo_t$	Hadri	Hom. Stationarity	Het. Unit Root	20.87***	Het. Unit Root
Δnec_t	Hadri	Hom. I(1 or 0)	Het. I(2) process	-4.03	
nec_t	Hadri	Hom. Stationarity	Het. Unit Root	30.84***	Het. Unit Root

Column (I): Test objective variable; Column (II): Test type (see the Glossary above the References); Column (III): Null hypothesis definition; Column (IV): Alternative hypothesis definition; Column (V): Test statistic; Column (VI): Final statistical decision. To account for cross-sectional spill-overs, the IPS tests are run with cross-sectional average-augmented test equations, while the Hadri test is rendered in its robust version. Following the Dickey and Pantula approach, first differences are tested first. Upon non rejection of the null hypothesis, the test stops, otherwise it continues to levels. ***: 1% statistical significance; **: 5% statistical significance; *: 10% statistical significance.

Table 2: National Level Test Results

$oppo_t$	H_0	H_a	*Statistic*	*Breaks*	*Decision*
(I)	(II)	(III)	(IV)	(V)	(VI)
$ADF_{2005/2020}$	I(1) process	I(0) process	-2.559		Unit Root
$KPSS_{2005/2020}$	I(0) process	I(1) process	0.768*		Unit Root
$PV_{2005/2020}$	I(1) process	I(0) process	-2.909	2008q1***	Unit Root
$CMR_{2000/2020}$	I(1) process	I(0) process	-2.948	2004q1***,2008q1***	Unit Root
nec_t	H_0	H_a	*Statistic*	*Breaks*	*Decision*
$ADF_{2005/2020}$	I(1) process	I(0) process	-2.178		Unit Root
$KPSS_{2005/2020}$	I(0) process	I(1) process	0.811**		Unit Root
$PV_{2005/2020}$	I(1) process	I(0) process	-6.733**	2015q3***	Stationarity
$CMR_{2000/2020}$	I(1) process	I(0) process	-4.380	2004q1***,2015q3***	Unit Root

Column (I): Test type (see the Glossary above the References); Column (II): Null hypothesis under analysis; Column (III): Alternative hypothesis; Column (IV): Test Statistic; Column (V): Break dates estimated (where applicable); Column (VI): Statistical decision. Note that the critical values of the test statistics vary by test. ***: value significant at 1%; **: value significant at 5%; *: value significant at 10%. The hypotheses concerning the integration of the series are only tested at the 5% significance level in case of the PV and CMR tests.

Table 3: Perron-Vogelsang Test, Opportunity Entrepreneurs, 2005-2020

Regions	$t-stat\ H_0: I(2)$	$t-stat\ H_0: I(1)$	*Break date*
(I)	(II)	(III)	(IV)
Andalucia	-10.511**	-5.159**	2007q1***
Aragon	-5.572**	-2.941	2009q3***
Asturias	-11.164**	1.776	2007q4***
Balearic Islands	-1.994	-8.049**	2009q4***
Canary Islands	-3.737**	-7.173**	2006q3***
Cantabria	-8.690**	-2.610	2006q4***
Castile and Leon	-3.130	-5.667**	2009q2***
Castile-La Mancha	-10.164**	-1.308	2008q4***
Catalonia	-2.001	-1.822	2008q4***
Valencian Community	-4.395**	-2.163	2007q4***
Extremadura	-7.742**	-3.285	2007q4***
Galicia	-9.867**	-4.065**	2013q2***
Community of Madrid	-13.680**	-11.038**	2009q4***
Region of Murcia	-3.518	-7.393**	2008q3***
Navarre	-8.576**	-11.145**	2009q4***
Basque Country	-4.353**	-3.166	2008q1***
La Rioja	-9.709**	-5.868**	2011q2***

Column (I): Spanish autonomous regions; Column (II): test statistic for the $I(2)$ null hypothesis; Column (III): test statistic for the $I(1)$ null hypothesis; Column (IV): dates for the unique endogenously retrieved break. ***: value significant at 1%; **: value significant at 5%; *: value significant at 10%. The hypotheses concerning the integration of the series are only tested at the 5% significance level in this table.

Table 4: Perron-Vogelsang Test, Necessity Entrepreneurs, 2005-2020

Regions	$t - stat\ H_0 : I(2)$	$t - stat\ H_0 : I(1)$	*Break date*
(I)	(II)	(III)	(IV)
Andalucia	-2.924	-4.503**	2013q4***
Aragon	-3.381	-2.385	2010q3
Asturias	-9.358**	-5.480**	2007q2
Balearic Islands	-11.797**	-2.983	2012q3
Canary Islands	-12.414**	-6.976**	2014q3***
Cantabria	-5.774**	-9.248**	2007q1
Castile and Leon	-4.410**	-1.544	2013q4***
Castile-La Mancha	-8.139**	-6.784**	2017q3***
Catalonia	-6.230**	-8.721**	2014q3***
Valencian Community	-9.272**	-2.408	2015q2***
Extremadura	-5.137**	-8.739**	2006q4***
Galicia	-2.627	-3.351	2015q2***
Community of Madrid	-3.537	-7.478**	2016q3***
Region of Murcia	-11.911**	-9.466**	2015q1***
Navarre	-8.113**	-5.338**	2015q1
Basque Country	-10.823**	-7.161**	2006q4***
La Rioja	-5.560**	-6.725**	2017q3

Column (I): Spanish autonomous regions; Column (II): test statistic for the $I(2)$ null hypothesis; Column (III): test statistic for the $I(1)$ null hypothesis; Column (IV): dates for the unique endogenously retrieved break. ***: value significant at 1%; **: value significant at 5%; *: value significant at 10%. The hypotheses concerning the integration of the series are only tested at the 5% significance level in this table.

