# Survival of pharmaceutical products: a cross-countries analysis

Cláudia Cardoso
*Polytechnic Institute of Cávado and Ave*
*Faculty of Economics, University of Porto*


Nuno Sousa Pereira
*Faculty of Economics, University of Porto*

# Motivation

■The purpose of this work is to understand the determinants of survival of pharmaceutical products and how their effect varies across countries.

■The three countries under study (Portugal, New Zealand and Sweden) implemented, at some point between January 1990 and October 2006 (the time length of our analysis), a reference price system for reimbursement of pharmaceuticals.

■ The reference price systems are different between countries and they are complemented with other measures in order to increase competition or simply to reduce expenditures with pharmaceuticals.

■Therefore, we intend to test if reference price systems encourage competition, in our case decreasing the rate of survival of pharmaceutical products, or if differences in rates result from other complementing measures.

# Hypotheses

- We broadly study the determinants of pharmaceutical product survival within Portugal, Sweden and New Zealand.

- We consider covariates that literature on product survival analysis applied to other industries had demonstrated to be relevant, controlling for country effects. (Virabhac et al., 2008; Figueiredo et al., 2006; Ruebeck, 2005; Requena-Silvente, 2005; Asplund et al., 1999; Greeinstein et al., 1998; Stavins, 1995)

- Also, we build on the previous analysis by considering the reference price system and other country-specific regulatory changes.

# Hypotheses

- Additionally, we test two specific hypotheses:

- First, the idea that differences between countries have impact not only on the survival rates itself but also on the effect of other variables on survival rates (*Hypothesis 1*). Therefore, such characteristics should be accounted when performing single-country analysis.

- Second, the isolate effect of reference price on product survival may be ambiguous, as it does not guarantee *de per se* a more competitive environment (*Hypothesis 2*).

# Data

- Our dataset includes 3543 products, marketed in:

  Portugal (1612 products)

  Sweden (986 products)

  New Zealand (945 products)

- Between January 1990 and October 2006, representing a random sample of 25% of the complete dataset of products of the three countries.

# Data

| | 1990 | | | 2005 | | |
|---|---|---|---|---|---|---|
| | PT | NZ | SE | PT | NZ | SE |
| Population (Thousands) | 9873 | 3363 | 8559 | 10563 | 4099 | 9030 |
| 0-14 years | 20.0% | 23.2% | 17.90% | 15.6% | 21.5% | 17.4% |
| 15-64 years | 66.4% | 65.7% | 64.30% | 67.4% | 66.4% | 65.3% |
| 65 and over | 13.6% | 11.1% | 17.80% | 17% | 12.1% | 17.3% |
| Gross domestic product - Million US$ at X-rate | 75391 | 43799 | 242129 | 186277 | 109778 | 357503 |
| Gross domestic product - /capita, US$ x-rate | 7636 | 13024 | 28289 | 17635 | 26782 | 39591 |
| Pharmaceutical sales – Million US$ at X-rate | 771* | 241** | 1163 | 2650 | 459 | 3946 |

