Characteristics of demand for antibiotics in primary care: an almost ideal model

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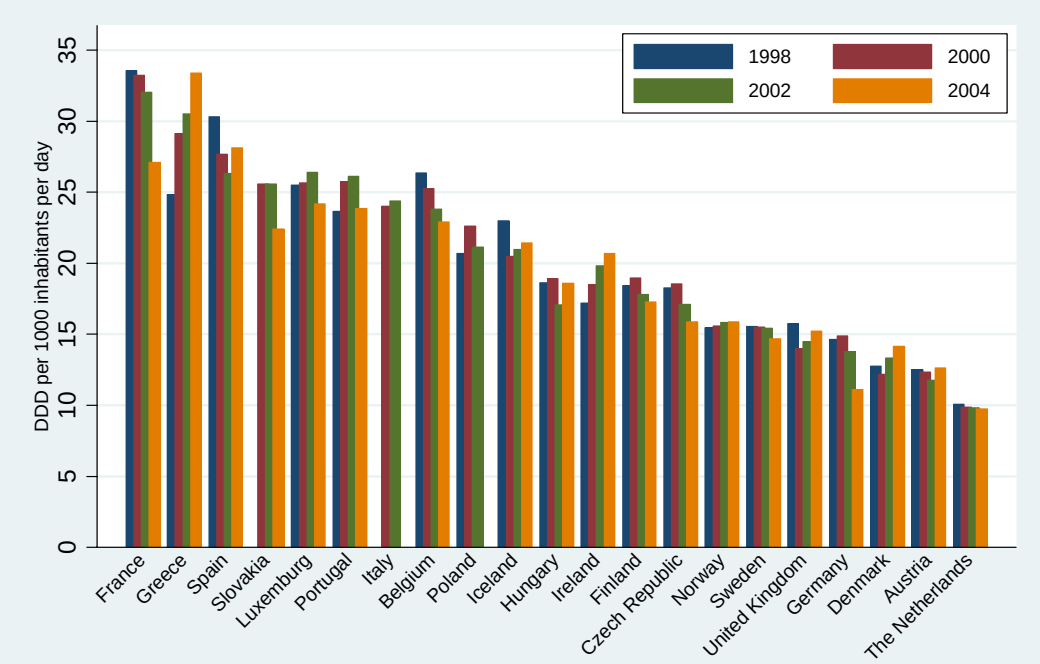
Objectives

- Determinants of antibiotic consumption structure (local mix) in outpatient care
- Complementary and substitution between different antibiotic classes

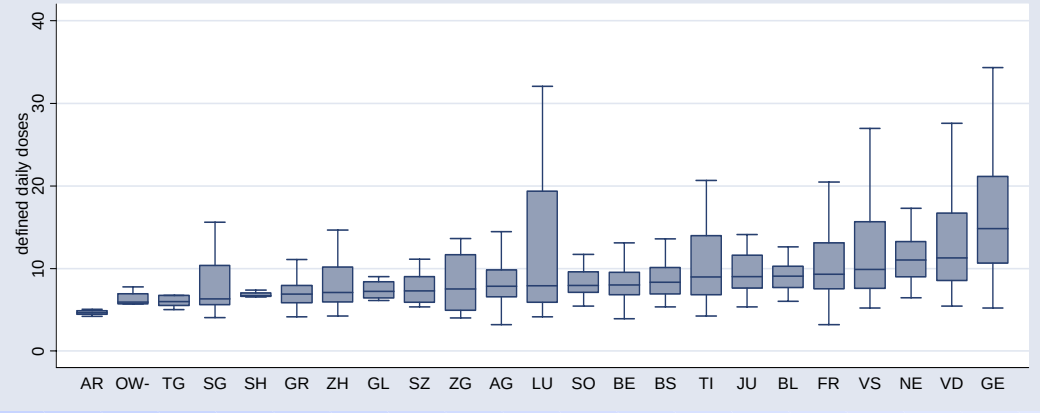
Motivation

Although antibiotic prescriptions have slightly decreased during the 90s and been roughly stable in recent years, **prescribing practices still vary widely across countries** (Elseviers et al. 2007)

and within countries (Filippini et al., 2006b)