Table 5: Clemente et al., Two Breaks, Opportunity Entrepreneurs, 2000-2020

Regions	*t-stat*	*Break 1 date*	*Break 2 date*
(I)	(II)	(III)	(IV)
Andalucia	-8,225**	2004q1***	2007q4***
Aragon	-2,222	2004q1***	2009q3***
Asturias	-2,492	2004q1***	2007q3***
Balearic Islands	-7,681**	2003q2***	2011q1***
Canary Islands	-8,130**	2004q1***	2006q3***
Cantabria	-3,488	2004q1***	2006q2***
Castile and Leon	-3,195	2004q1***	2008q1***
Castile-La Mancha	-4,894	2004q1***	2008q4***
Catalonia	-4,110	2004q1***	2009q4***
Valencian Community	-5,393	2004q1***	2007q3***
Extremadura	-7,692**	2004q1***	2007q4***
Galicia	-3,482	2004q1***	2005q4***
Community of Madrid	-8,434**	2004q1	2009q2
Region of Murcia	-3,145	2003q4***	2008q3***
Navarre	-1,909	2004q1***	2007q1***
Basque Country	-3,486	2004q1***	2008q1***
La Rioja	-6,919**	2004q3***	2006q2***

Column (I): Spanish autonomous regions; Column (II): test statistic; Columns (III) and (IV): dates of first and second detected breaks. The tests are shown in levels only. ***: value significant at 1%; **: value significant at 5%; *: value significant at 10%. The hypotheses concerning the integration of the series are only tested at the 5% significance level in this table.

Table 6: Clemente et al., Two Breaks, Necessity Entrepreneurs, 2000-2020

Regions	*t-stat*	*Break 1 date*	*Break 2 date*
(I)	(II)	(III)	(IV)
Andalucia	-8,442**	2004q1***	2006q2***
Aragon	-2,774	2004q4***	2013q3
Asturias	-6,954**	2004q1***	2008q4
Balearic Islands	-3,403	2004q1***	2012q3
Canary Islands	-4,596	2004q3***	2005q4***
Cantabria	-10,326**	2004q1***	2005q2
Castile and Leon	-4,668	2004q1***	2016q3***
Castile-La Mancha	-3,120	2004q1	2012q4
Catalonia	-5,184	2004q1***	2014q3***
Valencian Community	-8,817**	2004q1***	2016q1***
Extremadura	-3,565	2004q1***	2006q4***
Galicia	-1,635	2004q1***	2005q4***
Community of Madrid	-5,132	2004q1***	2016q1***
Region of Murcia	-2,503	2005q1***	2015q1***
Navarre	-6,589**	2004q1***	2015q1
Basque Country	-1,492	2004q2***	2006q4***
La Rioja	-9,246**	2003q4	2010q3

Column (I): Spanish autonomous regions; Column (II): test statistic; Columns (III) and (IV): dates of first and second detected breaks. The tests are shown in levels only. ***: value significant at 1%; **: value significant at 5%; *: value significant at 10%. The hypotheses concerning the integration of the series are only tested at the 5% significance level in this table.

Table 7: Perron and Vogelsang, Opportunity Entrepreneurs, 2005-2020

Sectors	t-stat $H_0 : I(2)$	t-stat $H_0 : I(1)$	*Break date*
(I)	(II)	(III)	(IV)
Agriculture	-6.686**	-6.849**	2007q3***
Manufacturing	-7.110**	-3.311	2008q1***
Construction	-8.296**	-1.722	2008q1***
Low-skill Service	-6.747**	-2.361	2008q4***
High-skill Service	-6.271**	-7.687**	2006q4**

Column (I): Sectors of activity in Spain; Column (II): test statistic for the $I(2)$ null hypothesis; Column (III): test statistic for the $I(1)$ null hypothesis; Column (IV): dates for the unique endogenously retrieved break. ***: value significant at 1%; **: value significant at 5%; *: value significant at 10%. The hypotheses concerning the integration of the series are only tested at the 5% significance level in this table.

Table 8: Clemente et al., Opportunity Entrepreneurs, 2000-2020

Sectors	t-stat $H_0 : I(2)$	t-stat $H_0 : I(1)$	*Break 1 date*	*Break 2 date*
(I)	(II)	(III)	(IV)	(V)
Agriculture	-1.577	-4.033	2004q1***	2007q3***
Manufacturing	-8.811**	-4.920	2004q1***	2008q3***
Construction	-5.629**	-2.529	2004q1***	2008q1***
Low-skill Service	-9.727**	-3.166	2004q1***	2008q1***
High-skill Service	-5.785**	-4.040	2004q1***	2018q1

Column (I): Sectors of activity in Spain; Column (II): test statistic for the $I(2)$ null hypothesis; Column(III): test statistic for the $I(1)$ null hypothesis; Column (IV) and (V): dates for first and second detected breaks. ***: value significant at 1%; **: value significant at 5%; *: value significant at 10%. The hypotheses concerning the integration of the series are only tested at the 5% significance level in this table.

