Regional Science and Urban Economics 49 (2014) 242–251

Contents lists available at ScienceDirect

Regional Science and Urban Economics

journal homepage: www.elsevier.com/locate/regec

Antibiotic consumption and the role of dispensing physicians ☆

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ARTICLE INFO

Article history:
Received 26 March 2013
Received in revised form 30 April 2014
Accepted 14 July 2014
Available online 22 July 2014

JEL classification:
I11
I18
D12
D21
D43
D81
D82

Keywords:
Physician dispensing
Prescribing behavior
Antibiotic use
Consumption spillovers
Spatial effects

ABSTRACT

The benefits of separating drug prescribing and dispensing are still unclear, in particular when drug consumption is characterized by important spillovers. We investigate the role of dispensing physicians in the consumption of antibiotics characterized by two opposite external effects: infection prevention and control, and bacterial resistance. We model the interaction between competing physicians (with and without dispensing of drugs) and patients exposed to bacterial infections and show that spatial effects of consumption may generate ambiguous results. Then, we propose an empirical exercise which exploits data from small geographic areas in Switzerland where two regimes – prescribing physicians and dispensing physicians – are possible. We consider spatial aspects of antibiotic consumption by means of combined spatial lag and spatial error econometric estimators for panel data (SARAR models). We find evidence that dispensing practices increase antibiotic use after controlling for determinants of demand and access, and spatial effects. Whether dispensing practices lead to an increase of antibiotic consumption beyond socially optimal levels is unclear and requires further research.

1. Introduction

Prescribing and dispensing of drugs are one of the main aspects of access to primary health care. In most developed countries, the main role of family physicians is to prescribe drugs without direct dispensing. Doctors are not allowed to sell drugs directly to their patients in several OECD countries such as Italy, Germany and Scandinavian countries. Still, direct dispensing is possible in some countries such as Switzerland, where physicians can sell drugs to their patients in most regions (cantons), with some exceptions across the country.

The reason for separating drug prescribing and dispensing is to optimize drug treatment by avoiding a conflict of interest for the prescriber and by ensuring good practice in dispensing (Trap and Hansen, 2003). Lundin (2000) shows that physicians are exposed to moral hazard and the amount and type of drugs prescribed depend on who bears the cost and on the existence of insurance companies that lead physicians to overprescribe. Evidence of moral hazard is reported by Chiappori et al. (1998) and Coulson et al. (1995), respectively, for the demand for home visits and the demand for prescription drugs. Liu et al. (2009) show that profit incentives do affect dispensing physicians, suggesting that physicians act as imperfect agents. Abood (1989) shows that dispensing doctors charge higher retail prices, whereas Rischatsch and Trottmann (2009) indicate that dispensing physicians have a greater probability of prescribing drugs that offer high margin, when compared with non-dispensing physicians. Gilbert (1998) and Morton-Jones and Pringle (1993) find that dispensing physicians issue more prescriptions per patient and have higher prescribing costs than non-dispensing physicians, respectively. Finally, Trap and Hansen (2002) examine differences in the rationality of the prescription in relation to diagnosis and symptoms and find that dispensing doctors prescribe an antibiotic 2.5 times more frequently than non-dispensing doctors. The authors conclude that dispensing practices may lead to increasing health hazards and bacterial resistance.

Nevertheless, the benefits of separating drug prescribing and dispensing are still unclear. This is because direct dispensing of drugs may increase patient benefits when consumption is characterized by important spillovers, particularly in areas where access to physician

☆ Support from the Swiss National Science Foundation is acknowledged (NRP 49 "Antibiotic Resistance", Project number: 4049406101253/1). We are grateful to Karine Moschetti for invaluable collaboration on early stages of this research. We thank participants of the III Health Econometrics Workshop (Siena, December 2012) and two anonymous reviewers for helpful comments and precious advice. Any remaining mistakes are ours. We also thank IMS Health Switzerland for providing data on antibiotic sales.
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http://dx.doi.org/10.1016/j.regsciurbeco.2014.07.005
0166-0462/

services is relatively poor. The purpose of this article is to investigate the role of dispensing physicians in the consumption of health care services (antibiotic treatment) characterized by important consumption externalities. External effects of consumption are relevant mainly for anti-infective drugs, and are certainly crucial for antibiotics. Antibiotic drugs are generally used to treat respiratory and gastrointestinal infections which are among the most common infectious diseases acquired in the community. As discussed by Hess et al. (2002), these infections are characterized by a spreading process across regions, i.e. the infection initiates in one region and then spreads across other regions (see Werneck et al. (2002) for an example of the spatial spread of an infection). Consequently, benefits from antibiotic use can extend to other individuals in the community. However, a second type of externality may arise because of endogenous bacterial resistance. This reduces antibiotic effectiveness and increases patient costs (Rudholm, 2002), which in turn enlarges the inefficiency caused by moral hazard.

The effects of consumption externalities are disregarded in all the above studies on the behavior of dispensing physicians. Hence, the main novelty of the paper as with respect to the existing literature is the inclusion of spatial spillovers in the analysis of antibiotic prescriptions by dispensing physicians. We innovate both from a theoretical and an empirical perspective. We first propose a theoretical model to investigate the behavior of different types of general practitioners under imperfect information on the nature of patient infections, and prevention and bacterial resistance externalities. We show that antibiotic prescriptions may be higher for dispensing practices, though consumption spillovers may lead to ambiguous results. Then, we propose an empirical exercise which exploits data from small geographic areas in Switzerland where two regimes – prescribing physicians and dispensing physicians – are possible. This provides the ground for a natural experiment.

