Empirica (2007) 34:89–115
DOI 10.1007/s10663-006-9022-z

ORIGINAL PAPER

Regional and sector-specific determinants of industry dynamics and the displacement–replacement effects

J. M. Arauzo · M. Manjón · M. Martín · A. Segarra

Published online: 28 February 2007

Abstract In this paper, we empirically assess the importance of regional and sector-specific determinants of industry dynamics. To this aim we test three hypotheses (originally proposed by Shapiro and Khemani (1987, Int J Indust Organ 5:15–26)) for the relationship between the entry and exit of firms: independence, symmetry and simultaneity. Estimates from a panel data system of equations seem to confirm the simultaneity hypothesis for Spain, i.e. we find evidence of a displacement (replacement) effect between the gross rate of entry (exit) and the gross rate of exit (entry). Also, our results show that, irrespective of the hypothesis we use, both sectorial and regional variables affect entry and exit.

Keywords Industry dynamics · Manufacturing · Regions

JEL C33 · R19 · R30

1 Introduction

The entry of new firms in a market is linked, among other factors, to the profits they expect to make, to the barriers to entry and to territorial factors that shape the environment in that region. The exit of firms, on the other hand, depends on factors such as the economic cycle, sunk costs and geographical variables that affect the ability of companies to survive (Caves 1998; Geroski 1995). We may therefore be tempted to conclude that the relation

J. M. Arauzo · M. Manjón (✉) · M. Martín · A. Segarra
Faculty of Business and Economics, Department of Economics and GRIT, Rovira i Virgili University, Av. de la Universitat, 1, 43204 Reus, Spain
e-mail: mma@urv.net

between entries and exits is likely to be weak, since the variables that affect the decision to enter are different from the variables that affect the decision to leave. However, this turns out to be a misleading conclusion because these are not isolated phenomena.

In fact, the correlation between the regional rates of entry and exit is usually strong (Keeble and Walker 1994; Reynolds et al. 1994). Empirical evidence also shows that entry and exit are closely related within manufacturing sectors. That is, industries with high rates of entry also have high rates of exit, and vice versa (Dunne and Roberts 1991). These two stylised facts suggest that the entries and exits of the markets are not independent processes but ones that are somehow interrelated. Entries can create a displacement effect that causes exits to increase and exits can free niches in the market and business resources that speed up the ability of potential producers to respond by entering (Acs and Audretsch 1990; Audretsch 1995). The question that arises is how to empirically assess these relations.

In this paper we will use a system of equations under three different scenarios originally proposed by Shapiro and Khemani (1987) in the form of alternative hypotheses. First, the symmetry hypothesis states that there is a link between entry and exit such that barriers to entry are also barriers to exit. Second, the simultaneity hypothesis states that the interdependence between entry and exit is derived not only from a symmetrical relationship, but also from the effects that entries have on exits, and vice versa. Third, the independence hypothesis states that there is no such link between entry and exit. Other studies have also used this type of approach but, on the whole, the empirical evidence is rather scarce.[1]

This paper aims to fill this void to some extent by presenting results for Spain. In particular, we will determine which hypothesis seems to have driven the entry and exit decisions of Spanish manufacturing firms during the 1980s and early 1990s. Moreover, we have extended the framework along two dimensions: regions and sectors. This means that our estimates show how regional and sectorial variables affect the gross rates of entry and exit of industrial establishments in the Spanish regions.[2] They also enable us to assess whether the effects of displacement (entry on exit) and replacement (exit on entry) are significant for Spain. This contrasts with previous studies that tend to neglect some components of these complex relations, thus either focusing on spatial factors or on sectorial factors and either analysing entry or exit.[3] Our results indicate that these approaches may not be appropriate because

[1] Evans and Siegfried (1992), for example, reported a close relationship between entry and exit in the manufacturing industries of the United States between 1977 and 1982. Kleijweg and Lever (1996) and Love (1996) reached similar conclusions about the manufacturing industries of Holland and England, respectively. More recently, a study by Fotopoulos and Spence (1998) on the manufacturing industries of Greece between 1982 and 1998 supported the symmetry hypothesis.

[2] We use several estimation methods for panel data models; the choice of method depends on the stochastic assumptions sustained by the three hypotheses of interest (see the appendix for details).

[3] See e.g. Siegfried and Evans (1994), Carree and Thurik (1996) and Manjón (2004) for an overview of this literature.

entry and exit are closely related in a complex way that involves both geographical and industry-specific factors (Audretsch and Fristch 1999).

We have structured the paper as follows. In Sect. 2 we discuss the importance of sectorial and regional factors and provide results for Spain under the independence hypothesis. In Sect. 3 we argue that independence may not be a valid framework. We therefore propose the symmetry and simultaneity hypotheses and describe them in detail. In Sect. 4 we present and compare the estimates under these hypotheses and discuss a number of caveats that may apply to the results. In Sect. 5 we summarise our main conclusions.

2 The basic framework

2.1 Sectorial and regional determinants of entry and exit

Many studies of business demography have focused on one side of market turnover, thus implicitly assuming that the independence hypothesis holds. That is, they have either analysed the factors determining the entry of new firms (Orr 1974; Geroski 1991; Baldwin 1995) or concentrated on why a productive activity is abandoned (Marcus 1967; Mata and Audretsch 1995; Doi 1999). The arguments in these papers vary, but the basic premise common to all of them is that new firms enter markets when the expected profit, after discounting the costs arising from the barriers to entry, is positive. They also argue that a firm will abandon its activity when the expected profits, taking into account the percentage of sunk costs that are not made up before leaving the market, are negative.[4]

In practice, the specification of the typical reduced-form model is given by the following expressions, which should be estimated separately using the most suitable method:

$$\begin{aligned} \mathrm{LNGRE} &= f(\mathrm{BARENT}) \\ \mathrm{LNGRX} &= f(\mathrm{BAREXI}), \end{aligned} \tag{1}$$

where f is a mathematical function—for example, linear—that links entry and exit to their determinants; LNGRE and LNGRX are, respectively, the natural logarithms of the gross rate of entry and exit; and BARENT and BAREXI are vectors of variables that take into account the presence of, respectively, barriers to entry and barriers to exit.[5]

[4] This approach is based on the concept of "limit pricing" developed in the studies of Bain (1949, 1956).

[5] We use the semilog specification because it is the most common one in the literature. See Orr (1974: 62–63), Shapiro and Khemani (1987: 17, note 6) and Fotopoulos and Spence (1998: 255–256) for a discussion on why it is used. Also, throughout this section we implicitly assume that the variables conforming BARENT and BAREXI are different. This is actually an extremely restrictive assumption since it implies that the cost structure is homogeneous, but it is nevertheless very useful as a benchmark. We shall discuss more appropriate frameworks (i.e. symmetry and simultaneity) in Sect. 3.

Notice that this approach focuses on the sectorial determinants of entry and exit. However, recent contributions to the literature on industry dynamics have concluded that the spatial dimension also needs to be taken into consideration. International empirical evidence shows that, even after controlling for differences in the industrial mix, there are substantial differences in the regional rates of entry and exit (Keeble and Walker 1994; Reynolds et al. 1994). This suggests that there are (dis)economies at the regional level that directly affect the decisions to enter and exit (Table 1).

Consequently, we should modify the econometric specification in (1) to include a second set of explanatory variables containing specific factors for each region that affect business rotation:

$$\begin{aligned} \text{LNGRE} &= f(\text{BARENT,REGIO}) \\ \text{LNGRX} &= f(\text{BAREXI,REGIO}), \end{aligned} \tag{2}$$

where REGIO is a vector of variables made up of regional characteristics relevant to the decisions to enter or exit.

2.2 Data, expected effects and econometric specifications

Table 2 gives the definitions of the variables we used in our study. We calculated the dependent variables LNGRE and LNGRX for each pairing of industry and region obtained for each year between 1980 and 1994. Gross rates of entry and exit were derived from the link between two Spanish databases: the *Registro de Establecimientos Industriales* (the Register of Industrial Establishments, REI) and the *Encuesta Industrial* (the Industrial Survey, EI). The REI provides the number of establishments created every year in the region-sector pairing (Entries_t) and the EI provides the number of existing establishments (Estab_t). Therefore, the number of exits (Exits_t) was obtained as Estab_{t+1} + Entries_t –Estab_t (negative values were replaced by zero). Gross rates of entry (exit) were calculated as the ratio between Entries_t (Exits_t) and $\text{Estab}_{t\text{-}1}$. We obtained maximum and minimum values of the logs of these variables by adapting the ‘‘modified Aitchison procedure’’ proposed by Fry et al. (2000) to control for the presence of zeros in some observations.[6]

[6] This may be due to the quality and/or the disaggregation of the data, although we do not have a way of finding out what the cause is. Taking logs causes a mathematical indeterminacy that we solved in the following way: (i) when both numerator and denominator were nil (most of these were ‘‘cells’’ in which both the REI and the EI provided zero values throughout the period), we used $\text{LNGRE}_t(\text{LNGRX}_t) = 0$; (ii) when either the entries or the exits in t were nil, we used a modified Aitchison procedure suggested by Fry et al. (2000). However, the design of Fry et al. (2000) uses cross-section data, so here we have opted for replacing the zeros along the time dimension. In particular, our minimum value of replacement is 1 (i.e. one establishment). Therefore, given that the minimum and maximum number of existing establishments in the sample were, respectively, 5 and 8,490, the minimum and maximum values of replacement are 1/5 and 1/8,490. With these limits we can test the sensitivity of the results to the replacements and define the dependent variables of Tables 3–5: lngre (min), lngre (max), lngrx (min) and lngrx (max). As a caveat, notice that our final sample contains only 11 sectors. ‘‘Ores and metals’’ and ‘‘Office Machinery’’ were eventually dropped because of the extreme number of indeterminacies we found.

