Entry in Pharmaceutical Submarkets: A Bayesian Panel Probit Analysis

Gianni Amisano
DG-Research, European Central Bank
Università di Brescia
Maria Letizia Giorgetti
Università degli Studi di Milano

Fondazione Enrico Mattei
Milano, November 2009

Motivation

The presence of potential differentiated entry strategies in differentiated pharmaceutical submarkets, that is for differentiated group of products, belonging to the same industry, has not been yet investigated.

We check if entry determinants of international pharmaceutical companies are the same across pharmaceutical submarkets or are submarket-specific.

We check if entry determinants of international pharmaceutical companies are the same for greenfield entry and any entry.

Previous literature

Literature on submarkets (Klepper and Thompson, 2006, Sutton 1998)

Literature on entry (Berry, 1992, aircraft sector), (Mazzeo 1998, motels), (Scott Morton 1999, pharmaceutical sector)

Literature on entry-exit reduced form models: Bresnahan and Reiss (1993), Hendricks,Piccione and Tan (1997), Netz and Taylor (2002).

Literature on sunk costs: Cabral and Ross (2008), Roberts and Tybout (1997)

Related Literature on Pharmaceutical sector: (Bottazzi and al. 2001), (Caves, Whinston and Hurwitz, 1991), (Kyle, 2006) , (Scott Morton, 1999).

Our questions

With our research we aim to answer the following questions:

1.how much do company characteristics matter in the entry process (global company size, submarket company size, lagged entry, lagged exit)?

2.Is there some difference between greenfield entry and any entry decisions?

3. Have the submarkets determinants (intensity of competition,demand, scale economies) the same role in all the pharmaceutical submarkets?

4. Which is the sunk costs role in entry decisions?

Our submarkets:

The level of segmentation, we employ, is the first level, Principal Anatomical Group. This first level classification(ATC classification) includes 16 submarkets:

1. A=’Alimentary Tract and metabolism’ products’;
2. B=’Blood and Blood Forming Organs’
3. C= ‘Cardiovascular system products’
4. D=’Dermatologicals’ products’
5. G=’Genito-Urinary System and Sex Hormones’ products’;
6. H=’Systemic hormonal preparations (excluding sex hormones)’ products’
7. J=’General Anti-Infective-Systemic’ products’
8. K=’Hospital Solutions’

9. L=’Antineoplastic and Immunomodulating agents’ products’

10. M=’Musculo-Skeletal System’ products’

11.N=’Central Nervous System’ products’

12. P=’Parasitology’ products’

13.R=’Respiratory System products’

14.S=’Sensory Organs’ products’

15.T=’Diagnostic Agents’

16.V=’Various’

Data Description

Epris Project

Balanced Panel: Period 1989-1998

Global dataset for each pharmaceutical submarket obtained by merging: Italy, Germany, France, Spain, UK, Canada, USA

208 International Companies in all the submarkets

IMS data about sales

Table 1: submarket definitions

code	description	no. companies
A	Alimentary Tract and metabolism products	164
B	Blood and Blood Forming Organs	123
C	Cardiovascular system products	154
D	Dermatological products	144
G	Genito-Urinary System and Sex Hormones products	132
H	Systemic hormonal preparations(excluding sex hormones) products	96
J	General Anti-Infective-Systemic products	142
K	Hospital Solutions	47
L	Antineoplastic and Immunomodulating agents products	94
M	Musculo-Skeletal System products	140
N	Central Nervous System products	155
P	Parasitology products	49
R	Respiratory System products	153
S	Sensory Organs products.	104
T	Diagnostic Agents	71
V	Various	102

Table 2A: occurrence of entries in the different submarkets, all entries (greenfield and non greenfield) in percentage

code	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
A	26,83	28,05	23,17	18,29	23,78	29,27	33,54	27,44	26,83	43,29
B	4,88	1,63	1,63	0,81	2,44	2,44	0,81	1,63	1,63	0,00
C	35,06	31,17	26,62	26,62	28,57	25,97	34,42	35,71	26,62	44,81
D	26,39	26,39	26,39	21,53	22,22	21,53	32,64	29,86	17,36	32,64
G	15,91	17,42	16,67	16,67	18,94	18,18	23,48	23,48	25,00	35,61
H	2,08	2,08	7,29	2,08	3,13	2,08	1,04	3,13	0,00	1,04
J	19,72	21,83	28,87	20,42	28,87	18,31	32,39	23,94	31,69	30,99
K	21,28	6,38	21,28	8,51	21,28	10,64	12,77	12,77	6,38	17,02
L	18,09	22,34	17,02	23,40	24,47	17,02	22,34	39,36	30,85	36,17
M	25,71	25,00	33,57	19,29	21,43	20,71	22,14	27,14	20,71	30,71
N	34,84	27,74	31,61	20,00	32,90	23,23	33,55	37,42	37,42	43,87
P	12,24	10,20	12,24	14,29	10,20	14,29	18,37	16,33	10,20	24,49
R	26,14	27,45	26,14	18,30	28,10	22,88	18,95	20,26	27,45	36,60
S	10,58	14,42	12,50	10,58	15,38	15,38	15,38	19,23	18,27	22,12
T	14,08	14,08	21,13	19,72	14,08	19,72	21,13	18,31	22,54	26,76
V	2,94	3,92	0,98	2,94	0,98	3,92	2,94	2,94	3,92	0,00

Table 2B: occurrence of greenfield entries in the different submarkets, in %

code	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
A	0,61	1,22	0,61	1,22	0,61	1,83	0,61	1,22	0,00	0,00
B	4,88	1,63	1,63	0,81	2,44	2,44	0,81	1,63	1,63	0,00
C	1,30	2,60	1,30	0,65	0,65	0,65	0,65	1,95	0,00	0,65
D	0,69	0,00	2,08	0,00	1,39	0,69	3,47	0,00	0,69	0,00
G	0,00	2,27	2,27	2,27	0,00	1,52	2,27	3,03	1,52	0,76
H	2,08	2,08	7,29	2,08	3,13	2,08	1,04	3,13	0,00	1,04
J	1,41	2,82	2,82	0,70	2,82	1,41	1,41	0,70	2,11	0,70
K	6,38	2,13	12,77	2,13	4,26	2,13	2,13	4,26	0,00	4,26
L	4,26	4,26	4,26	4,26	4,26	1,06	1,06	7,45	4,26	1,06
M	25,71	25,00	33,57	19,29	21,43	20,71	22,14	26,43	20,71	30,71
N	0,65	2,58	0,65	0,00	0,65	0,65	0,65	0,65	0,65	1,29
P	4,08	6,12	4,08	2,04	4,08	2,04	6,12	2,04	2,04	0,00
R	1,31	1,31	2,61	0,00	1,31	1,96	1,31	0,65	1,96	0,65
S	0,96	2,88	3,85	0,96	2,88	1,92	1,92	0,96	2,88	0,00
T	2,82	2,82	4,23	7,04	1,41	5,63	4,23	4,23	1,41	1,41
V	2,94	3,92	0,98	2,94	0,98	3,92	2,94	2,94	3,92	0,00

Table 4: descriptive statistics for the dataset, submarkets A, C, N, R.