Table 9: Perron and Vogelsang, Necessity Entrepreneurs, 2005-2020

Sectors	t-stat $H_0 : I(2)$	t-stat $H_0 : I(1)$	*Break date*
(I)	(II)	(III)	(IV)
Agriculture	-5.733**	-1.127	2007q2***
Manufacturing	-10.217**	-5.430**	2008q1***
Construction	-3.145	-3.486	2014q4***
Low-skill Service	-8.195**	-6.491**	2016q2***
High-skill Service	-7.493**	-10.222**	2010q2

Column (I): Sectors of activity in Spain; Column (II): test statistic for the $I(2)$ null hypothesis; Column (III): test statistic for the $I(1)$ null hypothesis; Column (IV): dates for the unique endogenously retrieved break. ***: value significant at 1%; **: value significant at 5%; *: value significant at 10%. The hypotheses concerning the integration of the series are only tested at the 5% significance level in this table.

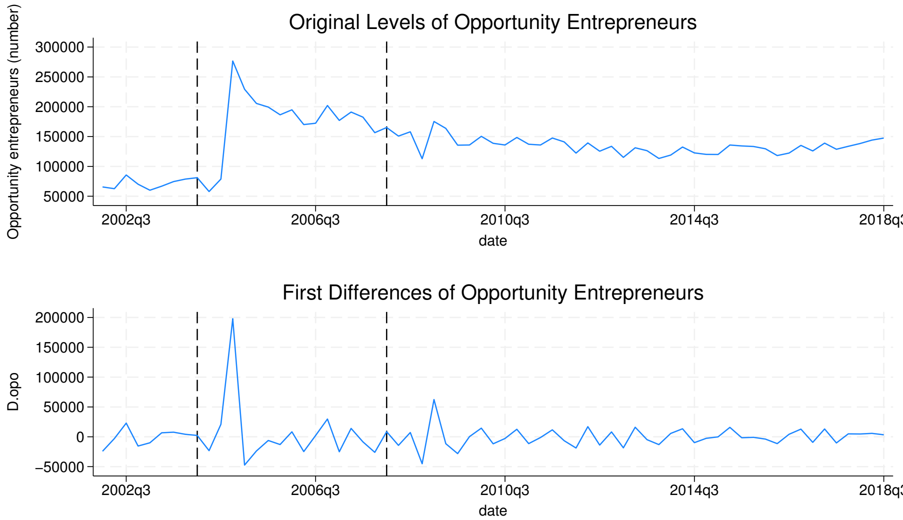
Table 10: Clemente et al., Necessity Entrepreneurs, 2000-2020

Sectors	t-stat $H_0 : I(2)$	t-stat $H_0 : I(1)$	*Break 1 date*	*Break 2 date*
(I)	(II)	(III)	(IV)	(V)
Agriculture	-4.963	-0.771	2004q1***	2007q2***
Manufacturing	-10.898**	-8.230**	2004q1***	2008q4***
Construction	-5.375	-3.869	2004q1***	2014q4***
Low-skill Service	-12.008**	-2.077	2004q1***	2016q2***
High-skill Service	-9.397**	-7.851**	2004q1***	2010q2*

Column (I): Sectors of activity in Spain; Column (II): test statistic for the $I(2)$ null hypothesis; Column(III): test statistic for the $I(1)$ null hypothesis; Column (IV) and (V): dates for first and second detected breaks. ***: value significant at 1%; **: value significant at 5%; *: value significant at 10%. The hypotheses concerning the integration of the series are only tested at the 5% significance level in this table.