Table 1 Sectorial and regional rates of entry and exit (average 1980–1994)

	Gross rate of entry	Gross rate of exit
Sectors (NACE R-25)		
Ores and metals	0.82	5.60
Mineral products	4.57	6.77
Chemical products	7.32	8.45
Metal products	6.74	7.49
Ag./Ind. machinery	8.46	9.99
Office machinery	2.56	3.08
Electrical goods	12.95	14.19
Transport equipment	15.05	15.81
Food/Bev./Tob.	3.23	5.43
Textiles	8.35	11.85
Paper/Printing	7.50	6.72
Rubber/Plastic	10.66	10.27
Other manufacturing	7.61	9.77
Total manufacturing	6.17	7.90
Regions (NUTS-2)		
Andalusia	6.81	7.90
Aragon	6.66	7.69
Asturias	5.66	7.07
Balearic Islands	5.39	8.03
Canary Islands	6.70	7.51
Cantabria	5.59	7.65
Castile-Leon	4.42	6.61
Castile-la Mancha	4.64	6.29
Catalonia	6.13	7.55
Valencia	7.32	7.52
Estremadura	3.54	6.76
Galicia	4.72	6.68
Madrid	9.46	10.43
Murcia	7.33	8.64
Navarre	4.53	5.40
Basque Country	5.70	7.10
La Rioja	4.73	6.78
Spain	6.17	7.90

Note: Gross rates of entry (exit) were calculated as the ratio between $Entries_t$ ($Exits_t$) and $Estab_{t-1}$ for each region and sector in period t, where $Entries_t$ is the number of establishments created in year t (source: REI), $Estab_t$ is the number of existing establishments in year t (source: EI) and $Exits_t = Estab_{t+1} + Entries_t – Estab_t$ (negative values have been replaced by zero)

As for the explanatory variables, BARENT and BAREX are vectors of structural characteristics that determine the nature and extent of the barriers to entry and the barriers to exit in each industry. For BARENT we considered well-known barriers such as measurements of technological intensity (R&DS), product differentiation (DIF), capital requirements (the average initial investment was denoted by K, and the average size of the concerns was denoted by SIZE) and the market power of the incumbents (profit margins, denoted by MARGIN, and market structure, denoted by MARKET). We also included a measurement of the benefits ex-post (BEXP) and a proxy for market turbulence (the percentage of micro-firms in the sector, denoted by MICROS). Among the barriers to exit, our regressions included

Table 2 Definition of variables

Variables	Definition	Source (*)
Dependent		
Gross rate of entry (GRE)	Entries$_t$/Number of existing establishments$_{t-1}$	REI and EI
Gross rate of exit (GRX)	Exits$_t$/Number of existing establishments$_{t-1}$	REI and EI
Sectorial		
Profit margins (MARGIN)	(Turnover—Staff costs—Intermediate inputs)/Turnover	EI
Technological intensity (R&DS)	R&D expenditure/Turnover	EIT and EI
Product differentiation (DIF)	Advertising expenditure/Turnover	TIO and EI
Capital requirements (K)	Capital stock$_t$/Number of existing establishments$_t$	IVIE and EI
Average size (SIZE)	Workers$_t$/Number of existing establishments$_t$	EI
Micro firms (MICROS)	Number of existing establishments with less than 10 workers/Total number of existing establishments	EI
Market structure (MARKET)	Concentration index, CR4	EI
Benefits ex-ante (BEXA)	Yearly variation of the Gross Operational Surplus$_{t-1}$	EI
Benefits ex-post (BEXP)	Yearly variation of the Gross Operational Surplus$_{t+1}$	EI
Regional		
Industrial diversity (DIV)	Inverse of the Herfindhal index	CRE
Relative specialisation (SPE)	Specialisation index (*)	CRE
Human capital (HUMAN)	Percentage of population holding a degree + Percentage of population with secondary education	CRE
Public capital (PUBLIC)	Public capital stock (estimated value)/Private capital stock (estimated value)	IVIE
Market accessibility (ACCESS)	Road and port infrastructures (estimated value)/Public capital stock (estimated value)	IVIE
Population structure (POPULATION)	Percentage of population aged between 30 and 44	CRE
Income per capita (INCOME)	Regional income per inhabitant	CRE
Micro-firms (MICROR)	Entries$_t$ with less than 10 workers/Total entries$_t$	REI and EI
Unemployment (U)	Regional rate of unemployment	CRE
Technological intensity (R&DR)	R&D expenditure/Turnover	EIT and CRE
Business cycle		
Manufacturing growth (MG)	Yearly variation of the Gross Added Value in manufacturing	EI
Industrial growth (IG)	Yearly variation of the Gross Added Value in the sector	EI
Regional manufacturing growth (RMG)	Yearly variation of the Gross Added Value in the manufacturing industry of the region	CRE
Region-sector growth (RSG)	Yearly variation of the Gross Added Value in the pairing region-sector	CRE

Notes (*): SPE is calculated as the added value of a sector in a region over the added value of manufacturing in the region divided by the added value of the sector in Spain over the added value of manufacturing in Spain. EIT denotes the ''Technological Innovation Survey'' (Source: National Institute of Statistics, INE); CRE denotes ''Regional Accounts'' (Source: INE); TIO denote Input–Output Tables (Source: INE); IVIE is the ''*Instituto Valenciano de Investigaciones Económicas*'' (Valencian Institute of Economic Research) benefitsex-ante (BEXA) and several variables that may indicate the magnitude of the sunk costs: technological intensity (R&DS), product differentiation (DIF), initial investment (K) and size of the concerns (SIZE). In general, entry barriers and sunk costs should negatively affect entry and exit, respectively. This is indeed what is mostly found in the literature (Siegfried and Evans 1994; Carree and Thurik 1996).

The vector of regional characteristics, REGIO, is made up of the following variables, which are typically used in studies that follow a spatial approach (Audretsch and Fritsch 1994, 1999; Armington and Acs 2002): measurements of industrial diversity (DIV) and the relative specialisation (SPE) of the region with respect to the Spanish economy; the level of training of the active population as a proxy for human capital (HUMAN); population structure (POPULATION) as a proxy for the population of potential entrepreneurs; the level of infrastructure (ACCESS) as a proxy for the accessibility to markets; and other general characteristics such as income per capita (INCOME), ratio of public to private capital (PUBLIC), the percentage of micro-firms (MICROR), the unemployment rate (U) and the technological intensity (R&D).

Unfortunately, there is little theoretical guidance on what might be the expected effects of these covariates on the dependent variables. Previous empirical evidence, however, suggests that the industrial diversity and specialisation of the region (Henderson et al. 1995; Costa et al. 2004), the quality of human capital (Armington and Acs 2002), the presence of potential entrepreneurs (Davidsson et al. 1994), better accessibility to markets (Arauzo 2005) and more micro-firms (Guesnier 1994; Blade and Nerlinger 2000) are all factors that tend to affect positively the entry of new firms. In contrast, the effects on firm entry of the regional income per capita, the ratio of public to private capital, the unemployment rate and the level of R&D are either ambiguous or have not been investigated—see e.g. Audretsch and Fritsch (1994) and Sutaria and Hicks (2004). This drawback generally applies to the exit of firms, which have received little attention from researchers interested in the geographical dimension of industry dynamics (Ilmakunnas and Topi 1999).

Finally, we also considered control variables to allow for the effects of the business cycle (CYCLE). These include the growth evolution of the whole manufacturing industry (MG), of the sector (IG), of the manufacturing industry of the region (RMG), and of the pairing region-sector (RSG). In principle, entries should be procyclical and exits should be anticyclical.

In summary, the econometric specification estimated under the independence hypothesis is the following (CONS is a constant term):

$$\begin{aligned} \mathrm{LNGRE}_{iqt} &= \mathrm{CONS} + \alpha_1 \mathrm{BARENT} + \alpha_2 \mathrm{REGIO} + \alpha_3 \mathrm{CYCLE} \\ &\quad + \left(\mu_i + \lambda_t + \eta_q + \varepsilon_{iqt}\right) \\ \mathrm{LNGRX}_{iqt} &= \mathrm{CONS}' + \alpha'_1 \mathrm{BAREXI} + \alpha'_2 \mathrm{REGIO} + \alpha'_3 \mathrm{CYCLE} \\ &\quad + \left(\mu'_i + \lambda'_t + \eta'_q + \varepsilon'_{iqt}\right). \end{aligned} \tag{3}$$

An interesting aspect of this econometric specification is that it alleviates concerns about the endogeneity of some explanatory variables (see e.g. Fotopoulos and Spence 1998) because the dimension over which they are calculated (sectorial or regional) is different from that of the dependent variables. Another interesting feature is the use of an error component model with sectorial (i) and territorial (q) effects to control for unobserved heterogeneity (Baltagi 2001). The descriptive statistics in Table 1 and previous empirical evidence in Spain highlight the need for such latent variables (see Segarra 2002 and Segarra et al. 2002). The sectorial classification we used was the NACE R-25 (the European industrial classification, two-digits) and we distinguished between 11 manufacturing branches, i = 1,……,11. The territorial disaggregation is given by the *Comunidades Autónomas* (Spanish regions, except Ceuta and Melilla, according to the European NUTS-2 classification), q = 1,……,17. We have also included a sectorial- and territorial-invariant component (t) to allow for time-specific effects, t = 1980,……,1994.