We consider spatial aspects of antibiotic consumption by means of combined spatial lag and spatial error econometric estimators for panel data (SARAR models). Spatial-econometric estimators in health economics have been recently applied, for instance, by Lachaud (2007), Moscone et al. (2007), and Moscone and Tosetti (2010a, 2010b). These studies underline the importance of taking spatial aspects into account when modeling the utilization of health care services. We are aware of only few empirical studies investigating spillover effects of antibiotic consumption (Filippini et al., 2009a, 2009b; González Ortiz and Masiero, 2013), though without considering dispensing practices. Our empirical analysis indicates that dispensing practices induce higher rates of antibiotic use, after controlling for patient characteristics, epidemiological factors, access to drug treatment, and consumption spillovers. Still, the welfare implications of this result are puzzling.

The remaining of the article is organized as follows. In Section 2 we sketch the theoretical model and discuss the implications of antibiotic externalities for dispensing and non-dispensing practices. Section 3 empirically investigates the impact of dispensing practices on antibiotic use and discusses the results. Section 4 concludes.

2. Antibiotic treatment in general practice: a theoretical approach

We investigate the market for antibiotic treatment by extending the classical product differentiation model (Hotelling, 1929) in an infinite-period framework where patients and general practitioners interact under imperfect information on the nature of infections and antibiotic consumption externalities. Nature assigns a health problem (bacterial or viral infection), $i \in \{b, v\}$, to each of the 2θ individuals uniformly distributed along a unit line at the beginning of each period. Consumers initially observe a symptom but cannot infer the type of infection they suffer from. Each generation of consumers lives for two periods. Therefore, in each period there is a mass of 2θ consumers: a mass θ^y composed of young consumers and a mass θ^o composed of old consumers. The proportion of young consumers entering the market and the proportion of old consumers leaving the market in each period are the same, with $\theta^y = \theta^o = \theta$. In the first period there is only one generation of consumers, θ, and all of them are young.

In the market there are 2 general practice firms (GP j, with $j \in [l, r]$) of equal size, located at the two extreme points of the distance. General practitioners can either be allowed to sell drugs directly to their patients or not. All individuals consult a doctor and differ with respect to their location and the type of infection. Doctors make prescriptions based on a diagnosis signal. The accuracy of a GP's prescription is related to the level of diagnostic services provided by the practice (e_j), which is not observable to the patient. Hence, we assume that patient's choice of practice is based upon costly distance.

Patients recover naturally from viral infections after a consultation. However, antibiotics are necessary to recover from bacterial infections. A second consultation is required if the patient suffers from a bacterial infection and an antibiotic is not initially prescribed. Consequently, the total demand for consultations of GP j by young patients in each period includes second consultations by patients with a bacterial infection who initially receive a wrong diagnosis. This is summarized by Eq. (13) in Appendix A.

2.1. Prevention and bacterial resistance externalities

At the beginning of each period, nature assigns a health problem to old patients in the market, like for young patients. However, old patients present a lower probability of infection because they have been exposed to antibiotics prescribed in the previous period. As a consequence, they benefit from the preventive effect of antibiotic use (see also Ellison and Hellerstein, 1999) and do not need to consult a doctor in the second period. We assume that the number of old patients with an infection decreases by a proportion $\phi \in [0, 1]$ of the number of young patients (now the old patients) receiving antibiotics in the previous period (from both practices). Antibiotic prescriptions are derived using the demand for consultations by young patients in Appendix A. Consider that only half of the initial number of consultations by young patients from each GP leads eventually to an antibiotic prescription, and some of the young patients receive antibiotics because of wrong diagnosis. Eventually, total demand for consultations for GP l in each period t can be derived by summing up the demand for consultations by young and old patients (see Eq. (14) in Appendix A). It is worth pointing out that diagnosis effort by GP j in period $t-1$ affects the demand for consultations of both GPs in the following period because of the preventive effect of antibiotic treatment.

A second external effect needs to be considered. The use of antibiotics in period $t-1$ reduces the effectiveness of antibiotic treatment in the following period because of bacterial resistance. This raises the cost of treatment and the cost for research and development of new drugs, which represent a negative externality from antibiotic consumption. We capture this effect by assuming that practices face increasing costs (ρ) to cure patients with resistant bacteria.[1]

2.2. Market equilibrium: the effects of spillovers and dispensing practices

General practitioners have an objective function that depends upon the benefits and costs of diagnostic services provided in each period. GPs maximize their discounted flow of profits non-cooperatively by choosing the level of diagnostic services and taking their competitor's strategies as given. Effort strategies can change over time.[2] Dispensing

[1] The parameter ρ can also be interpreted as the value of providing good care to patients. Indeed, better diagnostic services in $t-1$ reduce inappropriate antibiotic prescriptions and, consequently, reduce future risks for patients.

[2] When choosing diagnosis effort firms take into account the effects not only on their current period profits but also on their demand and costs (bacterial resistance) in the following periods. This dependence needs to be taken into account when solving the model for the equilibrium levels of diagnostic efforts. Profits in period t depend upon diagnostic services in period $t-1$ by both GPs. Also, the value function represented by the flow of all future profits depends on all future levels of diagnosis effort. Consequently, an equilibrium has to ensure that deviations from current period levels of effort in the future are not convenient. We require a perfect equilibrium, i.e. each GP selects the diagnosis effort that maximizes its intertemporal profit given the subsequent strategies of the other GP and itself, whose strategies depend only on the payoff-relevant history (Maskin and Tirole, 1988).