

SELF-EMPLOYMENT AND BUSINESS CYCLES: SEARCHING FOR ASYMMETRIES IN A PANEL OF 23 OECD COUNTRIES

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Abstract. The aim of this work is to identify whether the bidirectional relationship between entrepreneurship cycles and output gaps is asymmetric depending on the phase of the business cycle. To this end, we employ a panel threshold regression model in which different relations can prevail in each regime, defined by the values of the threshold variable. The findings of this article qualify previous empirical results. In particular, our estimates provide support for the existence of different responses – both in terms of sign and magnitude – of cyclical self-employment to output growth and of output growth to cyclical self-employment, depending on the value of the threshold variable. The result is highly important for policy makers and practitioners given that whether they ignore the asymmetric impact that an entrepreneurship promotion policy action might have on the real economy, the action might lead to unexpected effects.

Keywords: entrepreneurship, self-employment, business cycles, panel threshold models, OECD, asymmetries.

JEL Classification: L26, J23, E32, C23.

Introduction

The re-examination of the relationships between different macroeconomic variables – including entrepreneurship – and business cycles has become a hot policy issue at the time of writing because the ineffectiveness of the traditional stabilisation policies and the lack of confidence in the old active labour market policies. This fact has led to the search for alternative solutions to combat both stagnation and unemployment.

Entrepreneurship is a promising candidate in this respect, particularly if researchers can provide not only theoretical propositions but also robust evidence for how positive shocks in entrepreneurship lead to an expansionary phase of the business cycle in which case policies to promote self-employment might become a key pillar of any anti-crisis strategy.

Theoretical models posit that entrepreneurship could be either pro-cyclical or acyclical¹. In addition, arguments for counter-cyclicity are also possible: economic downturns can push people into self-employment, not only because the lack of paid-employment opportunities reduces the opportunity cost of this occupation² but also because of the higher availability of second-hand capital equipment during recessions (Binks, Jennings 1986). Thus, downturns might also induce increases in the rate of necessity entrepreneurs although it might reduce the rate of opportunity entrepreneurs. All things considered, propositions derived from theoretical models tend to agree with the basic prediction of pro-cyclicity but tend to diverge with regard to whether the relationship is lagged, led or contemporaneous, as well as on the definition of entrepreneurship. In this context, we must recognise the need to discriminate among theories and propositions and shed new light on this relationship. The availability of robust (and conclusive) empirical work on this relationship would provide the ideal tool to solve any controversial matter of this type.

However, the relationship between self-employment and GDP cycles is unfortunately far from being solidly sustained by robust empirical results. On the contrary, researchers have tested the relationship in a variety of ways: from controlling business cycle effects in empirical works with individual data on the determinants of entry (survival) into self-employment to time-series studies at the aggregate level. The latter include a handful of studies that have explored the relationship between output and entrepreneurship, relating the level of activity in the goods and services market to the level of entrepreneurship over the cycle. Taken together, these works offers inconclusive evidence that does not in any way contribute to resolving the current puzzle about this relationship.

In general, most of the previous empirical literature model the interaction between self-employment and output growth with a linear reaction function that is, by construction, symmetric. However, controlling for asymmetries by using non-linear methodologies is an advisable strategy given that: i) some theories and theoretical propositions suggest that different types of effects (in terms of intensity, sign or both) can be expected depending on the phase of the business cycle or on the situation of the self-employment sector³; ii) we should account for the possibility to calibrate the effect of an entrepreneurship policy action on the state of the economy⁴ or the effect of counter-recessionary policies on self-employment, depending on the situation of the self-employment sector; and iii) ignoring asymmetry when it is present produces not only bad forecasts but also errone-

¹ See Parker (2012) for a survey.

² The literature refers to this phenomenon by using different terms such as the “recession-push” effect, “turning unemployment into self-employment” (Baumgartner, Caliendo 2008), “necessity-” driven entrepreneurs (Reynolds *et al.* 2001), the “refugee-effect” (Carree, Thurik 2003) or even as the entry into self-employment as a “last resort”.