submarket A

	all	all	Y_{AE} = 0	Y_{AE} = 0	Y_{AE} = 1	Y_{AE} = 1	Y_{GF} = 0	Y_{GF} = 0	Y_{GF} = 1	Y_{GF} = 1
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
submkt_ndrugs	17,78	24,43	6,77	4,92	46,00	30,98	16,59	20,58	166,31	7,74
submkt_sales	7,83	3,00	6,57	2,53	11,07	1,03	7,78	2,96	13,92	0,20
total_ndrugs	109,95	150,89	41,11	25,04	286,53	190,41	102,90	128,69	992,62	121,10
total_sales	10,64	2,04	9,70	1,47	13,08	1,03	10,61	2,01	14,88	0,11
exit	0,25	0,43	0,00	0,00	0,90	0,31	0,25	0,43	1,00	0,00
sunk_costs	3,58	2,62	2,19	1,12	7,15	1,87	3,39	2,45	11,00	0,00
scale_ec	8,22	0,06	8,19	0,04	8,30	0,03	8,22	0,06	8,34	0,00
n_firms	155,00	1,73	154,08	1,04	157,36	0,48	154,98	1,72	158,00	0,00
submkt_size	7,62	0,14	7,55	0,10	7,78	0,05	7,62	0,14	7,84	0,00

submarket C

	all	all	Y_{AE} = 0	Y_{AE} = 0	Y_{AE} = 1	Y_{AE} = 1	Y_{GF} = 0	Y_{GF} = 0	Y_{GF} = 1	Y_{GF} = 1
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
submkt_ndrugs	15,62	22,39	4,46	3,36	39,82	26,63	14,32	18,15	139,25	39,05
submkt_sales	7,75	3,37	6,13	2,76	11,28	1,16	7,69	3,33	13,91	0,30
total_ndrugs	114,50	154,39	40,18	23,59	275,68	190,76	105,72	128,34	950,50	141,18
total_sales	10,65	2,08	9,58	1,48	12,97	1,09	10,61	2,05	14,85	0,12
exit	0,18	0,38	0,00	0,00	0,57	0,50	0,17	0,38	1,00	0,00
sunk_costs	3,40	2,61	1,91	0,95	6,64	2,08	3,15	2,33	11,00	0,00
scale_ec	9,15	0,17	9,06	0,08	9,35	0,14	9,15	0,17	9,52	0,00
n_firms	144,50	2,16	143,66	2,12	146,32	0,47	144,47	2,15	147,00	0,00
submkt_size	8,15	0,05	8,13	0,04	8,20	0,02	8,15	0,05	8,22	0,00

submarket N

	all	all	Y_{AE} = 0	Y_{AE} = 0	Y_{AE} = 1	Y_{AE} = 1	Y_{GF} = 0	Y_{GF} = 0	Y_{GF} = 1	Y_{GF} = 1
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
submkt_ndrugs	15,55	23,55	4,36	3,23	39,04	29,73	14,36	19,60	156,54	26,36
submkt_sales	7,75	3,10	6,25	2,55	10,89	1,22	7,70	3,06	13,49	0,22
total_ndrugs	108,11	133,95	39,88	23,47	251,40	155,48	102,86	121,53	728,77	68,66
total_sales	10,58	2,27	9,47	1,78	12,92	1,10	10,55	2,24	14,88	0,11
exit	0,17	0,38	0,00	0,00	0,54	0,50	0,17	0,37	1,00	0,00
sunk_costs	3,42	2,63	1,90	0,95	6,62	2,10	3,23	2,43	11,00	0,00
scale_ec	8,35	0,16	8,26	0,08	8,54	0,10	8,34	0,16	8,68	0,00
n_firms	146,70	1,27	146,11	1,13	147,93	0,26	146,69	1,27	148,00	0,00
submkt_size	7,81	0,16	7,72	0,10	8,00	0,07	7,81	0,16	8,09	0,00

submarket R

	all	all	Y_{AE} = 0	Y_{AE} = 0	Y_{AE} = 1	Y_{AE} = 1	Y_{GF} = 0	Y_{GF} = 0	Y_{GF} = 1	Y_{GF} = 1
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
submkt_ndrugs	12,79	21,24	4,20	3,49	38,24	29,78	11,28	16,71	126,50	18,51
submkt_sales	7,10	3,14	5,88	2,62	10,72	1,09	7,02	3,08	13,18	0,33
total_ndrugs	116,49	154,09	47,63	28,73	320,57	189,71	105,99	123,80	909,35	151,38
total_sales	10,71	2,07	9,84	1,54	13,31	0,95	10,66	2,02	14,82	0,12
exit	0,20	0,40	0,00	0,00	0,77	0,42	0,18	0,39	1,00	0,00
sunk_costs	3,78	2,75	2,41	1,30	7,84	1,74	3,68	2,64	11,00	0,00
scale_ec	7,82	0,07	7,80	0,06	7,90	0,01	7,82	0,07	7,91	0,00
n_firms	142,50	2,25	141,59	1,82	145,19	0,75	142,45	2,23	146,00	0,00
submkt_size	7,54	0,15	7,47	0,11	7,72	0,03	7,53	0,14	7,75	0,00

The Model

We use a discrete choice dichotomic bayesian probit model

$$p(y_{it} = 1 | I_{t-1}, \boldsymbol{\theta}) = p_{it} = \Phi(c_i + \mathbf{x}_{it-1}^{'} \boldsymbol{\lambda}) \qquad \#$$

$$\Phi(x) = \int_{-\infty}^{x} \frac{1}{\sqrt{2\pi}} \exp(-z^2/2) dz$$

$$i = 1, 2, .., n \text{ (units)}, \; t = 1, 2, \ldots, T \text{ (time)}$$

where c_i, following Wooldridge(2005) is

$$c_i = \boldsymbol{\gamma}_1^{'} \mathbf{Z}_i^{(1)} + \gamma_2 \mathbf{Z}_{i0}^{(2)} + \alpha_i \qquad \#$$

$$\alpha_i \backsim N(0, h_\alpha^{-1}) \qquad \#$$

We split our covariates into two groups:

$\mathbf{Z}_i^{(1)}$: the regressors which are strictly exogenous

$\mathbf{Z}_i^{(2)}$, the not strictly exogenous regressors.

Our dependent variable, y_{it}, is therefore "entry" defined as follows: we observe "entry" in submarket j at time t of company i, when $m_{it}^{(j)}$, the number of products sold by company i in submarket j increases by at least one unit since the previous year:

$$y_{AE,it}^{(j)} = I(\Delta m_{it}^{(j)} > 0) \qquad \#$$

where $I(\bullet)$ denotes the indicator function assigning unit values when the condition in brackets is satisfied and assigning zero values otherwise.

This notion embraces all kinds of entry, irrespective of whether or not the company was previously present or not in that particular market. We therefore indicate this variable as $y_{AE,it}^{(j)}$ where AE stands for "Any Entry".

This characterisation is introduced in order to potentially distinguish the so called "Greenfield Entries", which occur when a company enters in a submarket in which it was not present before:

$$y^{(j)}_{GF,it} = I(\Delta m^{(j)}_{it} > 0) \times I(m^{(j)}_{it-1} = 0) \qquad \#$$

where GF stands for "greenfield".

Our covariates:

Company specific determinants

1. measures of the company’s dimension within the submarket: number of drugs sold in the submarket (`submkt_ndrugs`) and sales within the submarket normalized by number of drugs sold in that submarket (`submkt_sales`).
2. Measures of the global dimension of the firm (across submarkets): number of drugs sold in all submarkets (`total_ndrugs`) and sales on all submarkets normalized by number of drugs globally sold (`total_sales`).
3. Exit decisions of the company in that submarket (`exit`).
4. Lagged entry decision of the company in that submarket (`lag_dep`) to capture potential state persistence.
5. A measure of company sunk cost, which is variable across companies and time: `sunk_costs`.

6. interactions with decisions on other submarkets, Dummy variables **`dummyA`** to **`dummyV`**.