What it is important to stress, though, is that this specification arises from the tenet that empirical studies of the determinants of entry and exit should consider at least two types of explanatory variables: one to control the nature and extent of the barriers to entry and exit in each industry and one for the specific features of each region in which the firm is located. Without doubt, regions are not homogenous in terms of their ability to create and support business projects. In fact, many industries tend to concentrate in certain geographical areas (Fujita et al. 1999). However, one can also argue that the inconsistent results of many regional studies are probably due to the fact that most of them do not differentiate between sectors (Audretsch and Fristch 1999).

2.3 Results under the hypothesis of independence

Results under the independence hypothesis are presented in Table 3. These include OLS and random-effects estimates. However, OLS estimates should just be taken as a starting point because they are biased and asymptotically inefficient. In contrast, the random effects estimator is consistent and asymptotically efficient under the null hypothesis of independence between covariates and latent effects. In the Spanish data set analysed in this study, this hypothesis tends to be rejected by the Hausman test.[7] We interpret this as a sign of misspecification that is addressed in the next section (Table 3).

[7] To compute the test we obtained the Fixed Effects estimates using the following transformation matrix:

$$P = I_N \otimes I_T \otimes I_Q - I_N \otimes \bar{J}_T \otimes \bar{J}_Q - \bar{J}_N \otimes I_T \otimes \bar{J}_Q - \bar{J}_N \otimes \bar{J}_T \otimes I_Q + 2\,\bar{J}_N \otimes \bar{J}_T \otimes \bar{J}_Q,$$

with $\bar{J}_N = J_N/N, \bar{J}_Q = J_Q/Q$ and $\bar{J}_T = J_T/T$, and where J_N, J_T and J_Q are matrices of ones of dimension N(regions), T (years) and Q (sectors), respectively. Estimates of the variance of the resulting estimators should be adjusted for the loss of degrees of freedom caused by estimating the model transformed in this way by OLS (see Baltagi 2001). The ratio of adjustment is $\frac{NTQ-k}{(NTQ-N-T-Q+2)-k}$, where k is the number of explanatory variables. However, since the ratio turned out to be practically 1 in our models the correction was judged unnecessary.

Table 3 Independence

	Entry				Exit			
	lngre (min)		lngre (max)		lngrx (min)		lngrx (max)	
	LS	RE	LS	RE	LS	RE	LS	RE
BARENT, BAREXI								
MARGIN	0.0049	0.0012	0.0079	0.0216				
	(0.0074)	(0.0104)	(0.0053)	(0.0075) *				
R&DS	0.2571	0.0923	0.2806	0.0711	0.2817	0.2048	0.1163	–0.0270
	(0.0311)*	(0.0646)	(0.0224)*	(0.0476)	(0.0813)*	(0.1326)	(0.0237)*	(0.0475)
DIF	–0.1849	–0.1362	–0.0659	0.0084	–0.1096	–0.0522	–0.0090	–0.0644
	(0.0470)*	(0.1596)	(0.0339)**	(0.1403)	(0.1111)*	(0.2062)	(0.0324)	(0.0879)
K	–0.0013	–0.0015	–0.0008	–0.0012	–0.0007	–0.0007	–0.0011	–0.0004
	(0.0002)*	(0.0006)*	(0.0002)*	(0.0004)*	(0.0007)*	(0.0011)	(0.0002)	(0.0004)
SIZE	0.0095	0.0132	0.0071	0.0071	0.0061	0.0110	0.0112	0.0082
	(0.0021)*	(0.0030)*	(0.0015)*	(0.0022)*	(0.0045)*	(0.0067)**	(0.0013)	(0.0022)*
MICROS	–0.0009	–0.0006	–0.0003	–0.0010				
	(0.0007)	(0.0016)	(0.0005)	(0.0012)				
MARKET	0.0048	0. 0037	0.0098	0.0252				
	(0.0039)	(0.0128)	(0.0028)*	(0.0107)*				
BEXA					–0.0002	0.0002	0.0021	–0.0018
					(0.0028)*	(0.0028)	(0.0008)	(0.0008)*
BEXP	–0.0018	–0.0013	–0.0019	–0.0017				
	(0.0009)*	(0.0008)	(0.0006)*	(0.0005)*				
REGIO								
DIV	–0.0162	–0.0439	–0.0396	–0.0458	0.1147	0.1101	–0.0528	–0.0446
	(0.0130)	(0.0148)*	(0.0093)*	(0.1024)*	(0.0360)*	(0.0375)*	(0.0105)*	(0.0112)*
SPE	–0.0004	–0.0001	–0.0006	–0.0004	–0.0007	–0.0004	–0.0004	–0.0002
	(0.0001)*	(0.0001)	(0.0001)*	(0.0001)*	(0.0004)*	(0.0004)	(0.0001)**	(0.0001)*
HUMAN	0.0109	0.0208	0.0071	0.0161	0.0095	0.0156	–0.0023	–0.0042
	(0.0043)*	(0.0053)*	(0.0031)*	(0.0036)*	(0.0118)	(0.0125)	(0.003)	(0.0038)
PUBLIC	–0.0426	–0.0410	–0.0193	–0.0178	–0.0187	–0.0198	–0.0013	0.0034
	(0.0071)*	(0.0089)*	(0.0051)*	(0.0061)*	(0.0198)	(0.0209)	(0.0034)	(0.0064)

Table 3 continued

	Entry				Exit			
	lngre (min)		lngre (max)		lngrx (min)		lngrx (max)	
	LS	RE	LS	RE	LS	RE	LS	RE
ACCESS	2.50×10^{-07}	-1.27×10^{-07}	-7.31×10^{-08}	-2.96×10^{-07}	-1.98×10^{-08}	-4.57×10^{-08}	-4.59×10^{-07}	-4.28×10^{-08}
	(1.47×10^{-07})**	(1.8710^{-07})	(1.0610^{-07})	(1.2810^{-07})*	(4.0510^{-07})*	(4.3210^{-07})	(1.1810^{-07})	(1.3310^{-07})*
POPULATION	–0.1887	–0.2059	–0.1001	–0.1146	–0.3579	–0.3382	0.0254	0.0386
	(0.0298)*	(0.0381)*	(0.0215)*	(0.0259)*	(0.0822)	(0.0871)*	(0.0240)*	(0.0269)
INCOME	0.0001	–0.0001	0.0002	0.0001	0.0021	0.0017	-5.37×10^{-06}	-7.13×10^{-06}
	(0.0002)	(0.0003)	(0.0002)	(0.0002)	(0.0007)	(0.0007)*	(0.0002)*	(0.0008)
MICROR	0.0148	0.0155	0.0002	3.45×10^{-06}	0.0034	0.0051	0.0009	0.0012
	(0.0007)*	(0.0006)*	(0.0005)	(0.0004)	(0.0019)**	(0.0020)*	(0.0006)**	(0.0005)*
U	0.0049	–0.0071	0.0018	–0.0036	0.0644	0.0060	0.0028	0.0020
	(0.0049)	(0.0055)	(0.0035)	(0.0038)	(0.0134)	(0.0139)*	(0.0039)*	(0.0041)
R&DR	0.1729	0.1841	0.1390	0.1170	0.1163	0.0990	0.0996	0.0905
	(0.0417)*	(0.0478)*	(0.0301)*	(0.0331)*	(0.1150)*	(0.0159)	(0.0336)	(0.0360)*
CYCLE								
MG	0.0178	0.0019	0.0187	0.0203	0.0203	0.0200	0.0042	0. 0061
	(0.0057)*	(0.0055)*	(0.0041)*	(0.0038)*	(0.0159)	(0.0159)	(0.0046)	(0.0046)
IG	0.0055	0.0024	0.0052	0.0012	0.0073	0.0064	0.0036	0.0025
	(0.0023)*	(0.0022)	(0.0016)*	(0.0015)	(0.0069)**	(0.0069)	(0.0020)	(0.0020)
RMG	0.0053	0.0046	0.0028	0.0019	–0.0238	–0.0247	–0.0029	–0.0030
	(0.0027)*	(0.0026)**	(0.0019)	(0.0018)	(0.0076)	(0.0077)*	(0.0022)*	(0.0021)
RSG	0.0011	0.0010	0.0009	0.0008	–0.0022	–0.0022	0.0005	0.0004
	(0.0004)*	(0.0003)*	(0.0003)*	(0.0002)*	(0.0010)	(0.0010)*	(0.0003)*	(0.0002)
F-test	44.49*	34.04*	41.02*	16.74*	8.84*	7.89*	21.18*	8.05*
Hausman		45.27*		84.67*		72.75*		6.31

Note: Definitions of lngre (min, max) and lngrx (min, max) can be found in footnote 6 to the text. All the explanatory variables are defined in Table 2. LS (RE) denotes Least Squares (Random Effects) estimates. * and ** mean that the coefficients are statistically significant at 5% and 10%, respectively. Standard errors are given in brackets. The *F*-test is the F-type statistic for testing the joint hypothesis that all coefficients are zero. Hausman is the χ^2-type statistic for testing the null hypothesis that covariates and latent effects are not correlated

The most important results from our first econometric approach are as follows. Sectorial variables that appear to be barriers to the entry of new companies are product differentiation and the average requirement of capital (in terms of initial investment). On the other hand, sectors whose established firms are larger and invest in R&D provide an opportunity for new operators to enter. Moreover, except for capital requirements, there is no clear evidence that sectorial barriers to exit exist.

