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## Corruption and use of antibiotics in regions of Europe



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### ABSTRACT

The aim of this article is to investigate the association between corruption and antibiotic use at sub-national level. We explore the correlation between, on the one hand, two measures of corruption (prevalence of corruption in the health sector and prevalence of bribes in the society) at regional level from the European Quality of Government Index; and, on the other, the consumption of antibiotics in those European regions from a 2009 Special Euro Barometer. In a multivariate regression model, we control for potential confounders: purchasing power of standardized regional gross domestic product, inhabitants per medical doctor and age-standardized all-cause mortality rates. We find that there is a strong positive association between both measures of corruption (i.e. in the health sector, and in the society at large) and antibiotics use; and that this association is robust to the introduction of the control variables. These results support previous findings in the literature linking corruption to higher antibiotic use at cross-national level. We show that corruption does seem to account for some of the remarkable between-region variation in antibiotic consumption in Europe.

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## 1. Background

Antibiotic resistance – an unavoidable side effect of the consumption of antibiotics – is one of the greatest global challenges to public health. Increasing bacterial resistance to existing antibiotics causes substantial morbidity and mortality and increases health care and societal costs. As the World Health Organization (WHO) points out, “a post-antibiotic era—in which common infections and minor injuries can kill—far from being an apocalyptic fantasy, is instead a very real possibility for the 21st century” [1]. In Europe alone, antimicrobial resistance is estimated to cause 25,000 deaths each year and result in related costs of over €1.5 billion in healthcare expenses and reduced produc-

tivity [2] while, in the US, it is estimated to cause 2 million illnesses and 23,000 deaths per year [3]. If resistance is left unchecked, a conservative estimate is that by 2050 an additional 10 million people are expected to die every year and the cumulative cost – among other, increased complications, waste, lengthier hospital stays and the development of more expensive drugs – will be more than one and a half times annual world Gross Domestic Product today (GDP) [4]. In other words, “rarely has modern medicine faced such a grave threat” [5].

There is a recognition that limiting antibacterial resistance is far from just a medical concern but rather a behavioural and social problem. Since consumption of antibiotics is considered to be the main driver of the development of antibacterial resistance [6], large-scale behavioural change in relation to antibiotic consumption is urgently called upon.

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In a European perspective, there is a huge variation in outpatient antibiotic consumption, variation in the class of antibiotics, dosage and treatment duration, and variation in the quality of outpatient antibiotic consumption between European countries [6–11]. This variation is unlikely to be the result of differences in the frequency of bacterial infections [6]. Take for instance Belgium and the Netherlands, which exhibit remarkable differences in antibiotic use, with the former using them to a much larger extent than the latter.

What could possibly account for this heterogeneity? Some researchers emphasize differences in regulatory practices and healthcare systems [6,7,12] while for others it is ineffective healthcare systems and poor enforcement of regulations what might explain the widespread non-prescription sales of antibiotics that are prevalent in many European countries [6]. There is also a growing literature exploring the effects of corruption on health care [13,14]. A pioneering analysis of a panel data set including 28 European countries found that “corruption is the main socioeconomic factor that explains antibiotics resistance” [15], leading the authors to conclude that addressing corruption and improving governance will lead to a reduction in resistance to antibiotics. Moreover, a report from the European Commission (2013, p. 146) explicitly brings up increased antimicrobial resistance as possibly being the result of improper market relations, since promotion of pharmaceutical products create loyalty and may trigger over-medicalization [16].

However, the literature linking corruption and antibiotics abuse has not taken into consideration sub-national differences. And we know from other studies that there are both very large within-state variations in levels of corruption [17] and consumption of antibiotics [11,18]. For example, there are pronounced differences across regions within the same country, such as the very high levels of antibiotic consumption in Spain’s Catalonia (or Italy’s Lazio) and the moderate levels in Spain’s Basque Country (or Italy’s Tuscany). The picture emerging from these findings is thus more nuanced than the conventional view that the rates of antibiotic use and resistance “remain low in northern European countries” while “reaching alarming levels in Southern and Central Europe” [6].

In general, the aim of this paper is to provide a more detailed map of the relationship between corruption and antibiotic consumption—by examining over 100 European regions instead of countries. Despite causality cannot be established in a cross-sectional study like the one presented here, our findings do indeed question the validity of national-level explanations of both corruption and antibiotics use, either institutional (e.g. the national health care system) or cultural (e.g. the national language).