7. Unobservable heterogeneity (random effects) and the way in which this is related to observed covariates.

Submarket determinants

8. A measure of scale economies: **`scale_ec`**. This variable has only variability in time.

9. A measure of submarket market size, as the total value of sales divided by the number of drugs sold in the submarket: **`submkt_size`**. This variable has only variability in time.

10. The number of incumbent companies in the submarket: **`n_firms`**. This has variability only in time.

All the observable covariates are lagged.

Table 3: definition of covariates

name	definition	comment	transformation	variability
submkt_ndrugs	number of drugs sold by company in the submarket	a measure of size of the firm in the submarket	lagged	across companies and in time
submkt_sales	value of sales of the company in the submarket divided by numner of drugs sold in the submarket	a measure of size of the firm in the submarket	logged and lagged	across companies and in time
total_ndrugs	number of drugs sold by the company in all submarkets	a measure of the global size of the firm in the submarket	lagged	across companies and in time
total_sales	value of sales of the company in the submarket divided by numner of drugs sold in the submarket	a measure of the global size of the firm in the submarket	logged and lagged	across companies and in time
sunk_costs	sunk costs of the company	measured as time between two consecutive entries	lagged	across companies and in time
scale_ec	scale economies	measured as the size of the median company (without lower tail of the size distribution)	lagged	in time
submkt_size	size of the submarket	total value of sales of all companies in the submarket divided by the number of drugs sold in that submarkets	logged and lagged	in time
n_firms	number of firms	number of active firms in the submarket	lagged	in time
exit	exit decision	exit decision of a company in the same submarket	lagged	across companies and in time

Model Specification

In order to have a realistic approach we make random effects dependent on covariates and we treat the initial observation in a proper way.

This could be done with three different approaches:

a) Specify a distribution for the initial condition : $p(y_{i0}|c_i)$ and this is very hard in general situations.

b) Provide a model for $p(c_i|y_{i0}, z_i)$ as in Wooldridge (2005)

c) Use a semi-parametric specification like in Arellano and Carrasco (2003).

There is also a non-parametric approach proposed by Honoré and Kyriazidou (2000) but its main drawback is that average partial effects cannot be calculated.

Hence we divide the covariates into two groups: $\mathbf{Z}_i^{(1)}$, the regressors which are strictly exogenous (of course among them we have the lagged dependent variable) and $\mathbf{Z}_i^{(2)}$, the not strictly exogenous regressors. We condition the distribution of the random effects c_i onto all values of the regressors in $\mathbf{Z}_i^{(1)}$ and only on the initial (pre-sample) value of the $\mathbf{Z}_i^{(2)}$:

$$p(c_i|\mathbf{Z}_i^{(1)}, \mathbf{z}_{i0}^{(2)}), i = 1, 2, \ldots, n \qquad \#$$

Just to fix ideas, let us consider a case in which the only not strictly exogenous covariate is the lagged dependent variable, then we specify the conditional distribution of random effects as

$$c_i = \boldsymbol{\gamma}_1' \mathbf{Z}_i^{(1)} + \gamma_2 y_{i0} + \alpha_i \qquad \#$$

$$\alpha_i \backsim N(0, h_\alpha^{-1}) \qquad \#$$

where $\mathbf{Z}_i^{(1)}$ is a $(TK \times 1)$ vector. Then:

$$p(y_{it} = 1) = \Phi(\mathbf{Z}_{i,t-1}' \boldsymbol{\beta} + \boldsymbol{\gamma}_1' \mathbf{Z}_i^{(2)} + \gamma_2 y_{i0} + \alpha_i) \qquad \#$$

$$\alpha_i \backsim N(0, h_\alpha^{-1}) \qquad \#$$

This might imply a very high number of additional regressors.

Alternatively: Mundlak (1978), Heckman (1981) :

$$c_i = \boldsymbol{\gamma}_1' \, \bar{\mathbf{z}}_i^{(2)} + \gamma_2 y_{i0} + \alpha_i \qquad \#$$

$$\bar{\mathbf{z}}_i^{(1)} = \frac{1}{T} \sum_{t=1}^{T} \mathbf{z}_{it}^{(1)} \qquad \#$$

If we have other regressors not strictly exogenous (beside the lagged dependent variable), these enter only like y_{i0}, initial (pre-sample) value.

A clear advantage of this approach(unlike in non-parametric approaches): average partial effects can be easily calculated (see next).

The disadvantage: strong assumptions (Gaussianity of the conditional distribution of c_i, linear dependency of its expected value on the values of regressors). These assumptions can be relaxed .

Computation of average partial effects

In most non-parametric approaches to modelling heterogeneity in non linear panel data model, the main difficulty is how to compute average partial effects (henceforth APEs). For a discussion on this issue, see Wooldridge (2005).

APEs: average sensitivity of the probability of observing $y_{it} = 1$ to marginal variations in the covariates:

$$\left[\frac{\partial p(y_{it} = 1)}{\partial x_{ijt}}\right]_{\mathbf{x}_{it}=\overline{\mathbf{x}}_i} = \int \left[\frac{\partial p(y_{it} = 1|\mathbf{y}, \boldsymbol{\theta}, \alpha)}{\partial x_{ijt}}\right]_{\mathbf{x}_{it}=\overline{\mathbf{x}}_i} p(\boldsymbol{\theta}, \alpha|\mathbf{y}) d\theta d\alpha_i =$$

$$= \int \phi\left(\overline{\mathbf{x}}_i'\boldsymbol{\beta} + \alpha\right)\beta_j p(\boldsymbol{\theta}, \alpha|\mathbf{y}) d\theta d\alpha_i \qquad \#$$

Having simulated the joint posterior distribution of all the parameters of the model, the above quantity can be consistently estimated (i.e. up to simulation noise) as:

$$\left[\frac{\partial p(y_{it} = 1)}{\partial x_{ijt}} \right]_{\mathbf{x}_{it}=\overline{\mathbf{x}}_i} = \frac{1}{M} \frac{1}{N} \sum_{m=1}^{M} \sum_{i=1}^{N} \phi\left(\overline{\mathbf{x}}_i' \boldsymbol{\beta}^{(m)} + \alpha_i^{(m)} \right) \beta_j^{(m)} \quad \#$$

Main findings

- **1**. The results are quite different if we model AE (Any Entry) or GE (greenfield) entry.
- **2**. Greenfield entry, significant regressors are:

  a)The number of incumbent companies (negative impact).

  b)The global company size (a negative impact)

  c) The sunk costs, positively related to entry decisions,

Cabral and Ross(2008).

- **3**. Any Entry: The number of significant regressors increases

a)market size (positive impact, only submarket N, but only if we consider the unrestricted model).

b)scale economies, that are rarely significant, are positively related to the probability of entry

c) The number of incumbent companies reduces the entry probability only in a small number of submarkets

d)The sunk costs assume a changing sign across submarkets: in some case they have a negative impact, in some case a positive impact.

e) A bigger size at submarket level, by a sort of saturation effect, reduces the probabilty of introducing another product (with some exceptions).

f)A bigger global size increases the probability of a further product introduction (Mitchell 2000).

A joint occurrence of these two last results, as we observe in some submarkets, seems to confirm the propensity of large companies to diversify (Mitchell 2000). If the global size is significant and positive and the size in that specific submarket is significant and negative, this induces a tendency of companies to diversy across submarkets over time.

This result holds for any types of entry because as already pointed out the greenfield entry is negatively correlated with global company size.