³ Theoretical rationales in favour of this argument may be summarised in the prosperity-pull and recession-push hypotheses.

⁴ Policy makers and practitioners ignoring the asymmetric impact that an entrepreneurship promotion policy action might have on the real economy depending on the phase of the business cycle where the action takes place might lead not only to ineffectiveness but could even have effects contrary to those desired.

ous inferences in hypothesis testing. For these reasons, the present work instead accounts for non-linearity by adopting a panel threshold regression model (Hansen 1999).

The remainder of this article is structured as follows. The next section briefly discusses the empirical evidence on entrepreneurship and the business cycle. The second section presents the different specifications and the estimation strategy. The third section describes the data and presents the results. The fourth section discusses the results. The final section concludes.

1. A selective review of empirical literature

This section provides a selective review of the recent contributions to the empirical literature on the evolution of GDP and self-employment. In general, most previous works focused on either examining the direction of the causality between business ownership and economic performance (usually tested by using Granger causality tests) or testing the two-way relationship between these two variables. Overall, the empirical results of this body of literature provide sometimes, conflicting results (see Dejardin 2011). The lack of consensus on the existence of this relationship and its direction is due to the use of different data sets and alternative econometric approaches. In Table 1, a selective summary of these empirical works is presented.

A general observation of the findings reported in this table enables us to state that the results have been mixed. On the one hand, in terms of the existence of the relationship, some studies reject it or provide weak evidence for the relationship, whereas others only focus on the causality between the two variables. Some works conclude that causality runs from entrepreneurship to economic growth (Hartog *et al.* 2010; Koellinger, Thurik 2012), whereas others state that it runs from economic growth to business ownership (Carmona *et al.* 2012; Aubrey *et al.* 2013); some studies suggest that there is no causality and in some cases even find bidirectional causality between these two variables (Parker *et al.* 2012). On the other hand, the sign of the estimated relationship seems to depend on whether the relationship is estimated in levels (i.e., estimations with trend components capturing a generally positive long-term relationship); when the estimation of the relationship is done by using de-trended components, negative relationships seem to prevail. In general, it could be argued that when time-series analysis has been applied to a single data set, results seem to be mixed as shown by the works included in the upper part of the table devoted to time-series analyses. We can classify the first empirical attempts to study this relationship in this group: they were time-series analyses using short time series with low frequencies (see Parker 1996 or Cowling, Mitchell 1997). Later, thanks to the valuable work of some researchers and institutions⁵, the re-examination of this relationship became possible. These efforts resulted in the availability of long time-series and comparable cross-country data, which allowed for the use of new econometric approaches (panel data models). In this first generation of studies with panel data, the use of pooled regression and fixed effect models was prevalent. Recently, dynamic panel data models have also been employed (Koellinger, Thurik 2012; Acs *et al.* 2012).

⁵ We refer here to the OECD, Eurostat, or the pioneering effort in harmonisation carried out by van Stel *et al.* (2010) in the EIM.