If we now consider the regional factors affecting the creation of new firms, we find that human capital and technological intensity have positive effects on entries, whereas specialisation, public capital and the proxy for entrepreneurs have negative effects. If we look at exits, there seem to be fewer in the more sectorially specialised regions. Also, exits are sensitive both to the percentage of micro firms in the region and to that region's unemployment rate. The effects of the regional variables are often ambiguous, however.

Finally, entries are clearly related to the economic cycle. As expected, the behaviour of entries is procyclical and negatively affected by ex-post profits. New firms grow especially with the upswing of the aggregate activity of both the industrial sector and the manufacturing industry. However, while entries are more sensitive to the intraindustrial effects, exits are more sensitive to the economic cycle in the region. Also, exits depend little on ex-ante profits. However, the parameters obtained are of little statistical significance.

3 Alternative hypotheses on the relationship between entry and exit

Despite the interest that these inferences may have, the independence hypothesis is clearly too simplistic a framework. The overall result we expect to see empirically under independence is a negative relationship between the rate of entry and the rate of exit, since we are assuming that the former is greater when extraordinary profits are expected (i.e. it is procyclical) and the latter is greater in periods of recession (i.e. it is anticyclical). Indeed, the partial correlation between the annual aggregate values for the Spanish manufacturing industry in the sample we analysed is $r = -0.47$.

However, further descriptive analyses of our data set reveal that, in both sectorial and territorial disaggregation, the patterns of entry and exit are not always conflicting (see Table 1). During the period of analysis, the average correlations between the gross rates of entry and exit sectorially and regionally were $\bar{r} = 0.62$ and $\bar{r} = 0.25$, respectively. This apparent contradiction is not exclusive to Spain and in fact it regularly occurs for other countries and periods. Moreover, studies on the American economy show that extraordinary profits in an industry affect both the decision to enter and the decision to leave.[8]

[8] For Spain see, for example, Callejón and Segarra (1999). A comparison of international evidence is found in Reynolds et al. (1994), Geroski (1995) and Caves (1998). On how entries and exits behave when there are supranormal profits, see Austin and Rosenbaum (1990), Dunne and Roberts (1991) and Rosenbaum and Lamort (1992).

These stylised facts of the industrial dynamics suggest that results under the independence hypothesis can only be viewed as preliminary evidence of the determinants of entry and exit. In fact, even though we are controlling for unobservable heterogeneity, our results are likely to be biased because of correlations between the disturbances and the omission of relevant variables suggested by the Hausman test (see Table 3). A more complex framework is therefore required. In this paper we will focus on the following two scenarios.

First, the determinants of the rate of entry and the rate of exit are identical (or are highly correlated). In this context, the barriers to entry become barriers to exit. Second, the entry of new companies encourages the closure of active companies, and vice versa. Entrances influence exits because they increase the pressure of competition in the market and displace the least efficient companies, and because the companies that decide to abandon the market leave behind niches of unsatisfied consumers that encourage new companies to enter. The first scenario leads to symmetry in the incidence of the variables for explaining entry and exit, while in the second scenario entries and exits have a certain simultaneity. We will now analyse each of these scenarios in more detail.

3.1 Symmetry

From the available empirical evidence we can deduce that, unlike what is said to happen when we assume independence, some factors acting as barriers to the entry of new firms also affect the exit of existing ones. Even assuming that the cost structures are heterogeneous, this may be due to the specificity and durability of some assets that eventually become sunk costs—see Caves and Porter (1976) and Eaton and Lipsey (1980, 1981). These specific investments signal to the potential entrants the barriers they must face if they are to compete in this market. Paradoxically, once the new company has entered the market, the investment becomes a disincentive to leave it. Following on from this argument, the ratios of exit should, on average, be lower in industries whose technological characteristics require capital investment with a long redemption period (Dunne et al. 1988; Dunne and Roberts 1991). However, this is difficult to prove precisely because it is difficult to know the proportion of sunk costs.

From the econometric point of view, the symmetry hypothesis states that the specification of the equations for entry and exit should be the same. Moreover, we would expect to see a strong sample correlation between the errors in Eq. (3). This is due to the omission of relevant variables as well as to common unobservable factors, as suggested by Shapiro and Khemani (1987). However, the literature advocates incorporating certain differential features to control for the peculiarities of each phenomenon. This also helps to identify the coefficients of the model. This means modifying (3) and using a new vector of exogenous variables that is common to both equations and includes both barriers to entry and barriers to exit. Formally, we have:

$$\begin{aligned} \text{LNGRE}_{iqt} &= \text{CONS} + \alpha_1\text{BARENT} + \alpha_2\text{REGIO} + \alpha_3\text{CYCLE} \\ &\quad + \alpha_4\text{BAREXI} + \left(\mu_i + \lambda_t + \eta_q + \varepsilon_{iqt}\right) \\ \text{LNGRX}_{iqt} &= \text{CONS}' + \alpha_1'\text{BAREXI} + \alpha_2'\text{REGIO} + \alpha_3'\text{CYCLE} \\ &\quad + \alpha_4'\text{BARENT} + \left(\mu_i' + \lambda_t' + \eta'_q + \varepsilon'_{iqt}\right). \end{aligned} \tag{4}$$

In this study, for example, the differences between the entry and exit equations arise from measurements of market power (entry barriers), benefits ex-ante (barrier to exit) and benefits ex-post (barrier to entry). Similarly, Shapiro and Khemai's seminal study (1987) includes the structure of the market as a specific determinant of entry and the growth of the industry as a specific determinant of exit. In the equations of Austin and Rosenbaum (1990), the difference lies in the efficient minimum scale and the ratio of investment to sales. In Evans and Siegfried (1992), the difference is between profits and margins. Rosenbaum and Lamort (1992) categorise incentives, barriers and other structural characteristics. Among the determinants of entry, Love (1996) includes variables related to the structure of the population (density and percentage of people employed in administrative posts), and among the determinants of exit he includes the percentage of homes owned in the area. Kleijweg and Lever (1996) distinguish between types of entry and exit and use lags. Finally, Fotopoulos and Spence (1998) apply lags to price-margin and the presence of small firms.

3.2 Simultaneity

Many of these studies have also investigated whether the rates of entry and exit in a given sector or region can be considered to be simultaneously determined in the model. The argument used to support the interdependence of the two decisions goes as follows. On the one hand, the entry of new firms in a market may cause established firms to leave. This is the so-called displacement effect. On the other hand, the "vacuum" left by those who leave liberalises useful resources and improves the chances of success of those who enter. This is the replacement effect.

From the econometric point of view, the general formulation of the equations is similar to that in (4), except that the endogenous variables now appear as covariates:

$$\begin{aligned} \text{LNGRE}_{iqt} &= \text{CONS} + \alpha_1\text{BARENT} + \alpha_2\text{REGIO} + \alpha_3\text{CYCLE} + \alpha_4\text{BAREXI} \\ &\quad + \alpha_5\text{LNGRX} + \left(\mu_i + \lambda_t + \eta_q + \varepsilon_{iqt}\right) \\ \text{LNGRX}_{iqt} &= \text{CONS}' + \alpha_1'\text{BAREXI} + \alpha_2'\text{REGIO} + \alpha_3'\text{CYCLE} + \alpha_4'\text{BARENT} \\ &\quad + \alpha_5'\text{LNGRE} + + \left(\mu_i' + \lambda_t' + \eta_q' + \varepsilon'_{iqt}\right). \end{aligned} \tag{5}$$

However, there is some controversy about whether this approach is consistent. While the first relationship between entry and exit seems to be generally accepted, the second (i.e. that exits affect entries) is more debatable. What is true is that the decision to enter always involves an exit at some time in the future, but the disappearance of a company does not necessarily involve the appearance of another. Empirical evidence confirms these doubts, as only in a few of the above-mentioned studies are the exit variables included in the entry equation statistically significant. We must therefore ask whether a displacement-replacement effect is actually involved or whether it is simply a continuous process of trial and error, i.e. natural churning.

The answers are still not conclusive. The results of Fotopoulos and Spence (1998) for the Greek manufacturing industry, for example, raise doubts about the nature and extent of the relationship between entries and exits. These authors conclude that most changes in the identity of active firms take place in the short term and on the fringes of the industries. A similar study of the British manufacturing industry made by Love (1996) concluded that the interaction between entry and exit is mainly a product of a ‘‘revolving door’’ effect (Acs and Audretsch 1990; Audretsch 1995). In this study we have found evidence of a displacement–replacement effect between entries and exits in Spain. An important difference with respect to other studies, however, is that we have considered both regional and sector-specific determinants of entry and exit.