Table 5A: Bayesian panel probit results, entry in submarket C, unrestricted model

regressor	pr. mean	prior std	post. Mean	post std	lower	median	upper	relevant	APE
submkt_ndrugs	0.00	1.00	-0.01	0.01	-0.04	-0.01	0.02	0	0.00
submkt_sales	0.00	1.00	0.03	0.04	-0.06	0.03	0.11	0	0.01
total_ndrugs	0.00	1.00	0.01	0.00	0.00	0.01	0.01	1	0.00
total_sales	0.00	1.00	0.16	0.07	0.03	0.16	0.30	1	0.05
exit	0.00	1.00	-0.17	0.12	-0.40	-0.17	0.06	0	-0.05
sunk_costs	0.00	1.00	0.07	0.03	0.01	0.07	0.12	1	0.02
scale_ec	0.00	1.00	0.26	0.73	-1.17	0.25	1.69	0	0.07
n_firms	0.00	1.00	-0.07	0.03	-0.12	-0.07	-0.01	1	-0.02
submkt_size	0.00	1.00	0.27	0.66	-1.03	0.28	1.55	0	0.08
lagdep	0.00	1.00	-0.10	0.12	-0.33	-0.10	0.13	0	-0.03
dummya	0.00	1.00	0.26	0.73	-1.16	0.26	1.72	0	0.08
dummyb	0.00	1.00	0.28	0.84	-1.38	0.29	1.93	0	0.08
dummyd	0.00	1.00	-0.02	0.23	-0.46	-0.02	0.42	0	-0.01
dummyg	0.00	1.00	0.14	0.15	-0.15	0.14	0.43	0	0.04
dummyh	0.00	1.00	-0.24	0.17	-0.56	-0.23	0.08	0	-0.07
dummyj	0.00	1.00	-0.10	0.16	-0.41	-0.10	0.21	0	-0.03
dummyk	0.00	1.00	0.14	0.14	-0.13	0.14	0.42	0	0.04
dummyl	0.00	1.00	0.11	0.16	-0.21	0.11	0.43	0	0.03
dummym	0.00	1.00	-0.20	0.16	-0.52	-0.20	0.11	0	-0.06
dummyn	0.00	1.00	0.00	0.15	-0.29	0.00	0.28	0	0.00
dummyp	0.00	1.00	-0.05	0.16	-0.37	-0.05	0.26	0	-0.01
dummyr	0.00	1.00	-0.03	0.22	-0.46	-0.04	0.40	0	-0.01
dummys	0.00	1.00	-0.29	0.17	-0.63	-0.29	0.02	0	-0.08
dummyt	0.00	1.00	-0.01	0.40	-0.80	-0.01	0.77	0	0.00
dummyv	0.00	1.00	0.02	0.15	-0.27	0.01	0.31	0	0.00
dummy1989	0.00	1.00	0.18	0.16	-0.13	0.18	0.49	0	0.05
intercept	0.00	1.00	0.08	0.98	-1.85	0.07	2.00	0	0.02
initial submkt_drugs	0.00	1.00	0.02	0.02	-0.01	0.02	0.05	0	0.01
initial submkt_sales	0.00	1.00	0.09	0.05	-0.01	0.09	0.19	0	0.03
initial total_ndrugs	0.00	1.00	-0.01	0.00	-0.01	-0.01	0.00	1	0.00
initial total_sales	0.00	1.00	-0.19	0.07	-0.33	-0.19	-0.05	1	-0.05
initial exit	0.00	1.00	0.08	0.22	-0.35	0.08	0.51	0	0.02
initial_sunk_costs	0.00	1.00	-0.04	0.70	-1.37	-0.04	1.35	0	-0.01
initial lagdep	0.00	1.00	0.19	0.70	-1.14	0.20	1.57	0	0.06
precision \alpha	0.50	0.70	2.10	0.59	1.20	2.02	3.49	1	
correlation btw p^ and y	0.57								
prop correct forecasts	0.71								

Table 5B: Bayesian panel probit results, entry in submarket C, restricted model

regressor	pr. mean	prior std	post. Mean	post std	lower	median	upper	relevant	APE
total_ndrugs	0.00	1.00	0.00	0.00	0.00	0.00	0.01	1	0.00
total_sales	0.00	1.00	0.18	0.05	0.07	0.18	0.28	1	0.05
n_firms	0.00	1.00	-0.01	0.01	-0.03	-0.01	0.00	0	0.00
sunk_costS	0.00	1.00	0.03	0.02	-0.01	0.03	0.08	0	0.01
intercept	0.00	1.00	0.78	0.93	-1.05	0.78	2.62	0	0.23
initial_total_ndrugs	0.00	1.00	0.00	0.00	-0.01	0.00	0.00	0	0.00
initial_total_sales	0.00	1.00	-0.11	0.05	-0.21	-0.11	-0.01	1	-0.03
initial_sunk_costs	0.00	1.00	-0.36	0.14	-0.64	-0.36	-0.08	1	-0.11
precision \alpha	0.51	0.72	2.56	0.63	1.57	2.47	4.02	1	
correlation btw p^ and y	0.55								
proportion correct forecas	0.71								

Table 6A: Bayesian panel probit results, entry in submarket N, unrestricted model

regressor	pr. mean	prior std	post. Mean	post std	lower	median	upper	relevant	APE
submkt_ndrugs	0.00	1.00	-0.04	0.02	-0.07	-0.04	0.00	1	-0.01
submkt_sales	0.00	1.00	0.01	0.04	-0.08	0.01	0.09	0	0.00
total_ndrugs	0.00	1.00	0.01	0.00	0.00	0.01	0.01	1	0.00
total_sales	0.00	1.00	0.07	0.06	-0.05	0.07	0.19	0	0.02
exit	0.00	1.00	-0.05	0.11	-0.27	-0.05	0.18	0	-0.01
sunk_costs	0.00	1.00	0.01	0.03	-0.05	0.00	0.06	0	0.00
scale_ec	0.00	1.00	-0.02	0.52	-1.03	-0.02	1.01	0	0.00
n_firms	0.00	1.00	-0.05	0.03	-0.11	-0.05	0.01	0	-0.01
submkt_size	0.00	1.00	1.21	0.50	0.24	1.21	2.19	1	0.37
lagdep	0.00	1.00	0.15	0.12	-0.08	0.16	0.38	0	0.05
dummya	0.00	1.00	-0.55	0.84	-2.21	-0.54	1.13	0	-0.17
dummyb	0.00	1.00	0.15	0.23	-0.30	0.15	0.59	0	0.04
dummyc	0.00	1.00	-0.10	0.14	-0.37	-0.10	0.17	0	-0.03
dummyd	0.00	1.00	0.22	0.19	-0.16	0.22	0.59	0	0.07
dummyg	0.00	1.00	-0.03	0.16	-0.34	-0.03	0.27	0	-0.01
dummyh	0.00	1.00	0.09	0.15	-0.20	0.09	0.37	0	0.03
dummyj	0.00	1.00	0.01	0.13	-0.24	0.01	0.27	0	0.00
dummyk	0.00	1.00	0.08	0.13	-0.19	0.08	0.33	0	0.02
dummyl	0.00	1.00	-0.12	0.15	-0.42	-0.12	0.17	0	-0.04
dummym	0.00	1.00	0.21	0.15	-0.08	0.21	0.50	0	0.06
dummyp	0.00	1.00	-0.17	0.15	-0.46	-0.17	0.13	0	-0.05
dummyr	0.00	1.00	-0.01	0.15	-0.29	-0.01	0.27	0	0.00
dummys	0.00	1.00	-0.90	0.43	-1.75	-0.90	-0.05	1	-0.27
dummyt	0.00	1.00	0.16	0.13	-0.10	0.16	0.42	0	0.05
dummyv	0.00	1.00	0.08	0.13	-0.18	0.08	0.34	0	0.02
dummy1989	0.00	1.00	0.29	0.13	0.04	0.29	0.55	1	0.09
intercept	0.00	1.00	-0.17	0.99	-2.11	-0.19	1.75	0	-0.05
initial_submkt_drugs	0.00	1.00	0.04	0.02	0.00	0.04	0.07	1	0.01
initial_submkt_sales	0.00	1.00	0.10	0.05	0.01	0.10	0.19	1	0.03
initial_total_ndrugs	0.00	1.00	-0.01	0.00	-0.01	-0.01	0.00	1	0.00
initial_total_sales	0.00	1.00	-0.12	0.06	-0.23	-0.12	-0.01	1	-0.04
initial_exit	0.00	1.00	0.24	0.18	-0.10	0.24	0.58	0	0.07
initial_sunk_costs	0.00	1.00	-0.41	0.71	-1.80	-0.41	0.98	0	-0.12
initial_lagdep	0.00	1.00	0.14	0.71	-1.26	0.13	1.53	0	0.04
precision \alpha	0.50	0.71	2.98	0.82	1.72	2.86	4.95	1	0.00
correlation btw p^ and y	0.54								
proportion correct forecas	0.66								

