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Testing for Hysteresis in Entrepreneurship in 23 OECD Countries

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Abstract

We explore the macro structure of entrepreneurship rates in a panel of 23 OECD countries over 1972-2006. We find that rates of entrepreneurship in OECD's countries exhibit persistence rather than hysteresis. Implications for the design of entrepreneurship policies are discussed.

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1. Introduction

How durable are shocks to entrepreneurship? In the light of continued growth in public policy programs designed to promote entrepreneurship across the OECD, it is timely to explore this question. Taking our cue from the unemployment literature (Røed, 1997; Camarero et al, 2006), we associate temporary shocks to entrepreneurship with mean-reversion to a "natural rate", while permanent shocks are associated with "hysteresis". An intermediate case is "persistence", where rates of entrepreneurship are stationary around a shifting natural rate.

This paper exploits harmonized data on 23 OECD countries over 1972—2006 to investigate the macro structure of entrepreneurship. The data are briefly discussed in Section 2. This study differs from previous research which has analyzed the time-series properties of entrepreneurship rates in single country settings without allowing for the possibility of structural breaks (Parker, 1996; Cowling and Mitchell, 1997; Bruce and Mohsin, 2006). In contrast, this study obtains greater test power by exploiting the cross-section dimension as well as the time-series dimension of the panel, and considers the possibility of structural breaks in the data generation process. To set our results in context, we present results derived from panel data unit root and stationarity tests which both do and do not incorporate structural breaks. Section 3 describes the tests. Section 4 presents the results, including those derived from running a novel test recently developed by Carrión-i-Silvestre, del Barrio and López-Bazo (2005) which allows for structural breaks. Breaks are found to be important features of the data. Our results distinguish between the three competing hypotheses of a natural rate, persistence and hysteresis. Implications for entrepreneurship policy are briefly laid out in the conclusion in Section 5.

2. Data

Following the bulk of previous research in the economics of entrepreneurship, self-employment is used as an operational definition of entrepreneurship (Parker, 2009). Specifically, we measure national non-agricultural self-employment rates, for 23 OECD countries over 1972—2006. Advantages of self-employment data include comprehensiveness, widespread availability, and consistency with the conceptual notion of entrepreneurs as risk-taking residual claimants (Knight, 1921).

Because of different conventions adopted by national statistical agencies, raw data on self-employment rates can be misleading for international comparisons. For example, US self-employment rates published in the OECD *Labor Force Statistics* exclude the owners of incorporated businesses, in contrast to the rates of European countries, which include them. Other differences relate to the inclusion or exclusion of part-time self-employees. Fortunately, the Compendia database (van Stel, 2008) has meticulously harmonized these data to enable international comparisons.

Table 1 presents some summary data on the evolution, both in absolute numbers and as a percentage of the labor force, of entrepreneurship rates in OECD countries using the COMPENDIA data set. In 2006 the average business ownership rate in the 23 countries was 10.9%, but there is clearly plenty of variation around this average. For instance, in Greece and Italy about one in every five members of the labour force are entrepreneurs, whereas less than one in every fourteen are entrepreneurs in Denmark, Switzerland and Luxembourg. Time-averaged summary statistics appear in Table 2.

[INSERT TABLES 1 AND 2 AROUND HERE]

3. Unit root and stationarity tests without structural breaks

We first use a battery of traditional panel unit root tests without breaks such as those proposed by Levin, Lin and Chu (2002), Breitung (2000), Im, Pesaran and Shin (2003), Hadri (2000), and the Fisher-ADF and the Fisher-PP proposed by Maddala and Wu (1999). Levin, Lin, and Chu (LLC henceforth), Breitung, and Hadri's tests all assume that there is a common unit root process so that is identical across cross-sections. By contrast, the Im, Pesaran and Shin's test (IPS henceforth), and the Fisher-ADF and Fisher-PP tests all allow for individual unit root processes so that may vary across cross-sections, combining of individual unit root tests to derive a panel-specific result and employing the existence of a unit root as a null (except in the Hadri's test).

However, there is a consensus about that in the presence of structural breaks the traditional unit root tests tend to under-reject the null of a unit root. Thus, we proceed to compute the extension of the Hadri (2000) test for stationary in variance in panel data with multiple structural changes under the null hypothesis, developed by Carrión-i-Silvestre et al. (2005) – CBL henceforth. This approach controls for heterogeneity since it allows for multiple structural changes and different number of breaks for each individual.