In particular, the goal of this paper is to investigate the association between two regional measures of corruption – prevalence of corruption in the health sector and prevalence of bribes in the society – and consumptions of antibiotics in the European regions. This paper uses novel data from the European Quality of Government Index [17] that collect perceptions of the prevalence of bribes in the public sector in general and the prevalence of corruption in the health sector in regions of Europe. The data

shows a strong bivariate association between these measures of corruption at the regional level and consumption of antibiotics in European regions—with data from a special 2009 Euro-Barometer survey on antibiotic consumption. When controlling in multivariate regression models for multiple confounders – e.g. purchasing-power standardized regional GDP per capita, inhabitants per medical doctor, age-standardized mortality rates – the associations between regional corruption and antibiotic consumption remain persistent and strong.

## 2. Methods

### 2.1. Independent variables

We test proxies for both indicators of corruption: the perception of corruption in the healthcare sector; and citizens’ reported experience of bribery. Data come from a survey data of about 85,000 EU citizens distributed in all the 206 NUTS-1 and NUTS-2 (Nomenclature des Unités Territoriales Statistiques) regions in Europe. Making use of telephone interviews in the local language of each region, randomly drawn respondents 18 years of age or older were asked questions relating to Quality of Government on the one hand and questions about demographics on the other. The survey was administered beginning in February 2013 and sampled 400 or more respondents in each region. The robustness and external validity of the data have been verified thoroughly [17].

To measure the perception of corruption in the healthcare sector, respondents were asked to rate on a 10-point scale the extent to which they agreed or disagreed with the following statement: ‘Corruption is prevalent in the public healthcare system in my area’ (agree/disagree 0–10). In the empirical analysis, higher scores indicate lower levels of healthcare sector corruption. To measure citizens’ reported experience with bribery, the following question was asked: ‘In your opinion, how often do you think other citizens in your area use bribery to obtain public services?’ Respondents were asked to answer on a 10-point scale (never/often 0–10). In the empirical analysis, higher scores indicate higher levels of bribery. The indicators of perceptions of corruption in the healthcare sector and perceptions of the prevalence of bribes in the society were aggregated from the individual level to the regional level as the mean score. The indicators are highly but far from perfectly correlated (Pearson’s  $R$  0.7430). This signifies that, although related, the indicators seem to measure different aspects of corruption. To increase comparability, the measures were also standardized so that the mean is 0 and the standard deviation is 1.

The measure of corruption in the healthcare sector ranges from the Hovedstaden region in Denmark (1.825, very low levels of healthcare sector corruption) to the region of Yugozapaden in Bulgaria (–2.268, very high levels of healthcare sector corruption). The measure of bribery in society ranges from the region of Midtjylland in Denmark (0.926, very low levels of bribery) to the region of Bucuresti-Ilfov in Romania (4.624, very high levels of bribery).

## 2.2. Dependent variable

The Special Eurobarometer 338 was in field between 13 November and 9 December 2009 and included residents aged 15 years or above in all the 27 EU member states. The survey concerned the use of antibiotics by Europeans, public knowledge and perceptions about antibiotics, and the impact of antibiotic awareness campaigns on the knowledge and practices of Europeans related to antibiotics. To measure antibiotic consumption, the following question was asked in the survey: ‘Have you taken any antibiotics orally such as tablets, powder or syrup in the last 12 months?’ In total, about 40% of all respondents answered that they had taken antibiotics during the past year. The answers to the question were aggregated to the regional level by means of the survey question regarding respondents’ region of residence.

## 2.3. Confounders

In the multivariate analysis, the confounders of purchasing power standardized regional gross domestic product (GDP), inhabitants per medical doctor and age-standardized all case mortality rates were included in the model because they are likely to be correlated with both the main independent variable, corruption, and the main dependent variable, antibiotic consumption [14,19].

The data on purchasing power standardized regional GDP 2011, inhabitants per medical doctor and age-standardized all case mortality rates 2008–2011 were obtained from Eurostat’s statistical depository.

## 2.4. Statistics

In the bivariate analysis, scatter plots were constructed to illustrate the association between the two dependent variables, prevalence of corruption in the health care sector and prevalence of bribes, and antibiotic consumption in the European regions.

Pearson’s R was calculated to investigate the correlation between these variables. Ordinary least square (OLS) regression models were used in the multivariate analysis, so as to investigate the link between the independent variables and antibiotic consumption, while controlling for the regional measures of purchasing power standardized regional GDP, inhabitants per medical doctor and age-standardized all case mortality rates.

The correlations between the independent variables were generally low or moderate in strength. The correlation between regional GDP and mortality rates turned out to be the strongest (0.692). However, multicollinearity diagnostics show that all Variance Inflation Factors (VIFs) were below 2.5.