Table 1. Summary of empirical studies on the GDP-Self-Employment relationship

Model	Type of data	Country level vs. multi-country	Empirical analyses characteristics				
			Econometric approach	Author(s)	Period/frequency	GDP-self-employment relationship	Non linear
Time series	Levels	UK	Cointegration / Johansen (1988, 1991)	Parker (1996)	1959–1991	Positive relationship	
		UK	Cointegration / Engle and Granger (1987)	Cowling and Mitchell (1997)	1972:2–1992:2	Positive relationship	
		EU-12	VAR forecast errors / Den Haan (2000)	Carmona et al. (2010)	1983–2008	Mixed evidence	
		Spain	VAR forecast errors / Den Haan (2000)	Carmona et al. (2012)	1980:1–2009:4	Positive relationship	
		22 metropolitan French regions	Granger causality / Engle and Granger (1987)	Aubry et al. (2013)	1993:1–2011:4	No relationship	
		EU-12	VAR and Granger and Instantaneous causality	Carmona et al. (2010)	1983–2008	Mixed	
		Brazil, Mexico, Argentina, Colombia	VAR models and Cointegration	Friss et al. (2010)	1985:1–2004:4	Self-employment is pro-cyclical	
		Spain and USA	State space models / Jaeger and Parkinson (1990) / Pérez-Alonso and Di Sanzo (2011)	Congregado et al. (2012)	1987:2–2008:4	Negative relationship (Spain) No relationship USA	✓
		22 OECD countries	VAR + Granger causality	Koellinger and Thurik (2012)	1972–2008	Mixed results	
		Spain	VAR, Granger and Instantaneous causality	Carmona et al. (2012)	1980:1–2009:4	Y→S	
Panel	Levels	UK	VAR + Granger causality + Bai-Perron Structural breaks	Parker et al. (2012)	1978:2–2010:3	S→Y, Y→S	✓
		Sweden	VAR + Granger causality + Bai-Perron Structural breaks	Box et al. (2014)	1850–2000	Y→S	✓
		22 metropolitan French regions	Granger causality	Aubry et al. (2013)	1993:1–2011:4	Mixed results	
		18 European countries	Pooled Data (Weighted Least Square)	Audretsch et al. (2002)	1993–1997	Positive relationship	
		23 OECD countries	Pooled Data (Weighted Least Square)	Carree et al. (2002)	1976–1996	Negative relationship	
		13 OECD countries	Static Panel Data	Robson (2003)	1965–1995	No relationship	
		12 OECD countries	Multivariate Panel Cointegration (FMOLS) / Pedroni (1999, 2000)	Parker and Robson (2004)	1972–1996	Positive relationship	
		German countries	OLS regressions	Audretsch and Keilbach (2004)	1998–2000	Positive relationship	
		36 Countries	OLS (Pooled data)	Van Stel et al. (2005)	2002	Positive relationship (in highly developed countries)	
		36 Countries	OLS (Pooled data)	Wennekers et al. (2005)	2002	Negative relationship	

End of Table 1

Model	Type of data	Country level vs. multi-country	Econometric approach	Empirical analyses characteristics			
				Author(s)	Period/frequency	GDP-self-employment relationship	Non linear
		19 OECD countries	Multivariate Panel Cointegration / Maddala and Wu (1997)	Torriani (2005)	1979–2000	No relationship	
		23 OECD countries	Weighted Least Squares (pooled data)	Carree <i>et al.</i> (2007)	1972–2004	Negative relationship	
		21 OECD countries	OLS (Pooled data)	Wennekers <i>et al.</i> (2007)	1976–2004	Negative relationship	
		39 countries	Two simultaneous equations model	Van Stel <i>et al.</i> (2007)	2000–2005	Positive relationship	
		36 countries	OLS cross section	Stam and van Stel (2009)	2002–2005	Positive relationship (No relationship in poor countries)	
		21 Countries	Fixed effects	Carree and Thurik (2008)	1972–2002	Mixed relationship	
		20 OECD countries	Panel cointegration / Engle and Granger (1987)	Erken <i>et al.</i> (2008)	1971–2002	Positive relationship	
		21 OECD countries	Panel VECM / Johansen (1988)	Hartog <i>et al.</i> (2010)	1981–2006	S→Y	
		43 Belgian regions	Dynamic Panel Data / Arellano and Bond (1991)	Dejardin (2011)	1982–2006	Positive relationship	
		18 countries	Feasible least square (FGLS) and Two-stage least square (2SLS)	Acs <i>et al.</i> (2012)	1981–1998	Positive relationship	
		29 Chinese provinces	GMM	Li <i>et al.</i> (2012)	1983–2003	Positive relationship	
		22 metropolitan French regions	Panel Granger causality / Dumitrescu and Hurlin (2012) / Panel cointegration / Pedroni (1999, 2004) and Kao (1999)	Aubry <i>et al.</i> (2013)	1993:1–2011:4	Y→S No long-run relationship	
		22 OECD countries	Trivariate VAR Granger causality + Panel GMM	Koellinger and Thurik (2012)	1972–2008	S→Y	
		19 OECD countries	Multivariate VAR Generalized Least Squares	Scholman <i>et al.</i> (2014)	2000:1–2007:4 1998–2008	Negative relationship in the short run and positive in the long run	
		22 OECD countries	Bivariate correlations	Lamballais Tessensohn and Thurik (2012)	2001–2011	Negative relationship	
		22 metropolitan French regions	Panel Granger causality Dumitrescu and Hurlin (2012)	Aubry <i>et al.</i> (2013)	1993:1–2011:4	Negative relationship	