Table 6B: Bayesian panel probit results, entry in submarket N, restricted model

regressor	pr. mean	prior std	post. Mean	post std	lower	median	upper	relevant	APE
submkt_ndrugs	0.00	1.00	-0.02	0.02	-0.05	-0.02	0.01	0	-0.01
submkt_sales	0.00	1.00	0.01	0.04	-0.06	0.02	0.09	0	0.00
total_ndrugs	0.00	1.00	0.01	0.00	0.00	0.01	0.01	1	0.00
total_sales	0.00	1.00	0.08	0.06	-0.03	0.08	0.20	0	0.02
submkt_size	0.00	1.00	0.17	0.12	-0.06	0.17	0.41	0	0.05
dummys	0.00	1.00	-0.76	0.41	-1.57	-0.76	0.03	0	-0.23
dummy1989	0.00	1.00	0.18	0.12	-0.06	0.18	0.41	0	0.05
intercept	0.00	1.00	-1.81	0.89	-3.56	-1.82	-0.08	1	-0.55
initial_submkt_ndrugs	0.00	1.00	0.02	0.02	-0.01	0.02	0.06	0	0.01
initial_submkt_sales	0.00	1.00	0.10	0.05	0.02	0.10	0.19	1	0.03
initial_total_ndrugs	0.00	1.00	-0.01	0.00	-0.01	-0.01	0.00	1	0.00
initial_total_sales	0.00	1.00	-0.12	0.05	-0.23	-0.12	-0.02	1	-0.04
precision \alpha	0.50	0.70	3.04	0.71	1.90	2.94	4.67	1	0.00
correlation btw p^ and y	0.53								
proportion correct forecas	0.67								

Table 7: Log posterior odds ratios, restricted versus unrestricted model

	a	b	c	d	g	h	j	k	l	m	n	p	r	s	t	v
Any Entry	47.60	25.96	71.23	39.77	66.55	15.76	80.28	61.71	35.62	45.18	28.90	79.20	61.07	63.28	56.77	-22.23
Greenfield	21.12	35.92	12.54	14.54	22.87	27.99	25.38	37.43	75.67	54.72	29.17	52.51	9.72	43.19	42.04	35.17

Table 8A: Bayesian panel probit results AE entry decisions for all submarkets, unrestricted model estimates

regressor	a	b	c	d	g	h	j	k	l	m	n	p	r	s	t	v
submkt_ndrugs	-2.25	-117.82	-	-1.18	-	-87.69	-	-1.70	-	-	-0.76	-	-0.85	-1.03	-	-
submkt_sales	-	-30.46	-	-	0.14	-15.83	-		-0.10	-	-	-	0.14	-	-	-28.07
total_ndrugs	2.63	-	1.01	1.32	-		0.92	-	-	1.11	1.07	-	1.09	-	-	85.55
total_sales	-	-	0.20	-	-	-9.48	0.22	-	0.17	-	-	-	-	-0.36	-	-10.19
exit	-	-	-	-0.08	-	-	-	-	-	-	-	-	0.07	-	-	5.07
sunk_costs	0.32	-	0.27	-0.45	-0.33	-17.62	-	-	-	-	-	-	-	0.60	-	64.00
scale_ec	-	-	-	-	0.76	-	-	-	-	-	-	-	1.79	-	-	-
n_firms	-	-	-11.68	-	-	-	-	-	-	-	-	-	-13.21	-	-	-
submkt_size	-	-	-	-	-	-	-	-	-	-	1.55	-	-	-	-	-
lagdep	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
interaction dummies	-	-	-	-	C-,D+	-	G+,R-	-	T-	-	S-	-	-	R+	-	-
dummy1989	0.04	-	-	-	-	-	-	-	-	-	0.04	-	-	-	-	-
intercept	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
initial_submkt_ndrugs	1.89	-117.16	-	1.17	-		-	1.85	-	-	0.65	0.94	0.97	1.25	-	-
initial_submkt_sales	-	-	-	-	-	-	-		-	-	0.92	-	-	-	-	-149.25
initial_total_ndrugs	-0.02	-	-0.01	-0.01	-	-	-0.01	-	-	-0.01	-0.01	-	-0.01	-	-	-
initial_total_sales	-	-	-2.38	-	-	100.82	-	-	-	-	-1.59	-	-	-	-5.76	-
initial_exit	-	-	-	-	0.66	-	-	-	-	-	-	-	-	-	-	-
initial_sunk_costs	-	-	-	-0.70	-0.39	-	-	-	-	-	-	-	-	-	-	-
initial_lagdep	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
precision \alpha	2.20	0.94	2.10	4.89	4.69	2.25	3.82	2.25	2.10	5.01	2.96	1.17	2.03	1.29	2.84	0.67
correlation btw p^ and y	0.53	0.78	0.57	0.50	0.48	0.67	0.48	0.50	0.58	0.49	0.54	0.54	0.54	0.55	0.53	0.80
proportion correct forecasts	0.67	0.91	0.71	0.63	0.64	0.88	0.64	0.69	0.73	0.67	0.66	0.66	0.68	0.70	0.66	0.90

Table 8B: Bayesian panel probit results AE entry decisions for all submarkets, restricted model estimates

regressor	a	b	c	d	g	h	j	k	l	m	n	p	r	s	t	v
submkt_ndrugs	-2.15	-51.02	-	-0.91	-	-121.77	-	-1.60	-	-	-	-	-0.73	-	-	-92.25
submkt_sales	-	-10.65	-	-	0.20	-13.38	-	-	-	-	-	-	0.16	-	-	-25.00
total_ndrugs	2.58	-	0.69	1.05	-	-	0.88	-	-	1.27	1.08	-	1.35	-	-	-
total_sales	-	-	0.22	-	-	-8.26	0.24	-	0.20	-	-	-	-	-	0.59	-8.68
exit	-	-	-	-	-	-	-	-	-	-	-	-	0.07	-	-	4.75
sunk_costs	-	-	-	-0.37	-0.38	-13.09	-	-	-	-	-	-	-	0.43	-	38.59
scale_ec	-	-	-	-	-	-	-	-	-	-	-	-	0.91	-	-	-
n_firms	-	-	-	-	-	-	-	-	-	-	-	-	-8.37	-	-	-
submkt_size	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
lagdep	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
interaction dummies					C-,D+		P-							R+		
dummy1989	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
intercept	-	-	-	-	-1.96	-	-1.62	-2.69	-2.40	-1.65	-2.32	-2.36	-	-	-2.07	-
initial_submkt_ndrugs	2.03	-38.79	-	1.06	-	-	-	1.89	-	-	-	0.58	0.93	-	-	-
initial_submkt_sales	-	-	-	-	-	-	-	-	0.10	-	0.13	-	-	-	-	-23.24
initial_total_ndrugs	-2.36	-	-	-1.01	-	-	-0.72	-	-	-0.84	-0.84	-	-1.37	-	-	-
initial_total_sales	-	-	-0.14	-	-	8.20	-	-	-0.12	-	-0.15	-	-	-	-0.57	-
initial_exit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
initial_sunk_costs	-1.75	-	-0.78	-0.87	-0.46	-	-	-	-	-	-	-	-	-1.77	-	-
initial_lagdep	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
precision \alpha	2.50	1.80	2.56	4.91	6.13	2.67	5.02	3.17	1.92	4.34	3.03	2.29	2.65	2.07	2.53	0.81
correlation btw p^ and y	0.52	0.67	0.55	0.48	0.45	0.59	0.45	0.48	0.56	0.48	0.53	0.46	0.52	0.52	0.51	0.75
proportion correct forecasts	0.66	0.91	0.71	0.61	0.60	0.88	0.62	0.71	0.72	0.66	0.67	0.65	0.67	0.70	0.63	0.89