4 Results under symmetry and simultaneity

4.1 Symmetry hypothesis

Under the symmetry hypothesis, we estimated the coefficients using a system of seemingly unrelated regressions (see the appendix for details on the estimation procedure). This means that we assumed that there was no direct relationship between entry and exit. However, these variables may be dependently distributed at the population level because of the correlation between the error terms of Eq. (3).

The empirical results from our sample of Spanish entries and exits do not support the assumptions of the symmetry hypothesis. Partial correlations between the OLS residuals were 0.2260 (using lngre-max and lngrx-max as dependent variables) and 0.0946 (using lngre-min and lngrx-min as dependent variables), while those from the fixed-effects residuals were 0.2162 (ibid.) and 0.0953 (ibid.). Therefore, the relationship between the decision to enter and the decision to exit seems to require more advanced hypotheses. In the next sub-section we explore the possibility of a simultaneous framework. However, as the sample correlations are not negligible, we think it is worth commenting briefly on the results of the estimations. As Table 4 shows, estimates based on OLS residuals and those based on fixed-effects residuals are quite similar. We will therefore analyse the statistical significance of the coefficients irrespective of whether they are from OLS or fixed-effects residuals.

Table 4 Symmetry

	Entry				Exit			
	lngre (min)		lngre (max)		lngrx (min)		lngrx (max)	
	LS	FE	LS	FE	LS	FE	LS	FE
BARENT, BAREXI								
MARGIN	0.0047	0.0037	0.0136	0.0112				
	(0.0108)	(0.0111)	(0.0077)**	(0.0079)				
R&DS	0.0960	0.0663	0.0809	0.0598	0.2245	0.2907	–0.0239	–0.0957
	(0.0655)	(0.0699)	(0.0483)**	(0.0508)	(0.1325)**	(0.1459)*	(0.0477)	(0.0565)**
DIF	–0.1809	–0.2010	–0.0063	0.0010	–0.0225	0.0871	–0.0582	–0.0925
	(0.1601)	(0.2279)	(0.1404)	(0.2294)	(0.2057)	(0.2420)	(0.0879)	(0.1533)
K	–0.0013	–0.0011	–0.0012	–0.0013	–0.0011	–0.0020	–0.0005	–0.0001
	(0.0006)*	(0.0007)	(0.0005)*	(0.0005)*	(0.0011)	(0.0012)	(0.0004)	(0.0005)
SIZE	0.0126	0.0123	0.0074	0.0072	0.0121	0.0162	0.0084	0.0061
	(0.0031)*	(0.0032)*	(0.0022)*	(0.0023)*	(0.0067)**	(0.0072)*	(0.0023)*	(0.0026)*
MICROS	–0.0001	0.0004	–0.0012	–0.0013				
	(0.0018)	(0.0019)	(0.0013)	(0.0014)				
MARKET	–0.0025	–0.0045	0.0223	0.0248				
	(0.0130)	(0.0171)	(0.0108)*	(0.0162)				
BEXA					0.0027	0.0153	–0.0008	0.0006
					(0.0030)	(0.0038)*	(0.0009)	(0.0011)
BEXP	–0.0005	–0.0003	–0.0023	–0.0024				
	(0.0011)	(0.0011)	(0.0007)*	(0.0008)*				
REGIO								
DIV	0.0025	0.0104	–0.0187	0.0251	0.1315	0.1064	–0.0515	–0.0187
	(0.0170)	(0.0253)	(0.0115)	(0.0171)	(0.0464)*	(0.0546)**	(0.0106)*	(0.0187)
SPE	–0.0002	–0.0001	–0.0005	–0.0005	–0.0005	–0.0005	–0.0003	–0.0003
	(0.0001)	(0.0001)	(0.0001)*	(0.0001)*	(0.0004)	(0.0004)	(0.0001)*	(0.0001)*
HUMAN	0.0099	0.0151	0.0056	0.0090	0.0083	0.0034	–0.0016	–0.0054
	(0.0061)*	(0.0089)**	(0.0040)	(0.0063)	(0.0152)	(0.0205)	(0.0036)	(0.0064)

Table 4 continued

	Entry				Exit			
	lngre (min)		lngre (max)		lngrx (min)		lngrx (max)	
	LS	FE	LS	FE	LS	FE	LS	FE
PUBLIC	–0.0372	–0.0372	–0.0096	0.0092	–0.0064	0.0156	–00009	0.0021
	(0.0093)*	(0.0137)*	(0.0063)	(0.0093)	(0.0255)	(0.0299)	(0.0058)	(0.0102)
ACCESS	1.88×10^{-07}	8.68×10^{-08}	-1.33×10^{-07}	-4.22×10^{-07}	-3.26×10^{-07}	-6.21×10^{-08}	-4.58×10^{-07}	-3.64×10^{-07}
	(1.86×10^{-07})	(2.66×10^{-07})	(1.26×10^{-07})	(1.81×10^{-07})*	(5.16×10^{-07})	(5.88×10^{-07})	(1.19×10^{-07})*	(1.99×10^{-07})**
POPULATION	–0.1954	–0.2321	–0.1018	–0.1117	–0.3698	–0.3260	0.0223	0.0199
	(0.0409)*	(0.0825)*	(0.0273)*	(0.0526)*	(0.1115)*	(0.1385)*	(0.0241)	(0.0508)
INCOME	0.0002	0.0001	0.0004	0.0001	0.0024	0.0023	1.86×10^{-5}	0.0002
	(0.0003)	(0.0006)	(0.0002)*	(0.0004)	(0.0009)*	(0.0012)*	(0.0002)	(0.0004)
MICROR	0.0157	0.0156	0.0002	0.0000	0.0046	0.0036	0.0014	0.0011
	(0.0007)*	(0.0007)*	(0.0005)	(0.0005)	(0.0020)*	(0.0020)**	(0.0006)*	(0.0006)**
U	0.0091	–0.0017	0.0032	–0.0083	0.0671	0.0247	0.0031	0.0072
	(0.0067)	(0.0092)	(0.0045)	(0.0064)	(0.0166)*	(0.0214)	(0.0042)	(0.0069)
R&DR	0.1779	0.1884	0.1419	0.0850	0.1372	0.2674	0.0985	0.0015
	(0.0569)*	(0.1003)**	(0.0381)*	(0.0662)	(0.1564)	(0.1885)	(0.0337)*	(0.0687)
CYCLE								
MG	0.0225	0.0210	0.0238	0.0209	0.0186	0.0298	0.0039	0.0019
	(0.0112)*	(0.0146)	(0.0069)*	(0.0131)	(0.0177)	(0.0496)	(0.0058)	(0.0101)
IG	0.0035	0.0036	0.0021	0.0023	0.0037	–0.0101	0.0016	0.0003
	(0.0023)	(0.0023)	(0.0016)	(0.0016)	(0.0071)	(0.0075)	(0.0021)	(0.0022)
RMG	0.0021	0.0018	0.0015	0.0016	–0.0229	–0.0147	–0.0022	–0.0006
	(0.0027)	(0.0027)	(0.0019)	(0.0019)	(0.0076)*	(0.0077)**	(0.0022)	(0.0023)
RSG	0.0011	0.0011	0.0009	0.0009	–0.0022	–0.0023	0.0004	0.0004
	(0.0004)*	(0.0003)*	(0.0002)*	(0.0002)*	(0.0010)*	(0.0010)*	(0.0003)	(0.0003)
F-test	29.95*	26.82*	7.86*	4.95*	6.11*	3.39*	9.01*	2.76*

Note: Definitions of lngre (min, max) and lngrx (min, max) can be found in footnote 6 to the text. All the explanatory variables are defined in Table 2. LS (FE) denotes SUR estimates based on Least Squares (Fixed Effects) residuals. * and ** mean that the coefficients are statistically significant at 5% and 10%, respectively. Standard errors are given in brackets. The *F*-test is the F-type statistic for testing the joint hypothesis that all coefficients are zero

Among the industry-specific factors, only the average stock of capital per establishment is a statistically significant barrier to entry. Thus, capital requirements seem to be the main obstacle to starting a new business. Also, entrances react negatively to ex-post profits and behave pro-cyclically. However, exits are not strongly linked to ex-ante profits. Moreover, they increase during recessions and especially when there is less industrial activity in the region. Entries, and particularly exits, are higher in labour- and technologically intensive sectors. This is consistent with the tenet that labour-intensive sectors tend to be mature industries (easy entry) with decreasing demand (easy exit), whereas technologically intensive sectors involve highly competitive environments with intense entry and exit.

As far as the geographical factors behind industrial rotation are concerned, technological intensity, human capital and small incumbents increase industrial rotation, especially in terms of entry. In terms of exits, industrial rotation is higher in regions with small incumbents, a wide industrial diversity and a high income per capita. These results seem to reflect entrants' preference for more dynamic regions (Guesnier 1994; Blade and Nerlinger 2000) and the revolving-door effect that is typically observed among small concerns (Caves 1998; Geroski 1995).[9] Also, a high ratio of public capital stock to private capital may be interpreted as a sign of regional underdevelopment that would consequently hamper entry. Last, location (dis)economies are likely to be behind the negative effects found for the specialisation index and the percentage of citizens aged between 30 and 44 (Davidsson et al. 1994; Henderson et al. 1995; Costa et al. 2004). However, it is difficult to fully discern the nature of these externalities in this empirical framework.