In total, indicators for both corruption/bribery and antibiotic consumption were available for 172 regions. However, to limit the residual from biased estimations of antibiotic consumption from regions with few respondents in the Eurobarometer survey, regions in which there were fewer than 50 answers were excluded from the analysis. The bivariate analysis consists of 117 regions, and 88 in the multivariate analysis. However, all analyses were

**Table 1**

Multivariate regression coefficients and standard errors of antibiotic consumption in the regions according to corruption in the healthcare sector, purchasing power standardized regional gross domestic product (GDP), inhabitants per medical doctor and age-standardized all case mortality rates.

Variable	Beta	S.E.	95% conf. int.
Corruption in the healthcare sector	-10.314***	1.491	-13.280 to 7.348
GDP in the regions (in €1000)	-0.075	0.162	-0.398 to 0.247
Inhabitants per medical doctor	0.021	0.117	-0.002 to 0.443
Age-adjusted all case mortality rates	-0.026***	0.006	-0.004 to 0.002
Constant	61.065***	9.409	42.351–79.779
N	88		
R <sup>2</sup>	0.398		

Source: European Quality of Government Index 2012, Special Eurobarometer 338, and Eurostat.

Levels of significance \*P < 0.05; \*\*P < 0.005; \*\*\*P < 0.001. Regions with fewer than 50 respondents were excluded.

also carried out including regions with few Eurobarometer respondents, and the difference between the restricted sample and the full sample is limited.

## 3. Results

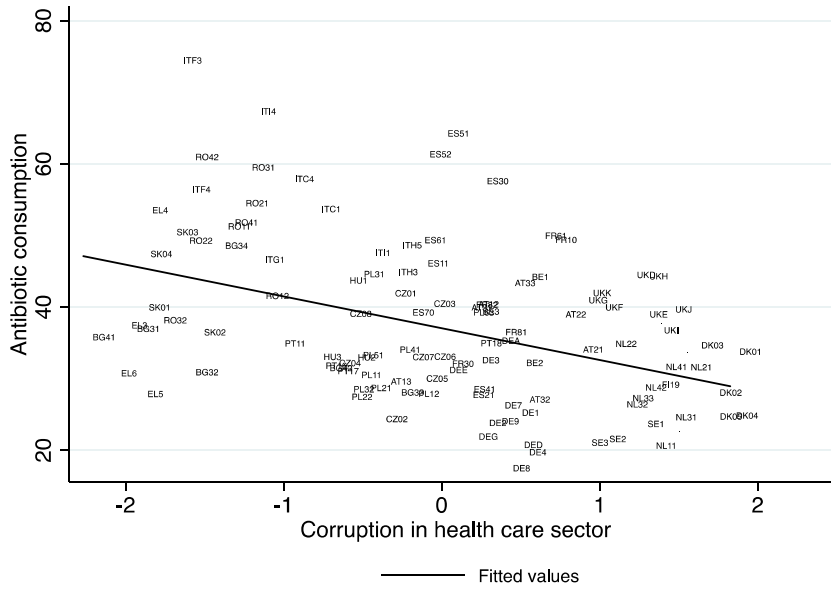
### 3.1. Bivariate analysis

Fig. 1 shows the bivariate correlation between the prevalence of corruption in the health sector and antibiotic use in the European regions. Low values in the X-axis indicate that individuals perceive that there is a great deal of corruption in their region (e.g. Campania, Vest), and high values correspond to perceptions of low corruption (e.g. Hovedstaden, Sjaelland). The correlation between these variables is -0.422 and significant at the 0.001 level. Individuals living in regions with high corruption in the health sector report consuming more antibiotics than individuals in regions with lower levels of corruption.