Table 9A: Bayesian panel probit results GF entry decisions for all submarkets, unrestricted model estimates

regressor	a	b	c	d	g	h	j	k	l	m	n	p	r	s	t	v
total_ndrugs	-	-	-	-	-	-	-	-15.31	-	1.11	-	-	-	-	-	6.63
total_sales	-4.91	-	-	-2.87	-	-1.80	-	-	-	-	-2.59	-	-	-2.09	-1.82	-1.38
sunk_costs	8.11	3.80	4.99	2.58	1.46	-	7.93	2.72	7.00	0.30	4.05	3.95	5.61	3.98	3.45	4.18
scale_ec	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
n_firms	-	-	-	-	-	-	-118.39	-15.03	-29.04	-	-	-27.93	-	-38.22	-	-25.21
submkt_size	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummya	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummyb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummyc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummyd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummyg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummyh	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummyj	-	-	-	-	-1.16	-	-	-	-	-	-	-	-	-	-	-
dummyk	-	-	-	-	-	-	-	-	-	-	-	-	-	-1.01	-	-
dummyl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummym	-	-	-	3.08	-	-	3.76	-	-	-	-	2.54	-	-	-	-
dummyn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummyp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummyr	-	-	-	1.01	-	-	-	-	-	-	-	-	-	-	-	-
dummys	-	-	-	-	-	-	-	-	-	-1.39	-	-	-	-	-	-
dummyt	-	-	8.08	-2.77	-	-	-	-	-	-	-	-	-	-	-	1.31
dummyv	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummy1989	-	0.33	-	-	-	-	-	-	-	-	-	-	-	-	-	0.26
intercept	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
initial_total_ndrugs	-	-	-	-16.36	-		-	14.68	-	-0.81	-	-	-	-	-	-10.33
initial_total_sales	-	-	-	-	-	13.89	-	-	-	-	-	-	-	-	-	-
initial_sunk_costs_1	-	-	-	-	-0.56	-	-	-	-	-0.76	-	-	-	-	-	-
precision \alpha	0.22	1.24	1.48	1.02	1.93	2.63	0.42	0.67	0.26	3.48	0.21	0.83	0.28	0.65	0.62	0.30
correlation btw p^ and y	0.71	0.47	0.54	0.56	0.40	0.40	0.64	0.57	0.70	0.50	0.63	0.56	0.66	0.61	0.64	0.65
proportion correct forecasts	0.87	0.71	0.82	0.80	0.68	0.64	0.83	0.75	0.79	0.68	0.88	0.73	0.85	0.75	0.72	0.82

Table 9B: Bayesian panel probit results GF entry decisions for all submarkets, restricted model estimates

regressor	a	b	c	d	g	h	j	k	l	m	n	p	r	s	t	v
total_ndrugs	-	-	-	-	-	-	-20.36	-13.21	-	1.29	-	-	-	-	-	-
total_sales	-1.73	-	-	-2.05	-	-1.64	-	-	-	-	-2.00	-	-	-1.25	-	-1.39
sunk_costs	2.41	1.32	1.25	-	-	-	3.86	1.89	3.57	-	2.16	2.28	2.30	1.96	1.70	3.25
scale_ec	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
n_firms	-	-	-	-	-	-	-25.79	-19.22	-16.68	-	-	-16.14	-	-	-	-14.26
submkt_size	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummya	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummyb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummyc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummyd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummyg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummyh	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummyj	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummyk	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.97	-	-
dummyl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummym	-	-	-	1.64	-	-	-	-	-	-	-	-	-	-	-	-
dummyn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummyp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummyr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummys	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummyt	-	-	-2.74	-1.79	-	-	-	-	-	-	-	-	-	-	-	-
dummyv	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dummy1989	-	0.25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
intercept	-	-6.21	-7.84	-	-6.89	-	-	-	-	-	-	-	-6.83	-	-	-
initial_total_ndrugs	-	-	-	-	-	-	-	12.09	-	-0.92	-	-	-	-	-	-7.48
initial_total_sales	-	-	-	-	-	1.17	-	-	-	-	-	-	-	-	-	-
initial_sunk_costs	-	-	-	-	-	-	8.00	-	-	-1.46	-	-	-	-	-	6.61
precision \alpha	0.77	2.59	2.54	1.66	3.03	3.29	1.20	1.80	1.73	4.62	1.12	2.44	0.65	2.11	1.79	0.89
correlation btw p^ and y	0.57	0.35	0.36	0.41	0.31	0.39	0.54	0.45	0.54	0.48	0.52	0.41	0.53	0.42	0.44	0.57
proportion correct forecasts	0.80	0.58	0.66	0.73	0.52	0.63	0.75	0.66	0.66	0.68	0.84	0.55	0.76	0.67	0.64	0.75

Figure 1A : prior and posterior distribution of the parameters, unrestricted model, Any Entry, submarket C