Source: OECD HEALTH DATA 2007, July 07

*Data from 1991; **Data from 1993

# Data: Descriptive Statistics (product-month panel)

| | Total | | Portugal | | Sweden | | New Zealand | |
|---|---|---|---|---|---|---|---|---|
| | Obs. | Mean | Obs. | Mean | Obs. | Mean | Obs. | Mean |
| Age (months) | 388679 | 153.10 | 171619 | 139.61 | 89442 | 141.41 | 127618 | 179.42 |
| No. of Products (national market) | 388679 | 2958.58 | 171619 | 3572.17 | 89442 | 2227.20 | 127618 | 2646.02 |
| No. of Firms (national market) | 388679 | 300.78 | 171619 | 408.26 | 89442 | 286.33 | 127618 | 166.38 |
| No. of Products (own firm) | 388679 | 45.01 | 171619 | 31.94 | 89442 | 33.69 | 127618 | 70.50 |
| New Products, last 12 months (own firm) | 388679 | 2.70 | 171619 | 2.40 | 89442 | 3.26 | 127618 | 2.73 |
| No. of Products (own firm, on the ATC-3 subgroup) | 388679 | 4.70 | 171619 | 4.51 | 89442 | 4.45 | 127618 | 5.12 |
| No. of Products (other firms, on the ATC-3 subgroup) | 388679 | 72.57 | 171619 | 100.28 | 89442 | 47.46 | 127618 | 52.90 |
| With Reference Price | 388679 | 0.62 | 171619 | 0.31 | 89442 | 0.91 | 127618 | 0.82 |
| With higher 10% reimbursement for generics, in Portugal | 388679 | 0.21 | 171619 | 0.47 | | | | |
| With mandatory substitution for generics, in Sweden | 388679 | 0.10 | | | 89442 | 0.42 | | |
| With public tenders for subsidized drugs, in New Zealand | 388679 | 0.21 | | | | | 127618 | 0.63 |
| Population (ln) | 388679 | 8.87 | 171619 | 9.22 | 89442 | 9.09 | 127618 | 8.24 |
| GDP per capita (ln) | 388679 | 9.71 | 171619 | 9.40 | 89442 | 10.34 | 127618 | 9.68 |
| Pharmaceutical Sales, per capita (USD) | 388679 | 161.96 | 171619 | 152.94 | 89442 | 301.64 | 127618 | 76.20 |