A common element in the studies reviewed until now is that they only analyse the relationship of the trend, not its cyclical components. However, the recent availability of longer and high-frequency time series has allowed for the analysis of the relationship between the fluctuations in output and the cyclical component of business ownership in both country-specific and cross-country studies (see Fiess *et al.* 2010; Carmona *et al.* 2010; Congregado *et al.* 2012; Koellinger, Thurik 2012; Parker *et al.* 2012; Scholman *et al.* 2014; Aubry *et al.* 2013 as examples of the former). In a strict sense, only these works may be regarded as studies on the relationship between business creation and business cycles⁶. Finally, and because of the sensitivity of the relationship analysis result to the sampling period even in country-specific studies, it is important to account for the possible existence of asymmetries in the relationship – i.e., allowing for nonlinearities in the relationship. Let us remember that ignoring asymmetry when it is present might produce erroneous inferences in hypothesis testing. Only a few studies have studied the possibility of a nonlinear relationship in country-specific analyses – see Parker *et al.* (2012) for the UK, Congregado *et al.* (2012) for Spain and the US and Box *et al.* (2014) for Sweden. However, to the best of our knowledge, no cross-country studies that account for nonlinearity exist at the present time. To fill this gap, the next section investigates whether self-employment rates have asymmetric responses to output gap, depending on the phase of the business cycle and analyses whether a shock in the self-employment rate has a different effect on the real economy depending on the phase of the business cycle or the cyclical evolution of the self-employment sector.

2. Model specification

As we mentioned above, in this section, we investigate not only whether cyclical self-employment influences subsequent output growth but also the reverse effect of business cycle fluctuations on cyclical self-employment. The relationship between cyclical real output and self-employment rates involves estimating the following equation:

$$\Delta s_{it} = \mu_i + \beta \Delta y_{it}, \quad (1a)$$

or its reverse:

$$\Delta y_{it} = \mu'_i + \beta' \Delta s_{it}, \quad (1b)$$

where Δs_{it} and Δy_{it} are the growth rates of self-employment and output, respectively, in period t for country i .

The previous two-way relationships described by equations 1a and 1b can be rewritten as a “gap” specification in which output and self-employment are measured in terms of the cyclical components or deviations from long-term trends. In general, this empirical relationship can be represented by the following set of equations:

$$y_{it}^c = y_{it} - y_{it}^n; \quad (2)$$

$$s_{it}^c = s_{it} - s_{it}^n; \quad (3)$$

⁶ We are conscious of the existence of an extant body of empirical literature on the relationship between unemployment and self-employment cycles at the aggregate level but the study of this relationship is out of the scope of this article.

$$y_{it}^c = \mu_i + \beta s_{it}^c + \varepsilon_{it}, \tag{4a}$$

or, alternatively, by:

$$s_{it}^c = \mu'_i + \beta' y_{it}^c + \varepsilon_{it}, \tag{4b}$$

where y_{it}^c captures the cyclical level of output (output gap), y_{it} is the log of the actual output, and y_{it}^n is the trend level of the output; correspondingly, s_{it}^c represents the cyclical self-employment rate (self-employment gap), s_{it} is the observed self-employment rate, and s_{it}^n is the natural self-employment rate. In contrast to Equation (1), these two Equations (4a and 4b) require information about self-employment and output trends, which are directly unobservable. Because it is the most common practice, we will consider the Hodrick-Prescott filter (Hodrick, Prescott 1997).