4.2 Simultaneity hypothesis

From an econometric point of view, the SUR used under symmetry is not unlike the first stage of the two/three stage procedures for estimating simultaneity –although as we show in the appendix, this is less clear-cut in error component models. In fact, the two estimation methods we used, EC2SLS and EC3SLS, differ only in terms of efficiency (incomplete and complete information, respectively). As we can see in Table 5, the results from the two methods are generally very similar, but as the sample correlations between the error terms of the equations of the model appear not to be nil, we will take the EC3SLS estimates as our main guide.

These estimates show that there is a clear relation between the creation and the closure of firms in the Spanish manufacturing industry. The gross rate of exits shows positive and significant values in the entry equation, while the gross rate of entries shows positive and significant values, albeit less so, in the exit equation. That is, industrial sectors and regions with a strong flow of

[9] Results are also consistent with previous work by Audretsch and Fritsch (1994) and Armington and Acs (2002) on the contribution of skilled workers to the creation of new firms, by Costa et al. (2004) on the importance of the industrial diversity of regions to stimulate entries and by Guesnier (1994) on the role played by existing firms as ‘‘incubators'' of new ones.

Table 5 Simultaneity

	Entry				Exit			
	lngre (min)		lngre (max)		lngrx (min)		lngrx (max)	
	EC2SLS	EC3SLS	EC2SLS	EC3SLS	EC2SLS	EC3SLS	EC2SLS	EC3SLS
BARENT, BAREXI								
MARGIN	–2.42 × 10–5	0.0004	0.0212	0.0128				
	(0.0112)	(0.0107)	(0.0079)*	(0.0066)**				
R&DS	0.0647	0.0404	0.1125	0.1003	0.2555	0.2276	–0.0541	–0.0714
	(0.0673)	(0.0664)	(0.0488)*	(0.0477)*	(0.1353)**	(0.1338)**	(0.0478)	(0.0467)
DIF	–0.1382	–0.1338	0.0849	0.0870	0.0559	0.0686	–0.0557	–0.0485
	(0.1622)	(0.1608)	(0.1427)	(0.1402)	(0.2050)	(0.2039)	(0.0866)	(0.0861)
K	–0.0014	–0.0012	–0.0012	–0.0009	–0.0013	–0.0006	–0.0001	0.0002
	(0.0006)*	(0.0006)*	(0.0005)*	(0.0005)**	(0.0012)	(0.0012)	(0.0004)	(0.0004)
SIZE	0.0101	0.0091	0.0052	0.0024	0.0098	0.0040	0.0056	0.0031
	(0.0034)*	(0.0033)*	(0.0023)*	(0.0022)	(0.0076)	(0.0075)	(0.0024)*	(0.0023)
MICROS	0.0001	0.0001	–0.0014	–0.0009				
	(0.0018)	(0.0017)	(0.0013)	(0.0011)				
MARKET	0.0083	0.0047	0.0170	0.0075				
	(0.0140)	(0.0134)	(0.0110)	(0.0092)				
BEXA					0.0125	0.0116	–0.0013	–0.0007
					(0.0040)*	(0.0038)*	(0.0010)	(0.0009)
BEXP	–0.0001	9.9×10^{-5}	–0.0020	–0.0013				
	(0.0011)	(0.0010)	(0.0007)*	(0.0006)*				
REGIO								
DIV	–0.0167	–0.0232	0.0286	0.0513	0.0677	0.0583	–0.0465	–0.0431
	(0.0226)	(0.0223)	(0.0159)**	(0.0149)*	(0.0394)**	(0.0390)	(0.0108)*	(0.0105)*
SPE	–0.0001	–0.0001	–0.0003	–0.0002	–0.0005	–0.0004	–0.0002	2.15×10^{-5}
	(0.0001)	(0.0001)	(0.0001)*	(0.0001)*	(0.0004)	(0.0004)	(0.0001)	(0.0001)
HUMAN	0.0137	0.0136	0.0099	0.0095	0.0022	–0.0014	–0.0027	–0.0047
	(0.0072)**	(0.0072)**	(0.0050)**	(0.0048)**	(0.0148)	(0.0146)	(0.0038)	(0.0036)
PUBLIC	–0.0376	–0.0333	–0.0043	–0.0052	0.0014	0.0104	0.0015	0.0016
	(0.0117)*	(0.0116)*	(0.0079)	(0.0077)	(0.0216)	(0.0213)	(0.0059)	(0.0057)

Table 5 continued

	Entry				Exit			
	lngre (min)		lngre (max)		lngrx (min)		lngrx (max)	
	EC2SLS	EC3SLS	EC2SLS	EC3SLS	EC2SLS	EC3SLS	EC2SLS	EC3SLS
ACCESS	1.15×10^{-07}	1.98×10^{-08}	-7.48×10^{-09}	2.20×10^{-07}	5.11×10^{-07}	5.21×10^{-07}	-4.34×10^{-07}	-3.34×10^{-07}
	(2.32×10^{-07})	(2.29×10^{-07})	(1.68×10^{-07})	(1.58×10^{-07})	(4.27×10^{-07})	(4.23×10^{-07})	(1.20×10^{-07})*	(1.16×10^{-07})*
POPULATION	–0.1657	–0.1242	–0.1317	–0.1372	–0.2591	–0.1987	0.0420	0.0628
	(0.0632)*	(0.0623)*	(0.0378)*	(0.0371)*	(0.0980)*	(0.0964)*	(0.0252)**	(0.0245)*
INCOME	–0.0001	–0.0003	0.0002	0.0002	0.0020	0.0019	–0.0001	–0.0001
	(0.0005)	(0.0005)	(0.0003)	(0.0003)	(0.0007)*	(0.0007)*	(0.0002)	(0.0002)
MICROR	0.0153	0.0150	–0.0004	–0.0008	–0.0025	–0.0112	0.0013	0.0012
	(0.0007)*	(0.0007)*	(0.0005)	(0.0005)	(0.0063)	(0.0061)**	(0.0006)*	(0.0006)*
U	–0.0033	–0.0056	–0.0053	–0.0066	0.0264	0.0255	0.0035	0.0044
	(0.0081)	(0.0080)	(0.0054)	(0.0053)	(0.0160)**	(0.0159)	(0.0043)	(0.0041)
R&DR	0.1350	0.0952	0.0657	0.0168	0.2010	0.1584	0.0685	0.0430
	(0.0821)**	(0.0810)	(0.0530)	(0.0512)	(0.1266)	(0.1251)	(0.0349)**	(0.0339)
CYCLE								
MG	0.0214	0.0198	0.0206	0.0198	0.0132	–0.0129	–0.0043	–0.0103
	(0.0098)*	(0.0098))*	(0.0073)*	(0.0072)*	(0.0425)	(0.0420)	(0.0068)	(0.0067)
IG	0.0035	0.0028	0.0011	0.0018	–0.0083	–0.0097	0.0008	–0.0015
	(0.0023)	(0.0022)	(0.0016)	(0.0015)	(0.0074)	(0.0072)	(0.0021)	(0.0020)
RMG	0.0034	0.0043	0.0022	0.0029	–0.0163	–0.0175	–0.0022	–0.0027
	(0.0028)	(0.0027)	(0.0019)	(0.0019)	(0.0076)*	(0.0076)*	(0.0022)	(0.0022)
RSG	0.0013	0.0015	0.0007	0.0006	–0.0028	–0.0034	0.0000	–0.0003
	(0.0004)*	(0.0004)*	(0.0002)*	(0.0002)*	(0.0011)*	(0.0011)*	(0.0003)	(0.0003)
LNGRE					0.1459	0.3471	0.3493	0.6672
					(0.1379)	(0.1322)*	(0.0962)*	(0.0844)*

Table 5 continued

	Entry				Exit			
	lngre (min)		lngre (max)		lngrx (min)		lngrx (max)	
	EC2SLS	EC3SLS	EC2SLS	EC3SLS	EC2SLS	EC3SLS	EC2SLS	EC3SLS
LNGRX	0.2405 (0.1241)*	0.4454 (0.1194)*	0.4586 (0.0956)*	0.7721 (0.0822)*				
F, χ^2-tests	26.76*	633.88*	7.21*	212.56*	4.61*	103.11*	8.86*	225.18*

Note: Definitions of lngre (min, max) and lngrx (min, max) can be found in footnote 6 to the text. All the explanatory variables are defined in Table 2. EC2SLS (EC3SLS) denotes Error Components Two- (Three-) Stage Least Squares estimates. * and ** mean that the coefficients are statistically significant at 5% and 10%, respectively. Standard errors are given in brackets. The F-(χ^2)-test is the F-(Wald-)type statistic for testing the joint hypothesis that all coefficients are zero in EC2SLS (EC3SLS) entries record a displacement effect that causes more firms to leave the market, while industrial sectors and regions with a strong flow of exits record a reassignment of business resources that manifests itself in the creation of more new firms.

This is the main result found under the hypothesis of simultaneity since, to a large extent, the introduction of the rates of entry and exit as explanatory variables does not alter the main conclusions reached under symmetry. To repeat, barriers to entry are created only by the requirements of initial capital, R&D expenditure helps to increase industrial rotation and entries are higher in labour-intensive sectors and in regions with a large supply of human capital, a high index of industrial diversity and a large number of micro companies. Moreover, the ratio of public capital to private capital, the age distribution of the population, and the specialisation of production appear to have a negative effect on the creation of firms.