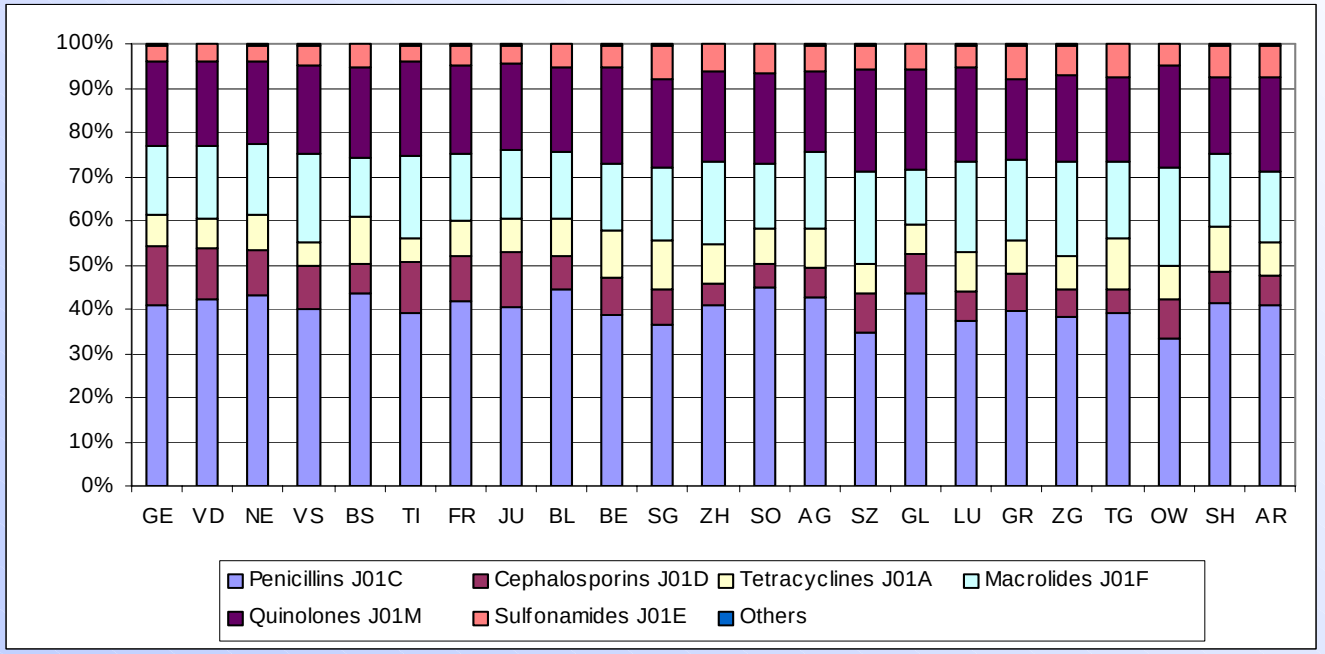


Within-canton variations in the per capita antibiotics use, 2002



Motivation

Regional **heterogeneity in antibiotic mix** within and between countries (Kern et al., 2006; Ferech et al., 2006; Elseviers et al., 2007). Optimal use?



Motivation

Physicians face tradeoffs (common respiratory infections):

1. Prescribe/delay antibiotic therapy under uncertainty of infection (viral/bacterial)
2. Substituting away some types of antibiotics with newer and more effective ones (broad vs. narrow spectrum). Variety may reduce resistance (Laxminarayan and Weitzman, 2002; Rowthorn and Brown, 2003)

> Doctors` attitudes towards a group of antibiotics: strategies influenced by patients' characteristics, antibiotic price and economic incentives

The literature

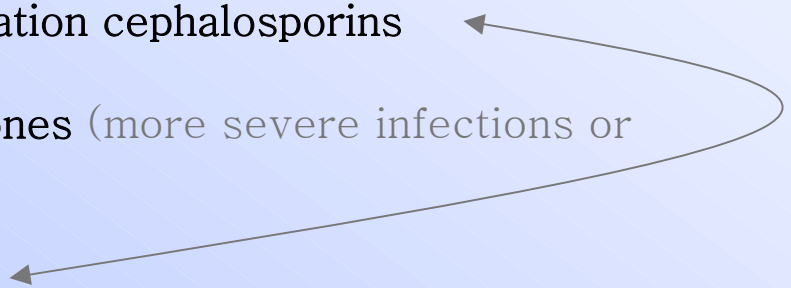
- **Resistance-induced antibiotic substitution** (Howard, 2004). No evidence that bacterial resistance significantly varies at local level. Other determinants?
- **Demand for specific antibiotic classes** (Ellison et al., 1997; Chaudhuri et al., 2003). Focus on two segments of the market: cephalosporins and quinolones. Chemist's view rather than physician's?
- **Determinants** of regional and local heterogeneity in the use of antibiotics within countries (Filippini et al., 2006a; 2006b). Consumption structure?