An alternative specification for the baseline models (4a and 4b) is given by:

$$y_{it}^c = \mu_i + \beta_s s_{it-1}^c + \beta_u u_{it}^c + \varepsilon_{it}; \tag{5a}$$

$$s_{it}^c = \mu'_i + \beta'_y y_{it-1}^c + \beta'_u u_{it}^c + \varepsilon_{it}, \tag{5b}$$

where the new term u_{it}^c is included to capture the inertia of the series that is not captured by s_{it}^c and y_{it}^c , respectively⁷.

2.1. Asymmetry

Although there is a substantial body of evidence supporting the notion that time series exhibit asymmetric behaviour over business cycles, the empirical literature concerning entrepreneurship and business cycles in which nonlinearities are taken into consideration is not too extensive. Certainly, most previous works model the relationship implicitly or explicitly by means of a linear reaction function that assumes, by construction, symmetric behaviour over the different phases of the business cycle. There are two possible reasons why we should check for asymmetry. On the one hand, ignoring the existence of asymmetry when it is present leads to a mis-specified model, which produces bad forecasts and erroneous inferences in hypothesis testing. On the other hand, incorrect inferences delay the opportunity to obtain a correct calibration of policies. To avoid these problems, we are going to extend our benchmark equations by allowing for different effects among different regimes defined by the output growth data or the cyclical self-employment data.

For these two reasons, we apply a class of panel threshold models developed by Hansen (1999) to characterise the relationship between cyclical self-employment and output gap

⁷ In Hartog *et al.* (2010), the effect of business ownership on GDP is contemporaneous, whereas the work of Carree and Thurik (2008) includes alternative lag structures. We argue that GDP growth may only have an impact on cyclical self-employment in future quarters/years. Because our analysis is focused on short-run impacts we will use a lag of one year for each variable in each equation for the lag structure. With regard to the reverse relationship, we will also argue that cyclical self-employment only has an impact on cyclical GDP after a certain amount of time since the start-up. We also assume a lag of one year.

in which parameters vary not only across individuals but also with time, allowing for the presence of asymmetries in the self-employment dynamics over the business cycle or in the reverse relationship. The two models are now defined as follows:

$$s_{it}^c = \mu'_i + \beta'_{y0} y_{it-1}^c I(d_{it} \leq k) + \beta'_{y1} y_{it-1}^c I(d_{it} > k) + \beta'_u u_{it}^c + \varepsilon_{it}; \quad (6a)$$

$$y_{it}^c = \mu_i + \beta_{s0} s_{it-1}^c I(d_{it} \leq k) + \beta_{s1} s_{it-1}^c I(d_{it} > k) + \beta_u u_{it}^c + \varepsilon_{it}, \quad (6b)$$

where μ_{i-1} is a fixed effect, d_{it} is the threshold variable, and k is the threshold parameter. I is the Heaviside indicator function, which equals 1 when the threshold condition is satisfied and 0 otherwise. In sum, in this model, the observations are divided into two regimes depending on whether the threshold variable d_{it} is smaller or greater than the threshold parameter k . The two regimes are distinguished by different regression slopes, β_0 and β_1 .

However, there is no reason to impose only two regimes. A more general specification with r thresholds will take the form of:

$$s_{it}^c = \mu'_i + \beta'_{y0} y_{it-1}^c I(d_{it} \leq k_1) + \beta'_{y1} y_{it-1}^c I(k_1 < d_{it} \leq k_2) + \dots + \beta'_{yr} y_{it-1}^c I(d_{it} > k_r) + \beta'_u u_{it}^c + \varepsilon_{it}; \quad (7a)$$

$$y_{it}^c = \mu_i + \beta_{s0} s_{it-1}^c I(d_{it} \leq k_1) + \beta_{s1} s_{it-1}^c I(k_1 < d_{it} \leq k_2) + \dots + \beta_{sr} s_{it-1}^c I(d_{it} > k_r) + \beta_u u_{it}^c + \varepsilon_{it}. \quad (7b)$$

These two equations will be the benchmark for the estimates reported in the next section.