# Non-Parametric Estimation



Survival functions
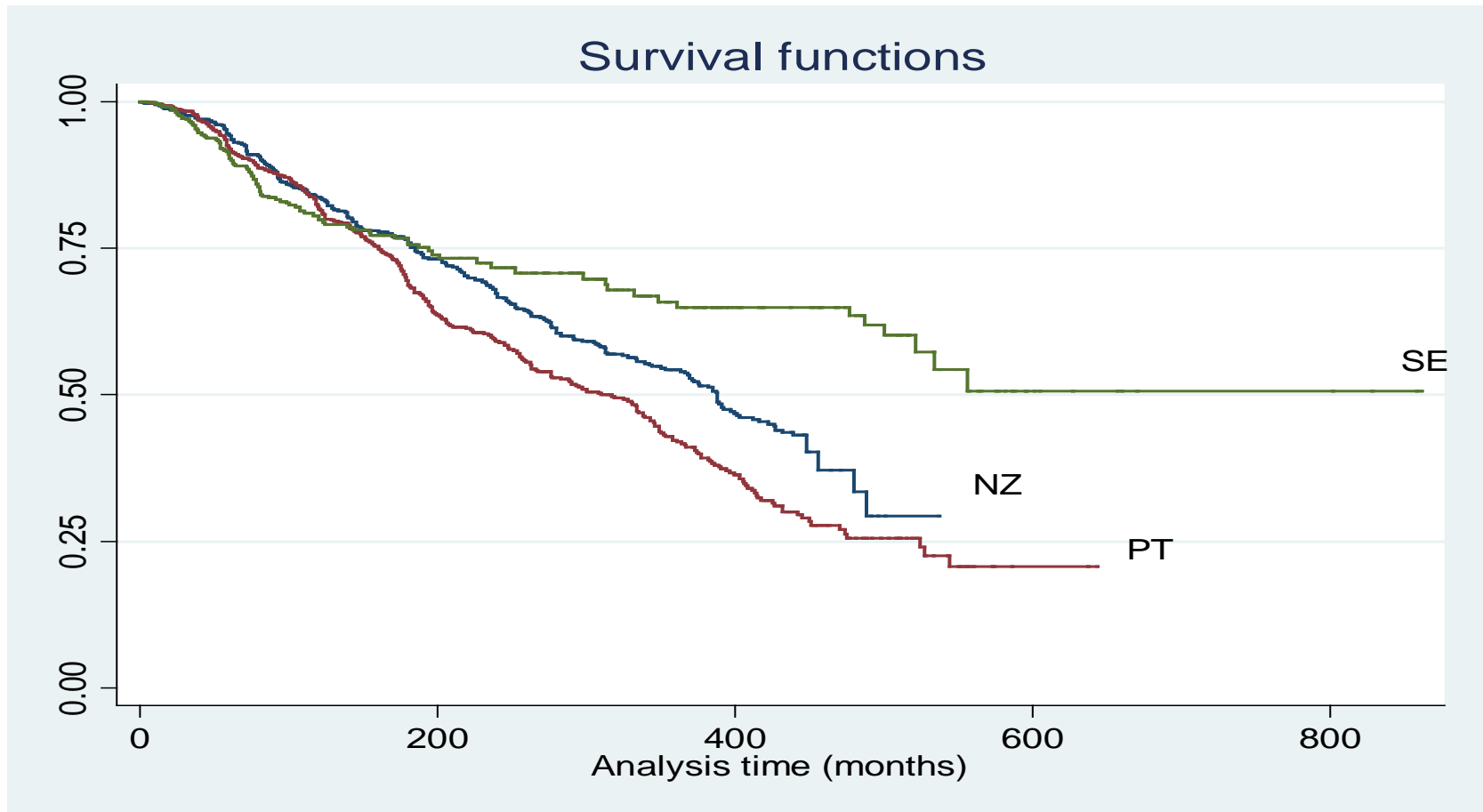
# Estimation

- A survival model is developed, taking into consideration the characteristics of:
  the national markets, such as regulation, dimension, degree of competition,
  and firm and product characteristics.

- The survival model is applied both on separated estimations for each country, and on estimations using data of the three countries.

# Results: Estimations for each country

| | Portugal | | Sweden | | New Zealand | |
|---|---|---|---|---|---|---|
| | (i) | (ii) | (i) | (ii) | (i) | (ii) |
| No. of Products (national market) | 1.001*** (4.79) | | 1.003*** (5.94) | | 1.004*** (4.80) | |
| No. of Firms (national market) | | 1.017*** (6.27) | | 1.030*** (5.62) | | 1.046* (1.89) |
| No. of Products (own firm) | 0.991*** (3.23) | 0.991*** (3.29) | 1.010*** (3.41) | 1.010*** (3.48) | 1.004** (2.23) | 1.004*** (2.60) |
| New Products, last 12 months (own firm) | 0.978 (0.89) | 0.978 (0.90) | 0.941** (2.37) | 0.939** (2.44) | 0.917*** (2.97) | 0.912*** (3.04) |
| Year of Firm's Entry | 1.000 (0.07) | 1.000 (0.03) | 1.002*** (3.78) | 1.002*** (3.84) | 0.999 (1.00) | 0.999 (0.82) |
| No. of Products (own firm, on the ATC-3 subgroup) | 0.987 (1.16) | 0.988 (1.13) | 0.966 (1.55) | 0.966 (1.54) | 0.976 (1.55) | 0.976 (1.52) |
| No. of Products (other firms, on the ATC-3 subgroup) | 1.000 (0.55) | 1.000 (0.40) | 1.007*** (2.98) | 1.007*** (3.05) | 1.008*** (3.21) | 1.009*** (3.45) |
| Non-prescription drug = 1 | 0.972 (0.17) | 0.977 (0.14) | 0.750 (0.52) | 0.755 (0.51) | 0.576*** (2.71) | 0.576*** (2.71) |
| With Reference Price | 0.309*** (6.59) | 0.316*** (7.55) | | | 0.554** (2.05) | 0.854 (0.56) |
| With higher 10p.p. reimbursement for generics, in Portugal | 6.633*** (7.41) | 3.557** (4.93) | | | | |
| With mandatory substitution for generics, in Sweden | | | 0.589 (0.73) | 0.764 (0.38) | | |
| With public tenders for subsidized drugs, in New Zealand | | | | | 0.194*** (3.92) | 0.575 (1.44) |
| Log-Likelihood | -1904.776 | -1892.589 | -560.036 | -562.765 | -1235.533 | -1247.106 |
| Observations | 170007 | | 88459 | | 126676 | |

# Results

We may conclude that the effect of market, firm and product characteristics is different from country to country.
Therefore, not only differences between countries imply different survival rates, *de per se*, but they also imply differences on other variables impact.