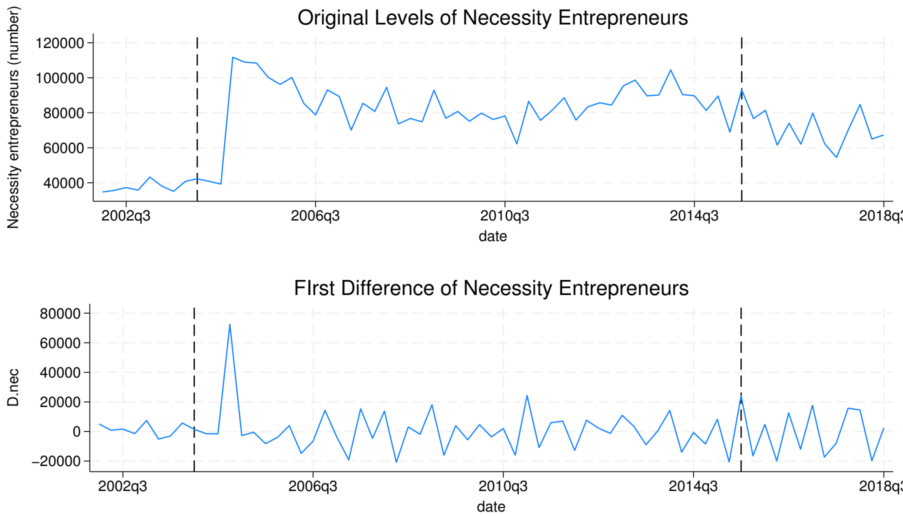
Figures

Figure 1: Opportunity Entrepreneurs, Unit Root Test, Two Breaks



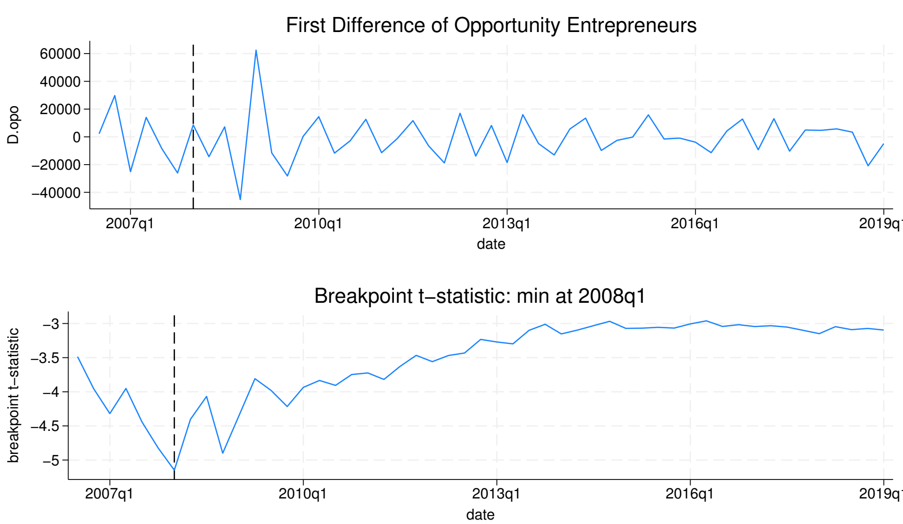
The number of opportunity entrepreneurs is shown in the upper panel. First differences of the series are reported in the lower panel. The dashed vertical lines show the estimated break dates: 2004q1 and 2008q1.

Figure 2: Necessity Entrepreneurs, Unit Root Test, Two Breaks



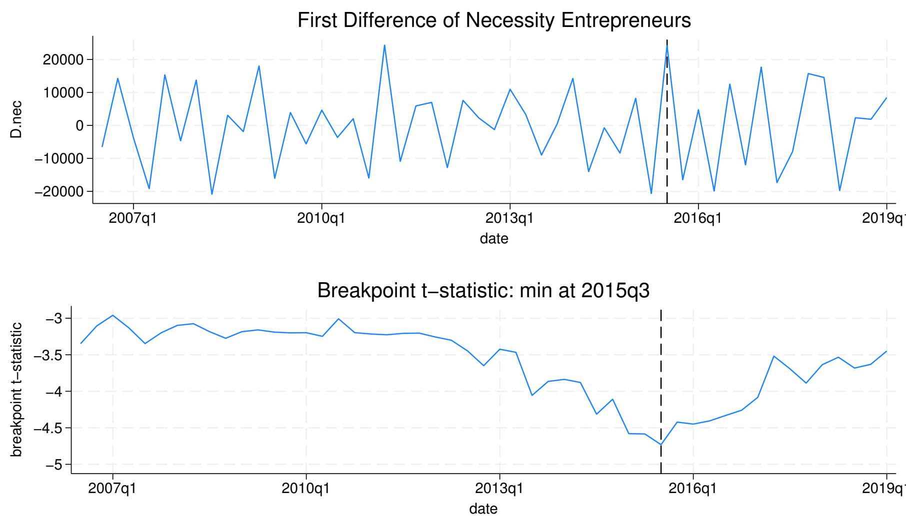
The number of necessity entrepreneurs is shown in the upper panel. First differences of the series are reported in the lower panel. The dashed vertical lines show the estimated break dates: 2004q1 and 2015q3.

Figure 3: Opportunity Entrepreneurs, Unit Root Test, One Break



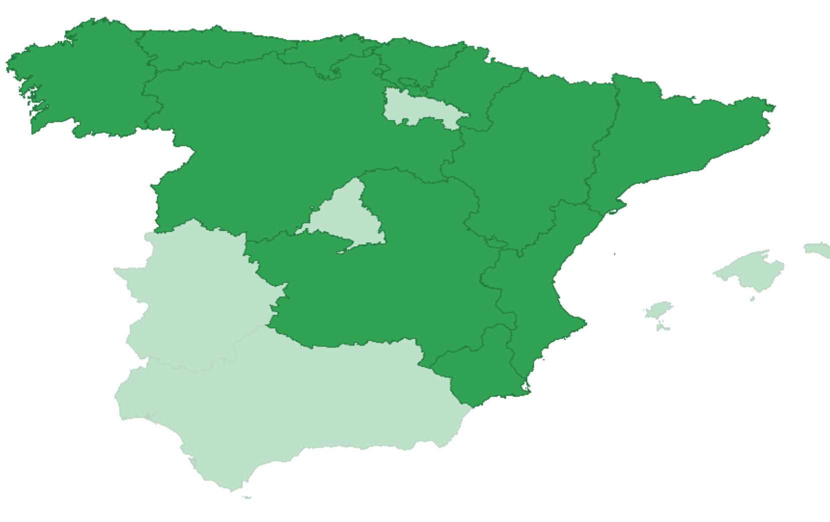
First differences of the series are reported in the upper panel. The lower panel shows the minimum, endogenously retrieved t-statistic and the associated break date.