3. Estimation and tests

This section presents the empirical results for the bidirectional relationship between cyclical self-employment and output gaps represented by Equations (7a) and (7b) based on the two alternative threshold variables mentioned above. More specifically, we compare results from the use of lagged cyclical self-employment as the threshold variable with those based on the lagged cyclical output. The obtained empirical results are presented in two steps. First, we look for threshold variables. Second, we report estimates of the relationship between entrepreneurship and output for the different subsamples – regimes.

3.1. Data

As already mentioned, our goal is to verify whether the two-way relationship between output gap and cyclical self-employment exhibits nonlinear or asymmetric behaviour. To this end, we use a sample of over four decades of annual time-series data from 23 OECD countries. In particular, we use data from Australia, Canada, Iceland, Japan, New Zealand, Norway, Switzerland, the United States and the EU-15 for the period from 1972 to 2011. Entrepreneurship is operationalised in terms of self-employment,

reflecting data availability at the time-series level. The *business ownership rate* (self-employment rate) is the number of business owners divided by the total labour force. Business owners are defined as the total number of unincorporated and incorporated self-employed individuals outside the agriculture, hunting, forestry and fishing industries – see Van Stel (2005: 108). These data are taken from EIM's COMPENDIA database (version 2011.1). *GDP* is taken from OECD National Accounts and is measured in millions of US \$ at 2000 constant prices.

3.2. Threshold variables

The next step should be the estimation of panel transition regression models (7a) and (7b) in which the determination of the threshold variable plays a crucial role in the strategy. We consider two potential candidates: cyclical self-employment and output gap lagged by one period.

On the one hand, in Equation 7a (7b), it appears plausible that past cyclical self-employment influences regime switching: a higher cyclical self-employment rate (output growth) implies a different impact on cyclical output (cyclical self-employment) than a lower level if entrepreneurship exhibits decreasing marginal returns. On the other hand, it is also possible that the transitions are induced by the phase of the business cycle, which is one of the main hypotheses to be tested in this work. As usual in the estimation of panel threshold regression models, we discriminate between these two candidates according to a statistical criterion. In particular, we choose those variables that i) minimise the sum of squared residuals (Hansen 1999) and ii) lead to the strongest rejection of the linearity hypothesis as threshold variables.

After selecting the threshold variables, the estimation of the panel threshold regression model⁸ defined by Equations (7a) and (7b) involves i) checking whether the threshold effect is statistically significant relative to a linear specification and, if this is the case, ii) determining the number of thresholds. In particular, the null hypothesis is tested through a likelihood ratio test⁹. This sequential process stops when the null is not rejected.

In our case, the results of both the linearity tests and the determination of the number of thresholds for models (7a) and (7b) are reported in Table 2. For the model described in Equation (7a), the F_1 linearity test clearly leads to the rejection of the null hypothesis of the linearity of the relationship between cyclical self-employment and the output gap, only when the lagged cyclical self-employment is the chosen threshold variable. This evidence corroborates the decision of estimating the relationship that runs from self-employment to output gap in a nonlinear form. The F_2 likelihood ratio test is also significant at the 10 and 1 percent levels for the lagged cyclical self-employment. This finding means that there are at least three regimes.

⁸ Since the variables need to be stationary in order to run the panel threshold regression, unit root tests have been applied. The results shows that the cycles used are stationary. Results available upon request.

⁹ In this test, the sum of the squared residuals of the specification with r regimes is tested against the specification with $r+1$ regimes.

Table 2. Linearity test and tests for threshold effects

	Equation 7a (threshold variable)		Equation 7b (threshold variable)	
	\mathcal{J}_{it-1}^c	s_{it-1}^c	\mathcal{J}_{it-1}^c	s_{it-1}^c
Test for single threshold (two regimes)				
RSS	70.463	68.076	0.257	0.254
F_1	9.431	37.946	5.531	16.316
p-value	0.220	0.000	0.443	0.013
(10%, 5%, 1% critical values)	(12.470, 15.504, 20.179)	(9.813, 12.422, 24.547)	(9.722, 11.809, 15.015)	(7.274, 8.236, 12.649)
Test for double threshold (three regimes)				
RSS	66.452		0.252	
F_2	19.673		4.702	
p-value	0.000		0.220	
(10%, 5%, 1% critical values)	(7.628, 9.895, 11.290)		(6.411, 7.675, 10.448)	
Test for triple threshold (four regimes)				
RSS	66.129			
F_3	3.940			
p-value	0.500			
(10%, 5%, 1% critical values)	(8.443, 10.354, 14.131)			

Notes: F_1 , F_2 and F_3 are the likelihood ratio statistics. p-values are obtained with 300 simulations (Hansen 1999). RSS: Residuals Sum of Squared.