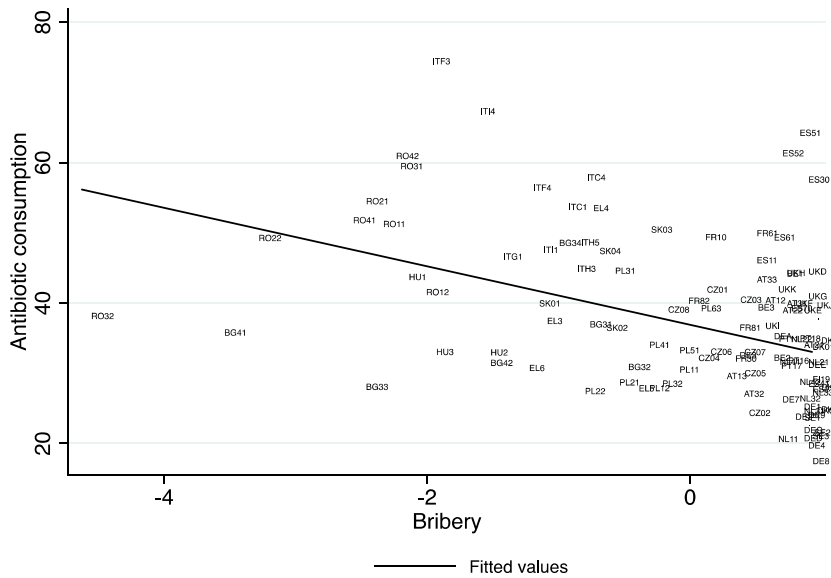
Fig. 2 displays the bivariate correlation between prevalence of bribery and antibiotic use in the European regions. Low values in the X-axis indicate high levels of bribery in the region (e.g. Bucuresti-Ilfov, Yugoapaden), and high values correspond to low levels of bribery (e.g. Mecklenburg-Vorpommen, Ita-Suomi). The correlation is -0.435 and is significant at the 0.001 level. Individuals experiencing that bribery is common in their region report consuming more antibiotics than individuals in regions where bribery is less prevalent.

### 3.2. Multivariate analysis

In order to check whether the bivariate correlation between corruption (or bribery) and antibiotic consumption is spurious, we perform a multivariate analysis where we control for alternative factors that could explain divergences in antibiotic consumption, according to the literature [24]. Table 1 shows that the negative association



**Fig. 1.** Corruption in the health sector and antibiotic use in the European regions, N = 117. Regions with fewer than 50 respondents were excluded. Source: European Quality of Government Index 2013 and Special Eurobarometer 338.



**Fig. 2.** Bribery and antibiotic use in the European regions, N = 117. Regions with fewer than 50 respondents were excluded. Source: European Quality of Government Index 2013 and Special Eurobarometer 338.

between corruption in the healthcare sector and antibiotic consumption is highly significant even when we control for the level of regional economic development (per capita *GDP in the regions*) and measures of the quantity (*inhabitants per medical doctor*) and the quality (*age-adjusted all case mortality rates*) of the healthcare system. It is noteworthy that there was no significant association between medical doctors per capita and antibiotic consumption. Yet there was a significant negative association between age-adjusted all case mortality rates and antibiotic consumption. Moreover,

there was no significant association between the regional per capita GDP and antibiotic consumption.

Table 2 is a copy of Table 1 except that, this time, the measure of bribery is used as an independent variable. The results are similar. There is a highly significant and strong negative association between bribery and antibiotic consumption, even when controlling it for the prevailing confounders in the literature for which we have data at the regional level. In this case, antibiotic consumption is not only significantly and negatively associated with the quality of the health at the regional level (*age-adjusted all case*

**Table 2**

Multivariate regression coefficients and standard errors of antibiotic consumption in the regions according to bribery, purchasing power standardized regional gross domestic product (GDP), inhabitants per medical doctor and age-standardized all case mortality rates.

Variable	Beta	S.E.	95% conf. int.
Bribery	−7.125***	1.089	−9.29 to −4.960
GDP in the regions (ln € 1000)	−0.375 <sup>†</sup>	0.158	−0.690 to −0.060
Inhabitants per medical doctor	0.001	0.011	−0.221 to 0.234
Age-adjusted all case mortality rates	−0.026***	0.006	−0.038 to −0.014
Constant	75.915***	9.990	56.045–95.784
N	88		
R <sup>2</sup>	0.374		

Source: European Quality of Government Index 2012, Special Eurobarometer 338, and Eurostat.

Levels of significance <sup>†</sup>P < 0.05; \*P < 0.005; \*\*\*P < 0.001. Regions with fewer than 50 respondents were excluded.

mortality rates) and with the level of economic development (per capita GDP in the regions), although the level of significance is lower. No significant association was found between inhabitants per medical doctor and antibiotic consumption.

#### 4. Discussion

If a great variation in antibiotic use across European countries has been found in numerous previous studies [6–11], our analysis corroborates others that also noted a great variation at the sub-national level [11,18]. Similarly to these studies, this variation is unlikely to be explained by differences in the frequency of bacterial infections. Take, for instance, the remarkable divergences between the neighbouring regions of Lazio and Toscana, or between Wallonie/Brussels and Flanders. Their pronounced differences in antibiotics consumption cannot either be accounted for by national cultural factors. Neighbouring regions within the same country behave very differently, and the question is why.

In order to address this puzzle, we have followed a growing interest among health researchers and policy-makers in how corruption affects health outcomes [20]. Corruption has been found to be negatively associated with a large variety of healthcare outputs and outcomes [14,20–25]. The effects of corruption may matter as much as – or even more than – traditionally explored factors such as health-spending measures [14] or the level of democratization [26]. Corruption is not only confined to developing countries; “corrupt practices in the health-care plague many developed countries” [14].