Figure 4: Necessity Entrepreneurs, Unit Root Test, One Break



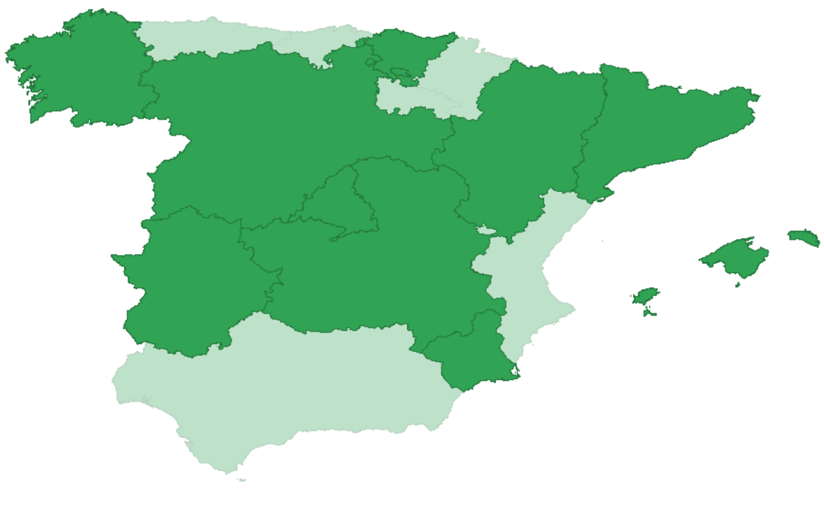
First differences of the series are reported in the upper panel. The lower panel shows the minimum, endogenously retrieved t-statistic and the associated break date.

Figure 5: Hysteresis in New Opportunity Entrepreneurs, Regional Level



Dark color: Spanish regions where hysteresis of new opportunity entrepreneurship was found by unit root two-break endogenous testing (CMR test). Canary Islands omitted.

Figure 6: Hysteresis in New Necessity Entrepreneurship, Regional Level



Dark color: Spanish regions where hysteresis of new necessity entrepreneurship was found by unit root two-break endogenous testing (CMR test). Canary Islands omitted.

A Appendix: Methodological Details

This Appendix A provides further formal and technical details on the methods outlined in the main paper.

A.1 Algorithmic Test Procedure

We generally follow the algorithmic procedure suggested by Dickey and Pantula (2002). In this procedure, upon failure to reject the null hypothesis of an $I(d)$ process, the procedure stops and a statistical decision on the order of integration follows. Otherwise, one proceeds to testing $I(d-1)$. We first test transformed, double differenced variables to account for the possibility of an order of integration at most equal to $I(2)$.

Thus, in case of the PV time series test (Perron and Vogelsang, 1992a,b), our first test equation is:

$$\Delta^2 y_t = g(t) + \alpha \Delta y_{t-1} + \sum_{j=1}^{p} \beta_j \Delta^2 y_{t-1} + \varepsilon_t \tag{A1}$$

Failure to reject the null of $\alpha = 0$ would lead us to declare the series are integrated of order two, $I(2)$. Rejection would instead lead us to the following test equation:

$$\Delta y_t = g(t) + \alpha y_{t-1} + \sum_{j=1}^{p} \beta_j \Delta y_{t-1} + \varepsilon_t \tag{A2}$$

for a final test of $I(1)$ versus the alternative of $I(0)$, i.e., stationarity.

A.2 Panel Data Unit Root Tests

The relevant test equation for the Levin et al. (2002) test (LLC) is:

$$\Delta entep_{i,t} = \alpha \, entep_{i,t-1} + x'_{i,t}\gamma_i + \sum_{j=1}^{p} \beta_{i,j} \Delta entrep_{i,t-1} + e_{i,t} \tag{A3}$$

where *entrep* stands for either new opportunity entrepreneurship (*oppo*) or new necessity entrepreneurship (*nec*). We have two relevant augmentations over the standard ADF benchmark model. First, γ_i is a set of panel-variant but time-invariant parameters (cross-sectional averages in our case as they are functional to the test), and second, $\sum_{j=1}^{p} \beta_{i,j}$ a sequence of time weights that capture potential time-wise correlation.

The lag order for the panel data tests has been decided by selecting the most parsimonious suggestion derived by the minimization of the log-likelihood based information criteria of Aikake and Hann-Quinn and the Schwartz-Bayesian. We reckon this method is the most efficient one for the panel data application given that the alternative would be checking all possible lag combinations for the 17 autonomous regions considered starting from a maximum lag order of 11. To parameterize the time series tests, we use the top-down approach instead (see below).

Rejection of the homogeneous null hypothesis of unit root based on a statistical test of α leads us to the second test, the Im et al. (2003) test (IPS). The relevant test equation is:

$$\Delta entrep_{i,t} = \alpha_i \, entrep_{i,t-1} + x'_{i,t}\gamma_i + \sum_{j=1}^{p} \beta_{i,j} \Delta entrep_{i,t-1} + \epsilon_{i,t} \tag{A4}$$

where the more realistic heterogeneous null hypothesis is expressed by coefficient α_i. The difference to the LLC test above is that the original autoregressive parameter, $\rho = (1 - \alpha)$, is left free to vary across the regions, $\rho_i = (1 - \alpha_i)$.

Finally, the Hadri (2000) test essentially flips the null and alternative hypotheses. Consider a benchmark standard random walk process:

$$\begin{aligned} &entrep_{i,t} = p_{i,t} + \gamma_{i,t} + u_{i,t}, \\ &\text{with } p_{i,t} = p_{i,t-1} + e_{i,t} \end{aligned} \tag{A5}$$

If, intuitively, the variance of the error term is equal to 0, $var(e_{i,t}) = 0$, so that the series collapses to a constant in terms of its expected value ($p_{i,t} = p_{i,t-1}$) and does not represent anymore a unit root component of $entrep_{i,t}$, then the series can be considered trend stationary around its deterministic component. The Hadri Lagrangean Multiplier test can thus be written as: $H_0 : \vartheta = \frac{var(e_{i,t})}{var(u_{i,t})} = 0$ versus an alternative $H_a : \vartheta > 0$. Given the random walk collapses to a constant if its variance is 0, the model would become, as we stated, purely deterministic with an *i.i.d.* stochastic component.