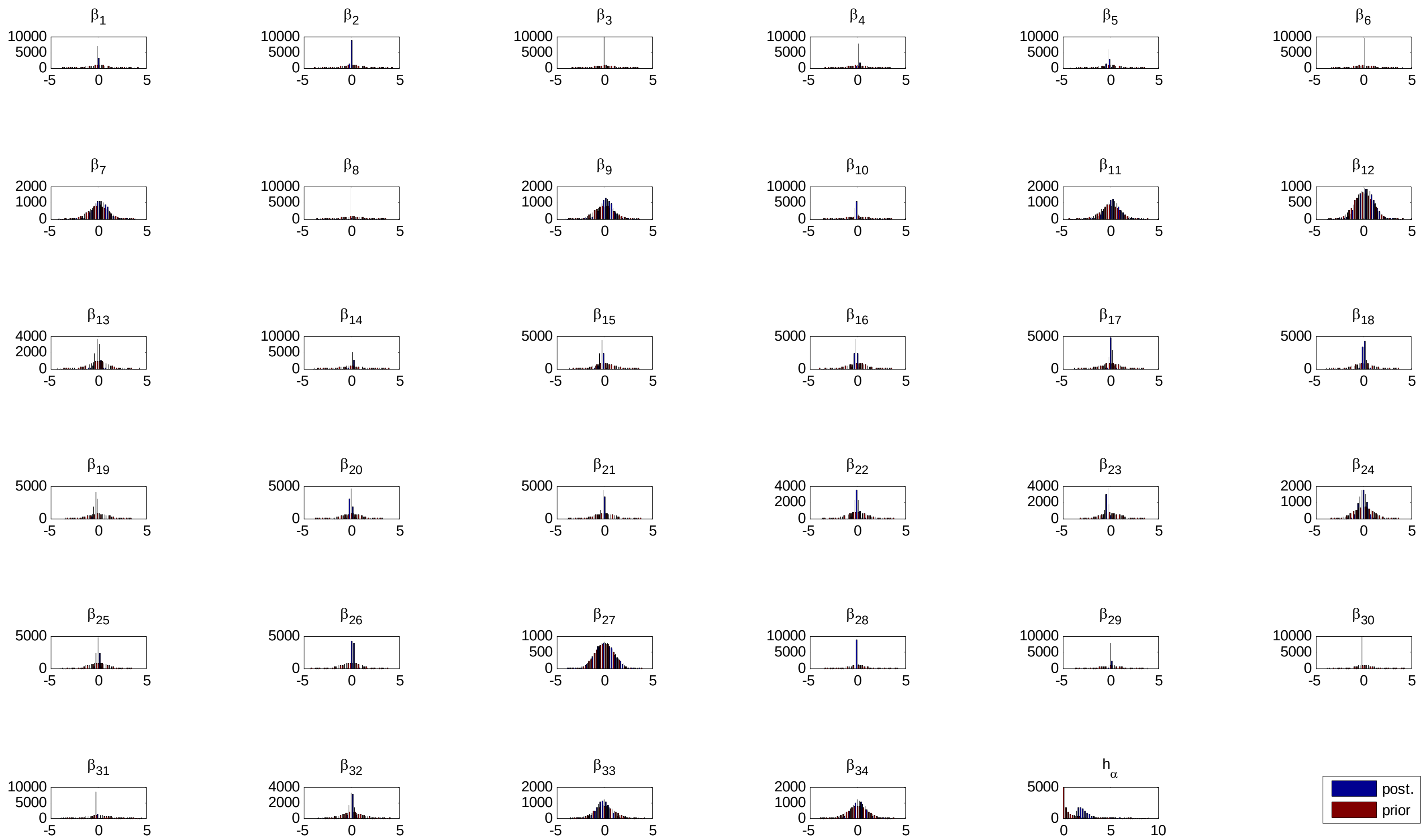


Figure 1B : prior and posterior distribution of the parameters, restricted model, Any Entry, submarket C

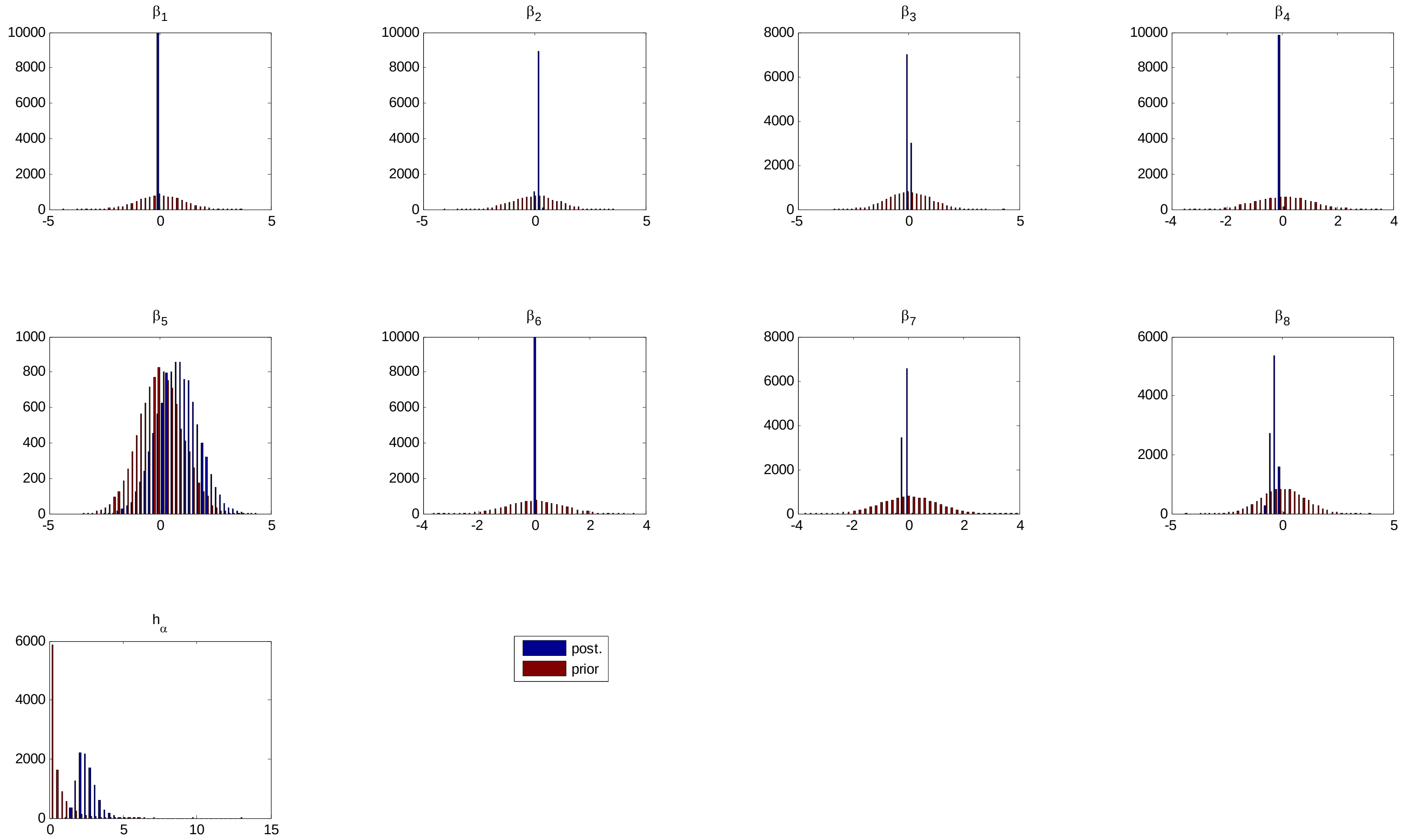


Figure 2A : prior and posterior distribution of the parameters, unrestricted model, Any Entry, submarket N