According to the procedure proposed by Hansen, it would be necessary in this case to estimate and test three thresholds, four thresholds and so on, until the corresponding F-test is statistically non-significant. Following this strategy, the F_3 likelihood ratio test is not statistically significant. Moreover, the presence of a strong threshold effect is detected when lagged self-employment is selected as a threshold variable. Therefore, the selected model is the one with three regimes, whose optimal threshold variable is cyclical self-employment lagged by one period, which minimises the sum of squared residuals.

Estimated threshold values for this three-regime model and the parameter estimates with the corresponding *t*-statistics are reported in Table 3. These parameters indicate when the switching between any of the three regimes occurs. For instance, if cyclical self-employment is greater than -0.444 and less than 0.315 , the country concerned switches to the second regime. For cases in which the deviation between the observed and natural self-employment rates – in absolute values, i.e., extreme regimes – is higher, output gap and cyclical self-employment show a positive relationship.

Table 3. Threshold estimates

	Model 7a		Model 7b	
	Estimate	95% Confidence interval	Estimate	95% Confidence interval
$\hat{\gamma}_1^r$	-0.444	[-0.445, -0.440]	-0.429	[-0.445, 0.398]
$\hat{\gamma}_2^r$	0.315	[0.240, 0.478]		

Table 4. Regression estimates of model

Model 7a		Model 7b	
Regressor	Coefficient estimate	Regressor	Coefficient estimate
$y_{it}^c I(s_{it-1}^c \leq -0.444)$	9.799*** (1.729)	$s_{it}^c I(s_{it-1}^c \leq -0.429)$	0.017*** (0.005)
$y_{it}^c I(0.315 > s_{it-1}^c > -0.444)$	-1.612*** (0.573)	$s_{it}^c I(s_{it-1}^c > -0.429)$	-0.004* (0.002)
$y_{it}^c I(s_{it-1}^c > 0.315)$	3.549*** (1.160)	u_{it}^c	-0.016*** (0.006)
u_{it}^c	-0.030*** (0.012)		

Note: Standard error in brackets. ***, ** and * indicate significance at 1%, 5% and 10%, respectively.

However, when the difference between the observed and natural self-employment rates is small in magnitude, in the second regime, the relationship becomes negative. Furthermore, and in light of these results, we note that the relationship between cyclical self-employment and cyclical output (9.799) is stronger in the lowest and highest regimes (3.549). Conversely, the link is weaker in the intermediate regime (-1.612).

According to the estimated threshold values, we can deduce the distribution of the countries among the different regimes (Table A1 in the annex). We observe that the majority of observations are in the second regime, which corresponds to a negative relationship. Observations from Portugal, Greece and Ireland are often in the extreme regimes. We may observe once again that thresholds allow for heterogeneity and time instability to be taken into account. Consequently, effective counter-recessionary economic policies only could encourage entrepreneurship in the two extreme regimes.

For the model described in Equation 7b in which output gap is the endogenous variable, the F_1 linearity test also leads to the rejection of the null hypothesis of linearity only in the case in which lagged cyclical self-employment is used as a threshold. As in model 7a, the test indicates the convenience of estimating the model in nonlinear form with two regimes. Therefore, the selected model is the one with two regimes in which the optimal threshold variable is the lagged cyclical self-employment.

Threshold values for this model and the estimates of the parameters for the two regimes are reported in Tables 3 and 4, respectively. If lagged cyclical self-employment is greater than -0.429, the country concerned switches to the second regime. If the deviation

between the observed and natural self-employment rates is lower than -0.429 , a higher cyclical self-employment leads to a positive impact on cyclical output. The distribution of the countries among the different regimes and thresholds for different countries are presented in Table A1.