The model

Almost Ideal Demand System (Ma and al., 2004; Lazaridis, 2004; Boetel and Liu, 2003)
Two-stage budgeting approach (antibiotics vs. other types of goods > different categories of antibiotics)

Decisions of rationale physicians
Doctors concerned with the effectiveness of a broad category of antibiotics compared to another one. Choice among a limited set of antibiotic categories:

group 1
Penicillins (classic)
group 2
Penicillins (amoxiclav) and 1st-2nd generation cephalosporins
group 3
3rd generation cephalosporins and quinolones (more severe infections or alternative to 2nd generation)
group 4
Macrolides (alternative to beta-lactams)



The model

Expenditure share of the ith group of antibiotics

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log(x/P) + \sum_{k=1}^{S} \nu_{ik} V_k + \sum_{l=1}^{L} \phi_{il} R_l + \sum_{t=1}^{T} \rho_{it} DT_t + u_i,$$

Additional **determinants** by a log-linear scaling procedure:

V_k	=	Demographic structure, cultural aspects (borderland location, language)
R_l	=	Practice regulation (self-dispensing)
DT_t	=	Time dummies

Data: short panel (2002 quarterly, 240 contiguous market areas)

Estimation: Zellner's Iterative Seemingly Unrelated Regression (SUR) procedure (classic penicillins dropped)

Estimation results

	Penicillins (amoxi/clav) and 1^{st} - 2^{nd} generations cephalosporins		3^{rd} generation cephalosporins and quinolones		Macrolides	
Obs.	960		960		960	
R^2	0.262		0.369		0.387	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Constant	0.758***	0.073	0.211***	0.056	0.211***	0.071
P_1	-0.021**	0.010	0.077***	0.010	-0.050***	0.010
P_2	0.248***	0.027	-0.141***	0.018	0.086***	0.022
P_3	-0.141***	0.018	0.031	0.023	0.032*	0.019
P_4	-0.086***	0.022	0.032*	0.019	0.104***	0.027
x/P	-0.000	0.004	0.004	0.003	-0.013***	0.004
POP_1	-0.008	0.028	0.035*	0.021	-0.027	0.027
POP_2	0.054**	0.027	-0.025	0.020	0.006	0.026
POP_4	0.032*	0.018	-0.005	0.014	-0.004	0.018
POP_5	0.008	0.010	0.032***	0.007	-0.037***	0.009
$DBOR$	0.010	0.006	-0.005	0.005	-0.015**	0.006
$DLAT$	-0.015**	0.006	0.042***	0.004	-0.025***	0.006
$SELF$	-0.034***	0.006	-0.003	0.005	0.040***	0.006
DT_1	-0.039***	0.006	0.020***	0.004	0.024***	0.005
DT_2	0.004	0.006	0.012***	0.004	-0.037***	0.005
DT_3	0.042***	0.006	-0.007*	0.004	-0.050***	0.005

* significant at 10%, ** significant at 5%, *** significant at 1%

Main findings (determinants)

- Population characteristics

  Elderly people increases the use of new cephalosporins/quinolones and reduces the use of macrolides

- Cultural aspects

  The Latin culture is associated with a more substantial use of new cephalosporins/quinolones and macrolides and a lower proportion of penicillins amoxi/clav and cephalosporins I-II