B Appendix: Alternative Measures of Opportunity and Necessity Entrepreneurship

In the main body of our paper, we considered entrepreneurial flows in their level value, i.e, the number of new opportunity and new necessity entrepreneurs in a region or sector. As such, as we already stated, the measures capture the idea of business creation. One might be concerned that the contribution of employment and non-employment to the construction of the opportunity and necessity entrepreneurial flows could represent a nuisance component of the long run memory of the series, influencing the outcome of the statistical tests we proposed to check for hysteresis in business creation. In order to tackle this eventuality, this section proposes the following alternative way to define the objective variables:

$$oppo_t \rightarrow \frac{oppo_t}{emp_{t-1}} \tag{B1}$$

$$nec_t \rightarrow \frac{nec_t}{nonemp_{t-1}} \tag{B2}$$

where emp_{t-1} indicates the number of paid employees and $nonemp_{t-1}$ the number of non-employed individuals in the region at time $t-1$. Thus, we normalize our original flow measures to take into account the stocks of paid employed and non-employed individuals before measuring the flows. These normalized measures reflect the rate of entry into opportunity and necessity entrepreneurship conditional on the original employment state. In other words, the normalized measures can be interpreted as the average propensities of individuals to make the transition to self-employment conditional on their current state.

B.1 Panel Data and National Level Tests

Table D1 in Appendix D shows panel unit root tests run with the new normalized variables for new opportunity and necessity entrepreneurship. We concentrate on the second generation tests, the Im et al. (2003) and Hadri (2000) tests. As in the main analysis, we again comfortably reject both the null hypotheses of homogeneous unit root and homogeneous stationarity across all the measures. We proceed to the analysis at the national and then regional level time series to allow for deterministic breaks. For opportunity entrepreneurship, the Dickey and Fuller (1979) test initially suggests the new opportunity rate to be stationary. However, after introducing the possibility of an endogenously retrieved break through the application of the Perron and Vogelsang (1992a) test, the statistical significance dramatically decreases with a break detected in $2007q1$, and we do not reject a unit root.

By considering the whole time series, and allowing for the presence of up to two breaks with the Clemente et al. (1998) test, the unit root null stands strongly unrejected, the first break matches the expected location of the systematic change ($2004q1$), and the second, idiosyncratic break effectively converges to the neighborhood of the Financial Crisis not only for opportunity, but also for necessity entrepreneurship. The results from using the normalized measure of opportunity entrepreneurship points at 2007 for the second break, somewhat earlier than the $2008q1$ break we obtained in the main analysis. This may be due to the normalization: the presence of a lagged denominator shifts the break to the left of the time series. Again the CMR test is capable of identifying the expected break dates and disentangling their effect from the time-wise evolution of the unit root. Overall, from this robustness check we conclude that there is a unit root in both national time series, as we did in the main analysis.

B.2 Regional Analysis

Tables D3 and D4 finally provide results on how regionally widespread the hysteresis phenomenon is when using the alternative measures of new opportunity and necessity entrepreneurship, respectively. We use the CMR test based on the full time series. We do not reject the null hypothesis of a unit root in 13 out of the 17 regions for new opportunity entrepreneurship, but only in 11 regions for new necessity entrepreneurship. Thus, again a unit root is more often found for new opportunity entrepreneurship. Like in the main analysis, the first break date is precisely estimated to be $2004q1$ for both new opportunity and necessity entrepreneurship in almost all regions. The second break date is almost always in the neighborhood of the Financial Crisis for opportunity entrepreneurs, like in the main analysis, but tends to be estimated to be slightly earlier in time. This is likely due to the lagged variable in the denominator, as we also observed in the national level tests. For necessity entrepreneurs, the result that the second break date is either around the Financial Crisis or between 2014 and 2016 (when statistically significant) is also similar to the main analysis.

C Appendix: Panel Unit Root Testing With Breaks

As a final robustness check, we test for hysteresis at the national level taking into account jointly all possible forms of heterogeneity, the presence of structural breaks, and correcting for the presence of potential spatial spill-overs. We do so by using the Karavias and Tzvalis (2014) panel unit root test, a procedure capable of tackling all these possibilities simultaneously.

Although computationally more intense, the Karavias and Tzvalis (2014) panel test has a number of useful properties, integrating many of the aspects of the tests employed in the main body of this paper: a heterogeneous alternative hypothesis taking into account different memory processes in the panel, cross-sectional averaging to take into account potential residual autocorrelation in the error term, robustness to patterns of heteroskedasticity in the residuals, the possibility to endogenously retrieve a break in both the null and alternative hypotheses, and dynamic bootstrapping of critical values.

However, the test also has some important disadvantages for our application, which led us not to include it in the main analysis. First, while the test performs well in small samples, it is intended for frameworks where the cross-sectional dimension tends to infinity while the temporal dimension is relatively smaller in magnitude, which is not the case in our data. Second, as we consider a panel procedure, the averaging process of the deterministic breaks, together with the normalization of the alternative measures we are considering in Appendix B, is likely to lead to a less precise identification of the exact timing of the break. Nevertheless, we expect the test to be at least able to confirm the presence of heterogeneous nonstationarity together with statistically significant break-dates.