The reference price system does not seem to stimulate competition *de per se*, even when we control for the impact of other regulatory measures.

# Results: Estimations for the three countries

| | (I) | (II) | (III) | (IV) |
|---|---|---|---|---|
| No. of Firms (national market) | 1.016*** | 1.017*** | 1.027*** | 1.016*** |
| | (14.93) | (7.86) | (7.18) | (7.56) |
| No. of Products (own firm) | 1.002** | 1.003** | 1.003** | 1.003*** |
| | (2.00) | (2.42) | (2.53) | (2.69) |
| New Products, last 12 months (own firm) | 0.960*** | 0.955*** | 0.953*** | 0.952*** |
| | (3.13) | (3.40) | (3.56) | (3.62) |
| Year of Firm's Entry | 1.001*** | 1.001*** | 1.001*** | 1.001*** |
| | (3.90) | (4.14) | (4.29) | (4.34) |
| No. of Products (own firm, on the ATC-3 subgroup) | 0.975*** | 0.975*** | 0.976*** | 0.976*** |
| | (3.26) | (3.26) | (3.25) | (3.25) |
| No. of Products (other firms, on the ATC-3 subgroup) | 1.001 | 1.001** | 1.001** | 1.001** |
| | (1.56) | (2.07) | (2.17) | (2.13) |
| Non-prescription drug = 1 | 0.753** | 0.747** | 0.746** | 0.745** |
| | (2.35) | (2.42) | (2.43) | (2.44) |
| If in Sweden = 1 | 5.183*** | 6.046*** | 54.879*** | |
| | (10.21) | (2.80) | (4.36) | |
| If in New Zealand = 1 | 85.865*** | 266.65*** | 1610.703*** | |
| | (12.74) | (9.31) | (8.38) | |
| With Reference Price | | 0.341*** | 0.497*** | 0.458*** |
| | | (8.40) | (4.44) | (5.40) |
| With higher 10% reimbursement for generics, in Portugal | | 2.868*** | 1.778** | 3.047*** |
| | | (4.44) | (2.25) | (4.67) |
| With mandatory substitution for generics, in Sweden | | 4.108** | 5.676*** | 13.422*** |
| | | (2.51) | (3.10) | (8.44) |
| With public tenders for subsidized drugs, in New Zealand | | 1.636*** | 1.299 | 2.569*** |
| | | (2.94) | (1.48) | (5.51) |
| Population (ln) | | | | 0.008*** |
| | | | | (9.29) |
| GDP per capita (ln) | | | | 0.745 |
| | | | | (1.02) |
| Pharmaceutical Sales, per capita (1000USD) | | | 0.991*** | |
| | | | (3.78) | |
| Log-Likelihood | -4509.923 | -4452.022 | -4444.530 | -4458.897 |

# Results

- When accounting for market, firm and product's characteristics, the country with minor probability of survival is New Zealand, followed by Sweden and then Portugal.

- We find no evidence of intra-firm competition. In fact, it seems that new products do not lead to the exit of existing products within the same firm.

- We find that inter-firm competition is important to explain pharmaceutical product survival: competition increases the probability of exit, as expected.

- We conclude that the introduction of a reference price system do not guarantee, *de per se*, the improvement of competition pressure and the consequent increase of product exit.

# Conclusions

- In this paper, we innovate by presenting a cross-countries analysis of product survival.

- We draw some methodological conclusions.

- First, we should be careful when extrapolating the results from single-country studies to other countries, because the results could vary a lot from country to country.

- Second, parametric estimations can improve substantially the insights on product survival. In our case, the parametric estimations add important results to the non-parametric estimation.

- We believe that the absence of evidence of intra-firm competition is the consequence of the prevalence of scale or scope economies over the dispute for scarce resources within firm's portfolios.

- The introduction of a reference price system does not imply, *de per se*, an increase of the likelihood of pharmaceutical product exit. This result may help explain the ambiguous results on the impact of reference price system on competition variables of previous papers.