It is also interesting to note that cyclical effects follow the same pattern under all of our hypotheses. That is, entries (exits) are positively (negatively) related to the economic cycle. In particular, start-up establishments are closely related to the expectations formed around the macroeconomic evolution of the Spanish manufacturing industry, while the closure of concerns has much more to do with the microeconomic conditions in the region.

However, the relationship between entry/exit and ex-ante/ex-post profits is more tenuous than in the other specifications. Also, under simultaneity it becomes more apparent that profit margins are a good incentive for new entrepreneurs. In any case, differences with respect to the results under symmetry are mostly evident for regional factors. In any case, differences between the results under simultaneity and the results under symmetry are mostly evident for regional factors. With regard to entries, for example, under simultaneity the coefficient of the technological intensity is non-significant but under symmetry it is positive. With regard to exits, differences involve the structure of the population, the diversity of the industrial mix and the percentage of micro companies.

4.3 Further discussion

All in all, estimates from the symmetry and simultaneity hypotheses tend to agree in their signs and significance. With obvious differences, all show that sectorial, regional and business cycle variables are important for analysing industrial rotation. Moreover, the overall significance of the models is not statistically rejected according to the F- and Wald-type tests. Our results therefore appear robust, although they may be affected by several specification errors, the most important of which may be linearity, dynamics and data sources. As these issues are clearly beyond the scope of this paper, here we will just provide a brief discussion of them and leave a more thorough analysis for future research.

Few studies have examined the non-linear relationships between the processes of entry and exit. We can cite the use of a bivariate Poisson model by

Mayer and Chappel (1992), who found, as we did, that allowing for a framework of interrelationship between entries and exits may alter the nature of the conclusions obtained under independence (see also Chappel et al. 1990). The results of these papers also agree with our findings on the effects of the business cycle and product differentiation (i.e. advertising expenditure). Differences in the nature of the dependent variable (counts vs. rates), however, make it difficult to properly compare their results with those in mainstream literature.

Similarly, the absence of dynamic analyses is surprisingly a common feature in this literature. This reinforces the impression that the factors determining the rates of exit are far from clear, either from the theoretical or from the empirical point of view. Some studies have included lags of the dependent variable on the right hand side of the model, but their real aim was to solve problems of identification, endogeneity and/or data availability—see e.g. Shapiro and Khemani (1987), Austin and Rosembaum (1990), Evans and Siegfried (1992) and Fotopoulos and Spence (1998). One exception to this is Manjón (2004), who used autoregressive models to analyse the dynamics of entry and exit in the Spanish manufacturing sectors (see also Carree and Thurik 1996). As expected, he reported statistically significant estimates for the lagged dependent variables. He also found evidence of the existence of a ‘‘conical revolving door’’ phenomenon, as described by Audretsch (1995).

As for the data sources, we can refer to the related studies collected in Segarra et al. (2002) that analysed industrial rotation in the Spanish manufacturing industry during the period 1994 to 1999. Interestingly, their conclusions were not substantially different from ours. First, they found a broad heterogeneity between the gross rates of entry and exit and, second, they provided evidence of a displacement–replacement effect. As they used different statistical sources and periods from those we have used in this study, we can conclude that our results appear to be robust to this potential criticism.

5 Conclusions

We have analysed the sectorial and regional factors determining the entry and exit of Spanish industrial concerns from three perspectives. The independence hypothesis assumes that entries and exits are independent processes and that the link between them, if any, is very weak. The symmetry hypothesis assumes that there is a link between entries and exits such that the barriers to entry are also barriers to exit. The simultaneity hypothesis assumes that the interdependence between entry and exit is derived from the influence of entries on exits, and vice versa. Our main conclusions from this empirical study are the following.

First and foremost, sectorial and regional variables provide significant estimates in all the specifications we analysed. This supports the idea that these factors are important for analysing industry dynamics. Second, independence seems to be too simplistic a framework for analysing entry and exit. The simultaneity hypothesis and the displacement-replacement effects appear to be the most plausible tenets guiding business demography in Spain. Decisions to enter and leave an industry are thus strongly related. Third, estimates from the symmetry and simultaneity hypotheses tend to agree, are relatively stable and jointly statistically significant. Results under these two hypotheses therefore seem robust. We could improve them by exploring aspects such as the linearity of the specification, the absence of dynamics and the incidence of our data sources but we will leave these aspects for future studies.

Acknowledgements The authors are grateful to the *Fundación Caja de Ahorros* and the CICYT (SEJ2004-05860/ECON and SEJ2004-07824/ECON) for their financial support and to M. Callejón and E. Cefis for their helpful suggestions. N. Gras and A. Roda provided excellent research assistance in the construction of the database used in this paper. An early version of this paper was presented to the "*IV Encuentro de Economía Aplicada*" (Reus, Spain). The current version has benefited from the comments of participants at the ZEW conference on "The Economics of Entrepreneurship and the Demography of Firms and Industries" (Mannheim, Germany) and from the excellent editorial task of J. Weigand (the Industrial Economics editor of the journal). The usual disclaimer applies.

Appendix: Estimation methods

The econometric framework is given by a system of M equations ($m = 1, \ldots, M$):

$$y_m = X_m \beta_m + u_m \tag{6}$$

and an error component structure:

$$u_m = Z_\mu \mu_m + Z_\lambda \lambda_m + Z_\eta \eta_m + \varepsilon_m \tag{7}$$

in which $Z_\mu = I_N \otimes e_T \otimes e_Q, Z_\lambda = e_N \otimes I_T \otimes e_Q, Z\eta = e_T \otimes e_N \otimes I_Q$; e_N, e_T and e_Q are vectors of ones and I_N, I_T and I_Q are identity matrices of dimension N, T and Q, respectively. ε_m is an idiosyncratic shock with classical properties and $\mu' = (\mu_1, \mu_2, \ldots, \mu_n), \lambda' = (\lambda_1, \lambda_2, \ldots, \lambda_t)$ and $\eta' = (\eta_1, \eta_2, \ldots, \eta_q)$. Also, y_m is a vector $(NTQ) \times 1$. X_m is a matrix of explanatory variables whose dimension is $(NTQ) \times (k_m + 1)$ and β_m is the vector $(k_m + 1)$ of model coefficients. In the application in this paper, $M = 2$ (entry and exit), $N = 17$ (regions), $T = 15$ (1980–1994) and $Q = 11$ (sectors), so that $NTQ = 2{,}805$.

To determine the most suitable method for estimating the parameters of Eq. (3) and systems (4) and (5), we must take into account the underlying assumptions in the various hypotheses regarding the stochastic behaviour of the variables and the error terms. Under the independence hypothesis, we used OLS and Random Effects estimators (see Table 3). The algebra of these estimators is omitted because they are so widely used—see e.g. Baltagi (2001) for details. Under the simultaneity hypothesis, we are dealing with a simultaneous equations model (SEM), while under the symmetry hypothesis the analytical reference corresponds to the particular case that defines a system of seemingly unrelated regressions (SUR). These are less familiar estimation techniques, so they probably need the following short descriptions.

Symmetry hypothesis SUR

From (6) and (7), we assume, without loss of generality, that the latent variables are random and independent vectors of the form $\mu \sim (0, \Sigma_\mu \otimes I_N)$, $\lambda \sim (0, \Sigma_\lambda \otimes I_T), \eta \sim (0, \Sigma_\eta \otimes I_Q)$ and $\varepsilon \sim (0, \Sigma_\varepsilon \otimes I_{NTQ})$, where $\Sigma_\mu = \left[\sigma^2_{\mu_{\text{ml}}}\right]$, $\Sigma_\eta = \left[\sigma^2_{\eta_{\text{ml}}}\right], \Sigma_\eta = \left[\sigma^2_{\eta_{\text{ml}}}\right]$ and $\Sigma_\varepsilon = \left[\sigma^2_{\varepsilon_{\text{ml}}}\right]$ are matrices of dimension $M \times M$. Also, the matrix of variances and covariances of the system $\Omega = [\Omega_{\text{ml}}]$ will be (Wansbeek and Kapteyn 1982):

$$\Omega = \sum_{s=1}^{5} \xi_s \otimes V_s \tag{8}$$

in which $\xi_1 = \Sigma_\varepsilon$, $\xi_2 = TQ\Sigma_\mu + \Sigma_\varepsilon$, $\xi_3 = NQ\Sigma_\lambda + \Sigma_\varepsilon$, $\xi_4 = NT\Sigma_\eta + \Sigma_\varepsilon$ and $\xi_5 = TQ\Sigma_\mu + NQ\Sigma_\lambda + NT\Sigma_\eta + \Sigma_\varepsilon$ are the characteristic roots of Ω. Moreover, $V_1 = P, V_2 = E_N \otimes \bar{J}_T \otimes \bar{J}_Q, V_3 = \bar{J}_N \otimes E_T \otimes \bar{J}_Q, V_4 = \bar{J}_N \otimes \bar{J}_T \otimes E_Q, V_5 = \bar{J}_N \otimes \bar{J}_T \otimes \bar{J}_Q$ are the corresponding matrices of eigenprojectors, in which $E_N = I_N - \bar{J}_N, E_T = I_T - \bar{J}_T$ and $E_Q = I_Q - \bar{J}_Q$. Given that, for every scalar r, it can be demonstrated that $\Omega^r = \sum_{s=1}^{5} \xi_s^r \otimes V_s$, from (8) the vector of parameters in (6) can be estimated by GLS. Further, to obtain feasible GLS we must first estimate the characteristic roots of Ω. One way is to use ANOVA estimates like $\hat{\xi} = u'V_s u / tr(V_s), s = 1, 2, 3, 4$ and substitute the vector u with the residuals from the OLS (Avery 1977) or fixed-effects (Baltagi 1980) estimates. Both techniques provide asymptotically efficient estimates of the model coefficients. These are reported in Table 4.