The Karavias and Tzvalis (2014) test is based on the following specification, entailing a common deterministic change in the mean of the process of each cross sectional unit (model $M1$, as the authors name it, which is more appropriate for pure random walks than models with drifts):

$$y_i = \varphi y_{i-1} + (1-\varphi)\left(a_i^{(\lambda)} e^{(\lambda)} + a_i^{(1-\lambda)} e^{(1-\lambda)}\right) + u_i, \quad i = 1, 2, \ldots, N \tag{C1}$$

where $y_i = (y_{i1}, \ldots, y_{iT})'$ is a vector containing the time varying observations for $t = 1, 2, \ldots, T$, across the cross-sectional units of the panel $i = 1, 2, \ldots, N$, $y_{i-1} = (y_{i0}, \ldots, y_{iT-1})'$ is vector y_i lagged once, $u_i = (u_{i1}, \ldots, u_{iT})'$ is the error term vector, e is a $(TX1)$-dimension vector of unitary values, and $e^{(\lambda)}$ and $e^{(1-\lambda)}$ are $(TX1)$-dimension vectors governing the deterministic change in the break. The test hypotheses is:

$$\begin{aligned} H_0 &: \varphi = 1 \\ H_1 &: \varphi < 1 \end{aligned} \tag{C2}$$

.

Table D5 reports the results of the tests, which we employ to check for the existence of homogeneous nonstationarity with one endogenously retrieved break based on the full panel data. All tests identify some degree of heterogeneous stationarity in the cross sections of the panel. This implies either absolute stationarity or nonstationarity in some regions with some stationary regional units. This finding is consistent with the results from the IPS tests in Table 1 and our findings in the main time series exercises. If we allow for at most one deterministic break to enter the test equation, results for the original variables $oppo_t$ and nec_t confirm heterogeneity of the persistence process together with an averaged break centered on 2004q3, just a couple of periods away from the more precisely estimated break in the CMR time series test in Table 2, where the break was centered around 2004q1. As for the alternative normalized variables considered in Appendix B, the break dates point at more extreme solutions at the boundaries of the time series, which may not be reliable. This might be due to the fact that the series were normalized with a lagged denominator, which may create some misalignment in break detection when compared to the original variables.[7] The statistical implication of heterogeneous stationarity is, nevertheless, confirmed once again.

[7] We also checked for an additional break, following the authors of the test, but we could not identify a statistically meaningful one in any of the four cases. This is however a result we would expect given that the panel estimation averages out deterministic and stochastic components and thus makes break detection more difficult.

D Appendix: Supplementary Tables

Table D1: Robustness: Panel Data Unit Root Tests Using Normalized Measures

Variable	*Test*	H_0	H_a	*Statistic*	*Decision*
(I)	(II)	(III)	(IV)	(V)	(VI)
$\Delta\frac{oppo_t}{emp_{t-1}}$	IPS	Hom. I(2) process	Het. I(1 or 0)	-29.530***	
$\frac{oppo}{emp_{t-1}}$	IPS	Hom. Unit Root	Het. Stationarity	-20.577***	Het. Stationarity
$\Delta\frac{oppo_t}{emp_{t-1}}$	Hadri	Hom. I(1 or 0)	Het. I(2) process	-4.176	
$\frac{oppo}{emp_{t-1}}$	Hadri	Hom. Stationarity	Het. Unit Root	12.475***	Het. Unit Root
$\Delta\frac{nec_t}{nonemp_{t-1}}$	IPS	Hom. I(2) process	Het. I(1 or 0)	-26.240***	
$\frac{nec_t}{nonemp_{t-1}}$	IPS	Hom. Unit Root	Het. Stationarity	-24.082***	Het. Stationarity
$\Delta\frac{nec_t}{nonemp_{t-1}}$	Hadri	Hom. I(1 or 0)	Het. I(2) process	-4.135	
$\frac{nec_t}{nonemp_{t-1}}$	Hadri	Hom. Stationarity	Het. Unit Root	12.528***	Het. Unit Root

Column (I): Transformed test objective variable; Column (II): Test type (see the Glossary above the References); Column (III): Null hypothesis definition; Column (IV): Alternative hypothesis definition; Column (V): Test statistic; Column (VI): Final statistical decision. To account for cross sectional spill-overs, the IPS tests are run with cross-sectional averaged-augmented test equations, while the Hadri test is rendered in its robust version. Following the Dickey and Pantula approach, first differences are tested first. Upon non rejection of the null hypothesis, the test stops, otherwise it continues to levels. ***: 1% statistical significance; **: 5% statistical significance; *: 10% statistical significance.