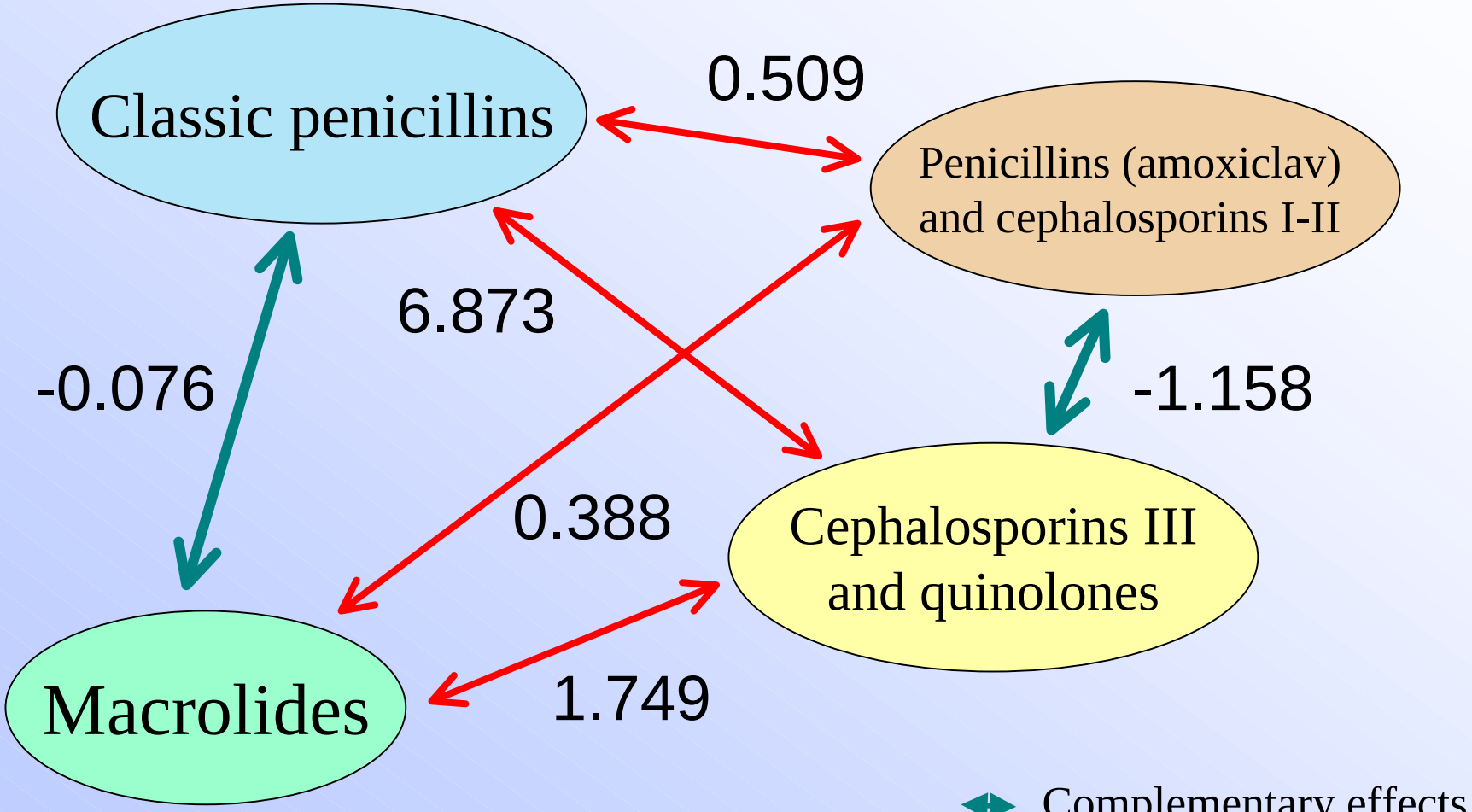
- Regulation

  Self-dispensing practices have a tendency to shift upward the demand for newer and more expensive antibiotics and to reduce the demand of traditional and less expensive antibiotics (penicillins amoxi/clav and cephalosporins I-II)

Main findings (own-price elasticity)

The highest own-price elasticity is found for the **most expensive antibiotic category** (group 3) and the **traditional** and less frequently used antibiotics (classic penicillins)

(Allen) Elasticity of substitution



Main findings (cross elasticities)

Complementary effects between antibiotics with a relative **narrow spectrum** and antibiotics with a relative **large spectrum**, and between **classic penicillins and macrolides**

Degree of substitution between other categories

Discussion

Own-price elasticity:

Latest generation cephalosporins/quinolones used to reduce **uncertainty**

Comparative advantage of **traditional antibiotic therapy substantially undermined**

Cross-price elasticity:

Switching to classic penicillins/macrolides rather than latest generations of cephalosporins/quinolones preferred

Patients' tastes > no switching between classic penicillins and macrolides

Conclusions

Contribution

We propose a **model** of the demand for **antibiotics for respiratory infections** prescribed in **outpatient** care

The approach includes **determinants** of the demand structure other than price, such as demographic and cultural characteristics of the population and practice self-dispensing status

Improvements

Data on the incidence of **bacterial resistance** at a local level

Policy implications

Local **taxation** of antibiotic components associated with levels of bacterial resistance may affect the antibiotic mix and, therefore, improve efficiency in consumption