Carrión-i-Silvestre et al. (2005) specify the following DGP under the null hypothesis of stationary in variance:

$$E_{i,t} = \alpha_i + \sum_{k=1}^{m_i} \theta_{i,k} DU_{i,k,t} + \beta_i t + \sum_{k=1}^{m_i} \gamma_{i,k} DT^{*}_{i,k,t} + \varepsilon_{i,t} \tag{1}$$

Where $E_{i,t}$ represents self-employment rate in country *i* at time *t*; where *i=1...N* and *t=1...T*, stand for the number of countries and time periods, respectively. The dummy variables for the changes in level and slope are given by $DU_{i,k,t}$ and $DT^{*}_{i,k,t}$, respectively, such that $DU_{i,k,t} = 1$ for $t > T^{i}_{b,k}$ and 0 otherwise, with $T^{i}_{b,k}$ denoting the k^{th} break location for the i^{th} individual for $k = 1,..., m_i$, $m_i \geq 1$. Likewise, $DT^{*}_{i,k,t} = t - T^{i}_{b,k}$, for $t > T^{i}_{b,k}$ and 0, otherwise. Finally the terms $\varepsilon_{i,t}$ are assumed to be independent across countries. Therefore, this model includes the following elements: *i)* Individual effects that are in fact individual structural break effects (or shifts in the mean caused by the structural breaks), *ii)* temporal effects if $\beta_i \neq 0$ and *iii)* temporal structural break effects if $\gamma_{i,k} \neq 0$ – when there are shifts in the individual structural time trend.

In sum, this specification is general enough to allow for unit-specific intercepts and time trends in addition to unit-specific mean and slope shifts. The test of the null hypothesis of a stationary panel follows Hadri (2000), who designs a test statistic that is simply the average of the univariate stationary test of Kwiatkowski et al. (1992) (KPSS hereafter). Therefore, CBL compute the panel stationary test as the average of univariate KPSS tests, that is:

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

where $LM(\hat{\lambda}_i) = \hat{\psi}_i^{-2} T^{-2} \sum_{t=1}^{T} \hat{S}^{2}_{i,t}$ is the univariate KPSS test for individual *i*, and $\hat{S}_{i,t} = \sum_{j=1}^{t} \hat{\varepsilon}_{i,j}$ stands for the partial sum process that is obtained using the estimated OLS residuals of Eq. (1), with $\hat{\psi}_i^2$ as the consistent estimate of the long-run variance of residual $\varepsilon_{i,t}$.

Because the test is dependent on the location of the breaks (λ_i), which is unknown, we use the procedure of Bai and Perron (1998), which is based on the global minimization of the sum of squared residuals, to determine the break locations for each unit. After the dates for all possible $m_i \leq m^{\max}$ for each *i* are estimated – being *m* and $m^{\max}$ the number of breaks and the maximum number of breaks, respectively – we must select the appropriate number of structural breaks. To this end, we use the modified Schwarz Information Criterion (LWZ) of Liu, Wu and Zidek (1997). The normalized test statistic is then computed as follows:

$$Z(\hat{\lambda}) = \frac{\sqrt{N}\left[\eta(\hat{\lambda}) - \bar{\xi}\right]}{\bar{\varsigma}} \xrightarrow{d} N(0,1) \tag{3}$$

where $\bar{\varsigma}^2$ and $\bar{\xi}$ are computed as the respective averages of the individual means and variances of $LM_i(\hat{\lambda}_i)$. The limiting distribution of the statistic is derived using sequential asymptotic theory in which $T \to \infty$ is followed by $N \to \infty$. Since the $Z(\hat{\lambda})$ statistic assumes cross-sectional independence, which is unlikely to hold in practice, we compute the bootstrap distribution of the panel stationary test with multiple breaks following Maddala and Wu (1999), in order to allow for any kind of cross-sectional dependence.

4. Empirical results

Table 3 reports the panel unit root and stationarity tests without allowing for structural breaks. The findings appear consistent: all of the tests suggest that entrepreneurship rates in these 23 OECD countries follow a unit root process. Therefore, these results seem to point to strong evidence of hysteresis (in the sense of Layard et al, 1991) – in rates of entrepreneurship for this group of countries.

[INSERT TABLE 3 AROUND HERE]

However, these conclusions are based on unit root tests that under the alternative assume a constant, unique, natural rate of entrepreneurship. In other words, these unit root tests are not robust to the presence of structural breaks, given that the presence of structural breaks might be shifting the natural rate. This fact is not surprising as the natural rate depends on the fundamentals of the economy and these fundamentals can change in accordance to institutional reforms or technological progress.