4. Discussion

We have tested whether the relation between entrepreneurship cycles (business creation) and business cycles is nonlinear. Estimating the two-way relationship and accounting for the possibility of nonlinear effects, the results qualify previous empirical studies and suggest that different types of effects prevail in different regimes. In short, the panel regression estimates from these regimes confirm that the two relationships are time-varying. For the first model, the intensity and sign of the output growth effect on cyclical self-employment in the two extreme regimes indicates the existence of a positive relationship between cyclical self-employment and the output gap, whereas a negative relationship characterises the second regime in which most of the observations are included. In terms of prior empirical literature, our findings are broadly consistent with previous studies which have related self-employment rates to aggregate economic performance (Fritsch, Mueller 2004; Thurik *et al.* 2008; Koellinger, Thurik 2012; Congregado *et al.* 2012; Parker *et al.* 2012). In particular, this paper has contributed to clarifying, to some extent, the puzzle in the literature on the cyclical nature of self-employment. Testing for the presence of asymmetries in the relationships, our results suggest that the interplay between entrepreneurship and business cycles differs depending on the state of the self-employment sector. Importantly, rather than rejecting previous evidence, our results serve to qualify its scope.

Conclusions

On the basis of our results some tentative recommendations can be advanced for practitioners. In this respect, our results should be considered not only as evidence in favour of the positive effects of entrepreneurship policy in combating stagnation and unemployment but also with regard to the issue of how counter-recessionary economic policy at the macro level helps to encourage self-employment. Therefore, the favourable effects of entrepreneurship promotion policies on output growth are guaranteed when cyclical self-employment rates are notably lower than the equilibrium rates. This result is highly important in light of the current situation in many countries in which other policies are failing to combat unemployment and to recover sustainable growth paths.

In addition, the evidence provided also suggests that effective policies at the macro level are also good strategies for encouraging high-quality entrepreneurship in order to stimulate employment and innovation, but only when cyclical self-employment is in the two extreme regimes – i.e., when the deviation of the self-employment rate from its natural value reaches extreme values.

Nevertheless, despite the importance of our findings, we should not forget that self-employment is not an unambiguously valid operationalization of entrepreneurship. This

limitation should be borne in mind when interpreting the results. In this article, the operationalization has been dictated by data availability considerations being aware that we only can aspire to capture a partial and incomplete representation of the entrepreneurship concept. With this caveat in mind, the empirical interpretability of our results is likely restricted to the specialized domain of entrepreneurship operationalized in terms of self-employment. Nevertheless, the availability of long time series of alternative indicators capturing the different elements that entrepreneurship involves is a major challenge for further research. Then, future work might fruitfully apply the methodology used in this article to a broader concept of entrepreneurship, and should also seek to apply it to the analysis of the impact of entrepreneurship not only on the economic growth but also on job creation or poverty reduction.

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APPENDIX

Table A1. Data distribution between regimes and countries

	Model a			Model b	
	Lower	Middle	Upper	Lower	Upper
Australia	3	28	9	4	36
Austria	0	35	5	1	39
Belgium	0	38	2	0	40
Canada	3	31	6	3	37
Denmark	1	38	1	1	39
Finland	1	35	4	1	39
France	0	39	1	0	40
Germany	0	40	0	0	40
Greece	8	25	7	7	33
Iceland	5	27	8	4	36
Ireland	2	34	4	3	37
Italy	1	35	5	2	38
Japan	0	40	0	0	40
Luxembourg	0	40	0	0	40
The Netherlands	0	39	1	0	40
New Zealand	5	29	6	5	35
Norway	4	30	6	4	36
Portugal	8	20	12	8	32
Spain	4	29	7	4	36
Sweden	2	34	4	2	38
Switzerland	1	35	4	1	39
United Kingdom	5	30	5	5	35
United States	0	39	1	0	40

Note: The threshold variable is the cyclical self-employment lagged by one period.

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