Table D2: Robustness: National Level Tests Using Normalized Measures

$\frac{oppo_t}{emp_{t-1}}$	H_0	H_a	*Statistic*	*Breaks*	*Decision*
(I)	(II)	(III)	(IV)	(V)	(VI)
$ADF_{2005/2020}$	I(1) process	I(0) process	-4.075***		Stationary
$KPSS_{2005/2020}$	I(0) process	I(1) process	1.950***		Unit Root
$PV_{2005/2020}$	I(1) process	I(0) process	-0.294	2007q1***	Unit Root
$CMR_{2000/2020}$	I(1) process	I(0) process	-2.341	2004q1***,2007q3***	Unit Root
$\frac{nec_t}{nonemp_t}$	H_0	H_a	*Statistic*	*Breaks*	*Decision*
(I)	(II)	(III)	(IV)	(V)	(VI)
$ADF_{2005/2020}$	I(1) process	I(0) process	-2.481		Unit Root
$KPSS_{2005/2020}$	I(0) process	I(1) process	2.11***		Unit Root
$PV_{2005/2020}$	I(1) process	I(0) process	-2.305	2007q3***	Unit Root
$CMR_{2000/2020}$	I(1) process	I(0) process	-3.747	2004q1***,2007q3***	Unit Root

Column (I): Test type (see the Glossary above the References); Column (II): Null hypothesis under analysis; Column (III): Alternative hypothesis; Column (IV): Test statistic; Column (V): Break dates estimated (where applicable); Column (VI): Statistical decision. ***: value significant at 1%; **: value significant at 5%; *: value significant at 10%. The hypotheses concerning the integration of the series are only tested at the 5% significance level in case of the PV and CMR tests.

Table D3: Robustness: Clemente et al., Two Breaks, Opportunity Entrepreneurship, Normalized Measure, 2000-2020

Regions	$\frac{oppo_t}{emp_{t-1}}$	*Break 1 date*	*Break 2 date*
(I)	(II)	(III)	(IV)
Andalucia	-4.603	2004q1***	2006q4***
Aragon	-0.652	2004q1***	2005q3***
Asturias	-2,479	2004q1***	2007q1***
Balearic Islands	-3.636	2003q2***	2006q4***
Canary Islands	-5.860**	2004q1***	2006q3***
Cantabria	-3.383	2004q1***	2006q2***
Castile and Leon	-4.270	2004q1***	2007q3***
Castile-La Mancha	-0.687	2004q1***	2007q3***
Catalonia	-7.860**	2004q1***	2007q2*
Valencian Community	-5.307	2004q1***	2007q4***
Extremadura	-5.442	2004q1***	2007q4***
Galicia	-3.731	2004q1***	2005q4***
Community of Madrid	-3.358	2004q1***	2008q3***
Region of Murcia	-2.657	2003q4***	2008q3***
Navarre	-3.277	2004q1***	2006q3***
Basque Country	-6.021**	2004q1***	2008q1***
La Rioja	-7.033**	2004q3***	2006q2***

Column (I): Spanish autonomous regions; Column (II): test statistic, referring to the normalized variable; Columns (III) and (IV): dates for first and second detected breaks. The tests are shown in levels only. ***: value significant at 1%; **: value significant at 5%; *: value significant at 10%. The hypotheses concerning the integration of the series are only tested at the 5% significance level in this table.

Table D4: Robustness: Clemente et al., Two Breaks, Necessity Entrepreneurship, Normalized Measure, 2000-2020

Regions	$\frac{nec_t}{nonemp_{t-1}}$	*Break 1 date*	*Break 2 date*
(I)	(II)	(III)	(IV)
Andalucia	-8.944**	2004q1***	2008q4***
Aragon	-2.752	2004q1***	2012q1
Asturias	-7.931**	2004q1***	2008q4*
Balearic Islands	-4.637	2004q2***	2008q2**
Canary Islands	-4.037	2004q1***	2006q3***
Cantabria	-11.085**	2004q1***	2007q1**
Castile and Leon	-8.412**	2004q1***	2008q3***
Castile-La Mancha	-2.649	2004q1***	2013q1*
Catalonia	-1.991	2004q1***	2009q2***
Valencian Community	-1.571	2004q1***	2016q1***
Extremadura	-3.584	2004q1***	2006q4***
Galicia	-1.986	2004q1***	2005q4***
Community of Madrid	-2.627	2004q1	2016q1***
Region of Murcia	-3.250	2004q4***	2014q1***
Navarre	-9.013**	2005q1***	2006q4***
Basque Country	-1.374	2004q3***	2006q4***
La Rioja	-8.192**	2003q4**	2006q3

Column (I): Spanish autonomous regions; Column (II): test statistic, referring to the normalized variable; Column (III) and (IV): dates for first and second detected breaks. The tests are shown in levels only. ***: value significant at 1%; **: value significant at 5%; *: value significant at 10%. The hypotheses concerning the integration of the series are only tested at the 5% significance level in this table.

Table D5: Robustness: Unit Root Tests, Karavias and Tzvalis (2014)

Variable	*Statistic*	*Break date*	*Decision*
(I)	(II)	(III)	(IV)
$oppo_t$	-47.437***	2004q3***	Het. Stationarity
nec_t	-58.997***	2004q3***	Het. Stationarity
$\frac{oppo_t}{emp_{t-1}}$	-0.01***	2020q1***	Het. Stationarity
$\frac{nec_t}{nonemp_{t-1}}$	-98.631***	2000q2***	Het. Stationarity

Column (I): Transformed test objective variable; Column (II): Test statistic on the autoregressive coefficient φ; Column (III): Break date; Column (IV): Statistical decision. All the tests refer to the $M1$ test model of Equation C1. None of the test equations includes a deterministic trend. Results with a nested trend do not change the statistical decisions presented in the table. The p-value statistics for each trial were bootstrapped with 500 repetitions. ***: 1% statistical significance; **: 5% statistical significance; *: 10% statistical significance.