Simultaneity hypothesis SEM

In this case the model is analogous to that from expressions (6), (7) and (8), except that there are endogenous variables on the right-hand side of the equation. Of the various methods in the literature for estimating SEM with panel data, the properties and simplicity of the one proposed by Baltagi (1981) make it best suited to our application (see Baltagi and Li 1992). The estimation methods are based on two-stage least squares (2SLS) with limited information and three-stage least squares (3SLS) with complete information. The identification condition is simply that the number of exogenous variables not included in the corresponding equation is greater than or equal to the number of endogenous variables.

Let the model given by (6) be rewritten in this case in compact form. A transformation matrix A is applied such that $y^* = Ay$, $Z^* = AZ$ and $u^* = Au$.

If the matrix of instruments used is W, the vector of coefficients will be given by $\beta_W = (Z^{*\prime}P_W Z^*)^{-1}Z^{*\prime}P_W Y^*$, where $P_W = W(W'W)^{-1}W'$ is the projection matrix of the instruments. In particular, if we define the transformation matrix in terms of the elements of the main diagonal of the matrix of variances and covariances of each equation ($A = \Omega_{\mathrm{mm}}^{-1/2}$),and apply 2SLS to the transformed model, we obtain the error component two-stage least squares (EC2SLS) estimator (Cornwell et al. 1992). Similarly, if we use the complete matrix ($A = \Omega^{-1/2}$) and 3SLS, we obtain the error component three-stage least squares (EC3SLS) estimator. Both GLS estimates are consistent and, in their feasible version, they are based on the residuals from an initial 2SLS estimation. These estimates are reported in Table 5.[10]

References

Acs ZJ, Audretsch D (1990) Innovation and small firms. The MIT Press

Arauzo JM (2005) Determinants of industrial location. An application for Catalan municipalities. Pap Reg Sci 84(1):105–120

Armington C, Acs ZA (2002) The determinants of regional variation in new firm formation. Reg Stud 36(1):33–45

Audretsch D (1995) Innovation and industry evolution. The MIT Press

Audretsch D, Fritsch M (1994) The geography of firm births in Germany. Reg Stud 28(4):359–365

Audretsch D, Fritsch M (1999) The industry component of regional new firm formation process. Rev Indust Organ 15:239–252

Austin JS, Rosenbaum DI (1990) The determinants of entry and exit rates into US manufacturing industries. Rev Indust Organ 5:211–223

Avery RB (1977) Error components and seemingly unrelated regressions. Econometrica 45:199–209

Bain JS (1949) A note on pricing in monopoly and oligopoly. Am Econ Rev 39:448–464

Bain JS (1956) Barriers to new competition. Harvard University Press

Baldwin JR (1995) The dynamics of industrial competition. Cambridge University Press

Baltagi BH (1980) On seemingly unrelated regressions with error components. Econometrica 48:1547–1552

Baltagi BH (1981) Simultaneous equations with error components. J Econ 17:189–200

Baltagi BH (1984) A Monte Carlo study for pooling time-series of cross-section data in the simultaneous equations model. Int Econ Rev 25:603–625

Baltagi BH (2001) Econometric analysis of panel data. John Wiley & Sons

Baltagi BH, Li Q (1992) A note on the estimation of simultaneous equations with error components. Econom Theory 8:113–119

Blade FJ, Nerlinger EA (2000) The spatial distribution of new technology-based firms: empirical results for West-Germany. Pap Reg Sci 79:155–176

Callejón M, Segarra A (1999) Business dynamics and efficiency in industries and regions. The case of Spain. Small Bus Econ 13:253–271

Carree MA, Thurik AR (1996) Entry and exit in retailing: incentives, barriers, displacement and replacement. Rev Indust Organ 11:155–172

Caves RE (1998) Industrial organization and new findings on the turnover and mobility of firms. J Econ Lit 36(4):1947–1982

Caves RE, Porter M (1976) Barriers to entry. In: Masson RT, Qualls PD (eds), Essays on industrial organization in honour of Joe Bain. Ballinger, pp 39–69

[10] Since the EC3SLS estimator is based on complete information, it is generally more efficient than EC2SLS. However, Baltagi (1984: 616) showed in Monte Carlo experiments with a similar model to ours that ‘‘going from EC2SLS to EC3SLS may not be worth the effort’’.

Chappel WF, Kimenyi M, Mayer WJ (1990) A poisson probability model of entry and market structure with an application to U.S. industries during 1972–1977. South Econ J 56:918–927
Cornwell C et al (1992) Simultaneous equations and panel data. J Econom 51:151–181
Costa MT, Segarra A, Viladecans E (2004) The location of new firms and the life cycle of industries. Small Bus Econ 22:265–281
Davidsson P, Lindmark L, Olofsson Ch (1994) New firm formation and regional development in Sweden. Reg Stud 28(4):395–410
Doi N (1999) The determinants of firm exit in Japanese manufacturing industries. Small Bus Econ 13:331–337
Dunne T, Roberts MJ (1991) Variation in producer turnover across US manufacturing industries in entry and market contestability. In: Geroski PA, Schwalbach J (eds), Entry and market contestability. Blackwell, pp 187–203
Dunne T, Roberts MJ, Samuelson L (1988) Patterns of firm entry and exit in US manufacturing industries. Rand J Econ 19:495–515
Eaton BC, Lipsey RG (1980) Exit barriers and entry barriers: the durability of capital as a barrier to entry. Bell J Econ 11:721–729
Eaton BC, Lipsey RG (1981) Capital, commitment and entry equilibrium. Bell J Econ 12:593–604
Evans LB, Siegfried JJ (1992) Entry and exit in United States manufacturing industries from 1977 to 1982. In: Audretsch DB, Siegfried JJ (eds), Empirical studies in honour of Leonard W. Weiss, Kluwer, pp 253–273
Fotopoulos G, Spence N (1998) Entry and exit from manufacturing industries: symmetry, turbulence and simultaneity—some empirical evidence from greek manufacturing industries, 1982–1988. Appl Econ 30:245–262
Fry JM, Fry TLR, McLaren KR (2000) Compositional data analysis and zeros in microdata. Appl Econ 32:953–959
Fujita M, Krugman P, Venables A (1999) The spatial economy. Cities, regions and international trade. MIT press, Cambridge, Massachusetts
Geroski PA (1991) Domestic and foreign entry in the United Kingdom: 1983–1984. In: Geroski PA, Schwalbach J (eds), Entry and market contestability: an international comparison, Basil Blackwell
Geroski PA (1995) What do we know about entry? Int J Indust Organ 13:421–440
Guesnier B (1994) Regional variations in new firm formation in France. Reg Stud 28:347–358
Henderson V,Kuncoro A, Turner M (1995) Industrial development in cities. J Polit Econ 103(5):1067–1090
Ilmakunnas P, Topi J (1999) Microeconomic and macroeconomic influences on entry and exit of firms. Rev Indust Organ 15:283–301
Keeble D, Walker S (1994) New firms, small firms and dead firms: spatial patterns and determinants in the United Kingdom. Reg Stud 28:411–427
Kleijweg AJM, Lever MHC (1996) Entry and exit in Dutch manufacturing industries. Rev Indust Organ 11:375–382
Love JH (1996) Entry and exit: a county level analysis. Appl Econ 28:441–451
Manjón, M (2004) Firm size and short-term dynamics in aggregate entry and exit. CentER Discussion Paper
Marcus M (1967) Firms' exit rates and their determinants. J Indust Econ 16:10–22
Mata J, Audretsch (eds) (1995) The post-entry performance of firms. Int J Indust Organ 13 (Special Issue)
Mayer WJ, Chappel WF (1992) Determinants of entry and exit: an application of the compounded bivariate poisson distribution to U.S Industries, 1972–1977. South Econ J 58:770–778
Orr D (1974) The determinants of entry: a study of the Canadian manufacturing industries. Rev Econ Stat 56(1):58–66
Reynolds P, Storey DJ, Westhead P (1994) Cross-national comparisons of the variation in new firm formation rates. Reg Stud 28(4):443–456
Rosenbaum DI, Lamort F (1992) Entry barriers, exit and sunk costs: an analysis. Appl Econ 24:297–304
Segarra A, Arauzo JM, Manjón M, Martín M (2002) Demografía industrial y convergencia regional en España. Papeles Econ Esp 93:65–78
Segarra A (ed) (2002) La creación y la supervivencia de las empresas industriales. Civitas, Madrid

Shapiro D, Khemani RS (1987) The determinants of entry and exit reconsidered. Int J Indust Organ 5: 15–26

Siegfried JJ, Evans LB (1994) Empirical studies of entry and exit: a survey of the evidence. Rev Indust Organ 9:121–155

Sutaria V, Hicks DA (2004) New firm formation: dynamics and determinants. Ann Reg Sci 38:241–262

Wansbeek T, Kapteyn A (1982) A class of decompositions of the variance–covariance matrix of a generalized error components model. Econometrica 50:713–724