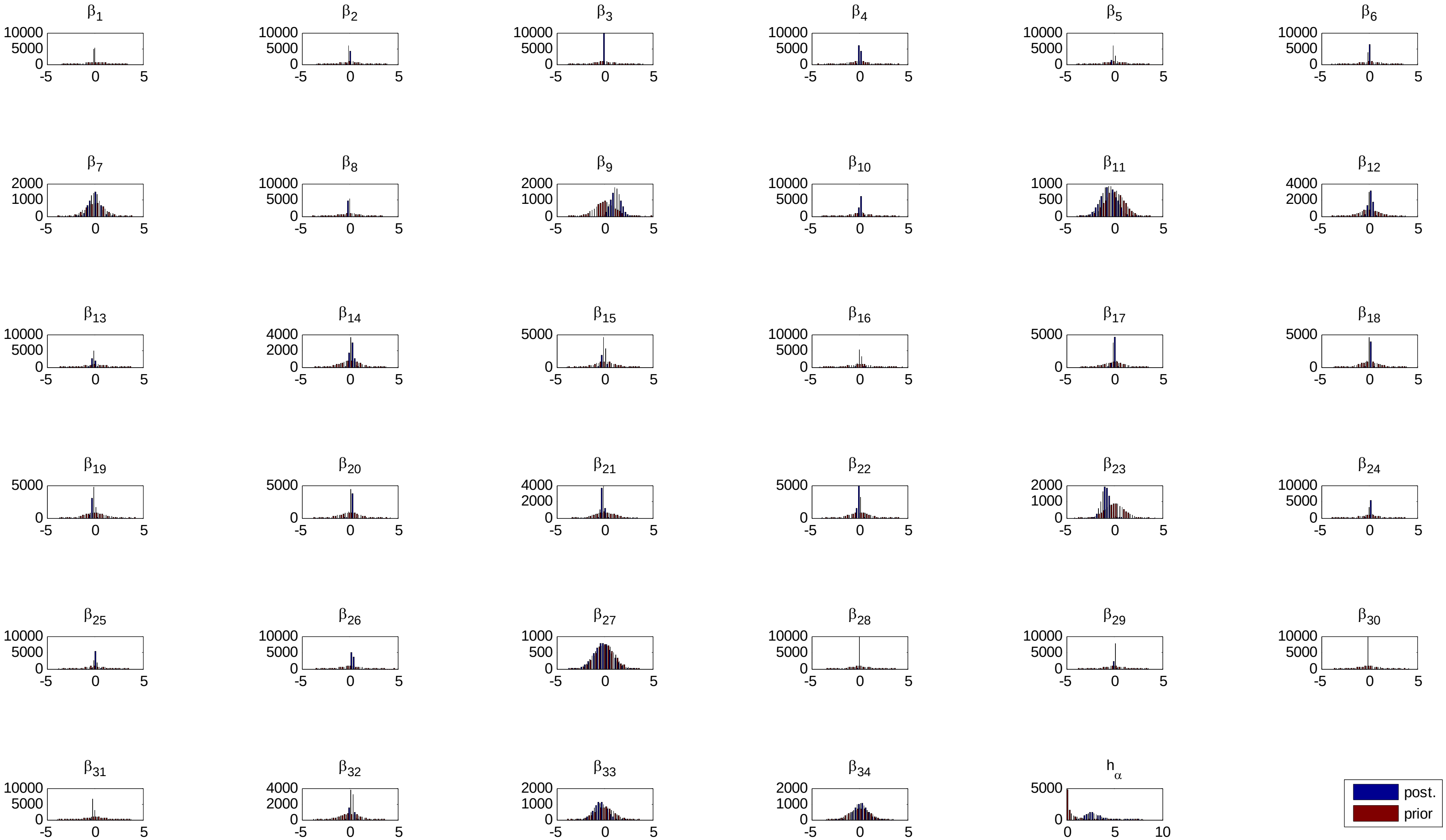
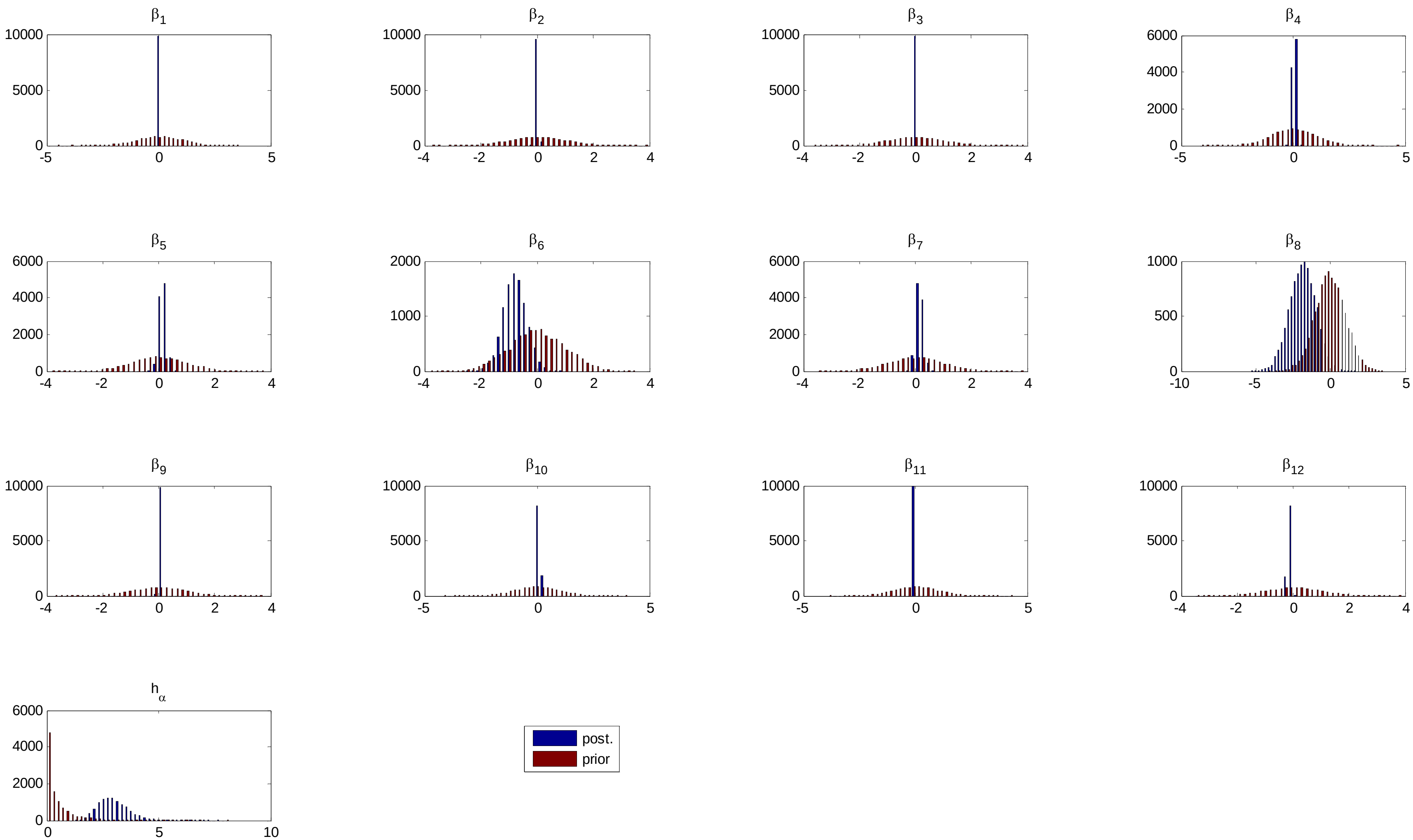


Figure 2B : prior and posterior distribution of the parameters, restricted model, Any Entry, submarket N



Legenda :

In Tables 5A-6B: The first two column indicate for each parameter of the model its prior mean and prior standard deviation. Then the successive columns indicate the posterior mean, standard deviation and the lower and upper bounds of the 95% highest posterior density univariate intervals for each of the parameters. The column labelled "`relevant`" contains values equal to one for the regressors which appear to be relevant: we define as "relevant " a covariate whose coefficient has a posterior density set that does not include zero.

The "restricted" model is then re-estimated by eliminating the irrelevant covariates.

In Tables 8A and 9B we report point posterior means of the elasticities of entry probabilities with respect to relevant (significant) regressors computed at the submarket specific mean values for the covariates. We report posterior means of the elasticities instead of the estimated values of the coefficients since in this way we can directly express the magnitude of the effects of changes of the covariates on the entry probabilities.

In all the Tables we also report two measures of fit of the estimated model, namely:

1. the correlation between the dependent variable and the fitted probabilities. The values of fitted probabilities used in the computation are their posterior mean values.
2. The sample proportion of correct predictions: a correct "prediction" is when a low computed fitted probability, i.e. lower than the unconditional probability, correspond to a zero value for the dependent variable, and viceversa. Once again, the posterior means of the fitted probabilities are used.