In particular, this study has explored the statistical association between antibiotic consumption and two measures of corruption. The analysis shows a significant and strong negative association between these measures of corruption and antibiotic consumption. The percentage of the population stating that they have consumed antibiotics in the past year was significantly lower in regions with low levels of corruption, both when corruption is measured as the

perception of corruption in the health sector and when corruption is measured as a direct experience with bribes.

To minimize the possibility of a spurious relationship, we include multivariate OLS regression models controlling for potential confounders, such as the level of economic development (measured by the regional GDP per capita) and the quality of the healthcare in the region (measured by the number of inhabitants per medical doctor and age-standardized all case mortality rates). The association between the two independent variables (corruption in the health sector and bribery) and the dependent variable (antibiotic consumption) is found to be persistent and strong when it is also subjected to these controls.

What are the mechanisms connecting high levels of corruption and high antibiotic consumption? The data presented here cannot identify the particular mechanisms, but, unlike previous studies we find an association between two different proxies for corruption (corruption in the health sector and bribery), thus indicating that the mechanisms may be multiple. Those mechanisms have been pointed out in the literature. In general, several scholars have noted that a characteristic of healthcare is the prevalence of problems of asymmetric information that give opportunities for abuse [14]. Different players may take advantage of their privileged position for personal gain, including the government regulator, the payer (social security, private or public health insurance), the provider (public or private), the drug and equipment suppliers, and the patients [27].

In the first place, researchers have remarked that corruption in the supply of pharmaceutical could explain the connection between overall levels of corruption in a country and its health outcomes [25]. The existence of an influential market of vendors and pharmaceutical firms creates a risk of bribery [28], and the discretion that health professionals have in deciding what medicines, and in what quantities, are needed increases the opportunity for abuse [20]. Physicians may become both psychologically and financially dependent on pharmaceutical firms as a result of gifts, and physicians may reciprocate by prescribing drugs of those pharmaceuticals [13,29]. These mechanisms may help to explain the link between measures of corruption in the health sector and antibiotic abuse. In addition, scholars also note that the relation between patients and health professionals also presents risks of bribery, as a result of information asymmetries and a demand for health services, which is largely inelastic [20]. Consequently, patients can ask, or be asked to, follow inappropriate procedures (e.g. antibiotics) in exchange for under-the-table payments [30]. These mechanisms may help to explain the link between measures of patients' direct experience with corruption (i.e. bribery) and antibiotic abuse.

##### 4.1. Strengths and limitations

This study is the first to investigate the link between regional levels of health system corruption/prevalence of bribery and consumptions of antibiotics. In the light of large regional variation in both prevalence of corruption and consumptions of antibiotics in Europe, this study is an extension of prior findings about the link between corrup-

tion and antimicrobial resistance at the national level [15]. Even so, the study has several limitations. The current study may be sensitive to ecological fallacy, i.e. to draw inferences about an individual level relationship based on aggregated data analysis. Future studies might address the relationship between corruption and individual consumption-patterns of antibiotics. Moreover, residual confounding from availability of non-prescription of antibiotics may account for part of the co-variation between corruption and antibiotic consumption. Additionally, social desirability might influence on respondents answering the question about their own consumption of antibiotics. Lastly, the relationship between corruption and antibiotic consumption could be spurious to cultural factors, such as cultural dimensions, that, in cross-country analyses, have been found to affect – or, to be more precise, to be statistically correlated, since the causation of culture is inherently difficult to falsify – both for explaining corruption and quality of governance [31] and antibiotic use [32]. Future research with reliable regional data on cultural dimensions should help to disentangle the relations, and the direction of the causal arrow, between corruption, cultural values, and health outcomes such as antibiotic consumption.

## 5. Conclusions

Using novel data from the European Quality of Government Index, the paper finds that indicators of corruption – the prevalence of corruption in the health sector and prevalence of bribes in the relations between citizens and public institutions – are strongly and positively linked to consumption of antibiotics. The association between corruption in the health sector (and the extension of bribery in the society) and antibiotic consumption is found to be persistent and strong also when controlling for indicators of socioeconomic development as well as the quality of the healthcare system. This paper thus shows that dysfunctional public institutions seem to be factors accounting for some of the notable sub-national variation in antibiotic consumption across Europe. Consequently, policy-makers interested in promoting a prudent use of antibiotics should pay attention to the role of governance and corruption.

## Competing interests

There are no competing interests.

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## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.healthpol.2016.12.010>.

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