To deal with this issue, Table 4 presents the results from the panel stationary test of CBL that allows for up to five level and slope shifts in the trend function. Panel A reports the results from individual KPSS test with multiple breaks. In general, at least one structural break was detected in all countries considered and, in nine of them we found up to three breaks. As reported in Panel B of the table, the panel KPSS test assuming asymptotic normality and cross-independence rejects the null hypothesis in favour of hysteresis at the 1 per cent level.

However, these conclusions are overturned when we consider the critical values from the bootstrap distribution. Thus, as widely recognized in the literature, the assumption of cross-sectional independence led us to spuriously reject the null as a result of size distortions. But, *after allowing for cross-sectional dependence*, the critical values shift dramatically to the right of the upper tail of the standard normal distribution indicating that the null hypothesis (hysteresis) cannot be rejected at the 5% level – see Panel C in Table 4. Therefore, our most robust results actually suggest that entrepreneurship rates in our sample of OECD's countries exhibit persistence rather than hysteresis.

[INSERT TABLE 4 AROUND HERE]

5. Concluding remarks

This paper investigated the hysteresis hypothesis in rates of non-agricultural self-employment ("entrepreneurship") for 23 OECD countries over 1972—2006. Whereas panel unit and stationarity tests suggested that entrepreneurship rates exhibits hysteresis, i.e. evolve as unit root processes, allowing for multiple structural breaks (courtesy of Carrión et al’s, 2005, test) reveals the converse. The statistical implication is that shocks have highly persistent but not permanent effects on entrepreneurship.

The economic implications of these findings include the following observations. First, shocks induced by public policy measures (e.g. the introduction of loan guarantee schemes, publicly-subsidized start-up support services, changes in entry regulations, etc) will not have permanent effects on national rates of entrepreneurship. Instead, their effects will die out over time. Whether such policy changes shift the “natural rate” of entrepreneurship has not been established in this paper, however. That would be a suitable topic for a more thorough-going project which might explore the association between structural breaks and policy shifts. Second, classical econometric models such as least squares remain will remain valid when analyzing data on entrepreneurship rates; an important implication for researchers however is the need to condition on changes in economic and policy regimes in so doing.

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Table 1. Summary of non-agricultural self-employment in the OECD

Country	Number of business owners (x 1,000)			Business ownership rate in labor force (%)		
	1972	**1989**	**2006**	**1972**	**1989**	**2006**
Austria	281	247	375	9.3	7.2	9.1
Belgium	423	489	527	11.1	11.8	11.1
Denmark	200	173	201	8.2	6.0	6.9
Finland	145	208	230	6.6	8.1	8.6
France	2468	2443	2336	11.3	9.9	8.4
Germany*	2070	2129	4033	7.6	7.1	9.7
Greece	524	745	963	16.1	18.8	19.7
Ireland	86	131	233	7.7	10.2	11.1
Italy	3190	4563	5221	16.2	19.8	21.0
Luxembourg	15.6	12.4	15.8	10.5	6.8	4.8
Netherlands	564	536	979	9.7	8.0	11.5
Portugal	435	627	701	12.1	13.4	12.9
Spain	1551	1901	2872	11.6	12.3	13.3
Sweden	292	310	380	7.4	6.9	8.5
UK	2002	3210	3466	7.9	11.3	11.2
EU-15	**14248**	**17725**	**22532**	**10.4**	**11.4**	**12.1**
Iceland	9.4	12.9	19.7	9.6	9.1	11.3
Norway	165	174	214	9.7	8.1	8.8
Switzerland	225	268	296	6.3	6.9	6.9
United States	7354	13708	15385	8.2	10.8	10.1
Japan	6479	7564	5830	12.5	12.1	8.8
Canada	734	1490	2127	7.9	10.5	11.8
Australia	734	1304	1691	12.6	15.8	15.9
New Zealand	138	199	289	10.6	12.2	13.1
Total	**30086**	**42444**	**48384**	**10.0**	**11.3**	**10.9**

* West-Germany for 1972 and 1989.

Note: Business ownership is defined as including both the owner-managers of incorporated and unincorporated businesses, but excluding unpaid family workers and wage-and-salary workers operating a side-business as a secondary work activity. Business owners in the primary sectors of the economy are also excluded. See van Stel (2008).

Data Source: EIM: COMParative Entrepreneurship Data for International Analysis. Source of table: Wennekers et al. (2008).

Table 2. Time-averaged summary statistics

Country	Mean	Maximum	Minimum	Std. Dev.
Austria	0.076	0.093	0.064	0.008
Belgium	0.113	0.126	0.104	0.007
Denmark	0.068	0.084	0.056	0.008
Finland	0.072	0.086	0.059	0.009
France	0.095	0.113	0.081	0.009
Germany	0.076	0.097	0.065	0.009
Greece	0.187	0.202	0.161	0.010
Ireland	0.099	0.117	0.077	0.014
Italy	0.190	0.210	0.159	0.019
Luxembourg	0.074	0.105	0.048	0.015
The Netherlands	0.091	0.115	0.078	0.011
Portugal	0.137	0.168	0.111	0.017
Spain	0.120	0.133	0.105	0.009
Sweden	0.074	0.085	0.065	0.006
United Kingdom	0.096	0.116	0.071	0.015
Iceland	0.095	0.116	0.074	0.014
Norway	0.080	0.097	0.064	0.009
Switzerland	0.070	0.087	0.062	0.007
USA	0.099	0.109	0.082	0.009
Japan	0.114	0.131	0.088	0.015
Canada	0.106	0.140	0.074	0.020
Australia	0.156	0.168	0.126	0.010
New Zealand	0.119	0.144	0.090	0.017

Table 3: Panel unit root and stationary tests without structural breaks for 23 OECD countries

Method	Statistic
LLC	0.198
Breitung	4.708
IPS	2.556
Fisher-ADF	28.016
Fisher-PP	38.909
Hadri	8.536***

Notes: LLC and IPS represent the panel unit roots test of Levin et al. (2002) and Im et al. (2003), respectively. Fisher-ADF and Fisher-PP represent the Maddala and Wu (1993) Fisher-ADF and Fisher-PP panel unit root tests, respectively.

*** indicates statistical significance at the 1 percent level.

Probabilities for Fisher-type tests are computed by using an asymptotic chi-square distribution. All other tests assume asymptotic normality.

A time trend and an intercept included in all underlying specifications. The modified AIC was used to select the optimal lag length.

Table 4: Individual and panel KPSS test statistics. Sample 1972-2006 (T=35)

Panel A: Country specific test

Country	Test	m_i	$\hat{T}^1_{b,1}$	$\hat{T}^1_{b,2}$	$\hat{T}^1_{b,3}$	$\hat{T}^1_{b,4}$	$\hat{T}^1_{b5}$
Austria	0.079	1	1985				
Belgium	0.182	2	1980	1997			
Denmark	0.105	1	1988				
Finland	0.504	3	1977	1985	1991		
France	0.035	4	1977	1987	1993	2002	
Germany	0.213	4	1981	1991	1997	2002	
Greece	0.099	3	1983	1991	1999		
Ireland	0.063	2	1981	1996			
Italy	0.024	2	1978	1991			
Luxembourg	0.090	1	1994				
The Netherlands	0.028	2	1983	1993			
Portugal	0.403	3	1981	1986	1994		
Spain	0.108	2	1977	1987			
Sweden	0.162	1	1993				
United Kingdom	0.127	3	1980	1989	1999		
Iceland	0.068	2	1983	1995			
Norway	0.068	2	1982	2002			
Switzerland	0.107	3	1979	1991	2000		
USA	0.072	4	1977	1983	1988	1999	
Japan	0.189	3	1979	1988	1994		
Canada	0.045	1	1997				
Australia	0.041	1	1981				
New Zealand	0.104	2	1982	1995			

Panel B: Panel KPSS test with multiple breaks assuming cross-section independence		
	Test	p value
$Z(\hat{\lambda})$ (homogeneous)	15.795	0.000
$Z(\hat{\lambda})$ (heterogeneous)	40.480	0.000

Panel C: Bootstrap distribution (allowing for cross-section dependence)				
	90%	95%	97.5%	99%
$Z(\hat{\lambda})$ (homogeneous)	15.342	16.659	17.841	19.587
$Z(\hat{\lambda})$ (heterogeneous)	55.125	60.351	65.426	71.652

Notes: The specification contains country-specific intercepts and linear trends. $Z(\hat{\lambda})$ (homogeneous) and $Z(\hat{\lambda})$ (heterogeneous) denote the panel stationary test with multiple breaks developed by Carrion-i-Silvestre et al. (2005) for the case of homogeneity and heterogeneity, respectively, in the estimation of the long-run variance. The bootstrap distribution for $Z(\hat{\lambda})$ is based on 20.000 replications. The number of break points has been estimate using the LWZ information criteria allowing for a maximum of m_i =5 structural breaks.