Ecological Economics 75 (2012) 114–125

Contents lists available at SciVerse ScienceDirect

Ecological Economics

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

Analysis

Pollution, shadow economy and corruption: Theory and evidence ☆

Amit K. Biswas [a,b], Mohammad Reza Farzanegan [a,c,*], Marcel Thum [a,d]

[a] Faculty of Business and Economics, Technische Universität Dresden, Germany
[b] Department of Economics & Politics, Visva-Bharati, Santiniketan, India
[c] ZEW Mannheim, Germany
[d] ifo Dresden and CESifo, Germany

ARTICLE INFO

Article history:
Received 10 February 2011
Received in revised form 28 October 2011
Accepted 6 January 2012
Available online 31 January 2012

JEL classification:
Q53
Q56
Q58

Keywords:
Environmental pollution
Shadow economy
Corruption
Panel data

ABSTRACT

We study how the shadow economy affects pollution and how this effect depends on corruption levels in public administration. Production in the shadow economy allows firms to avoid environmental regulation policies; a large informal sector may be accompanied by higher pollution levels. Our theoretical model predicts that controlling the levels of corruption can limit the effect of the shadow economy on pollution. We use panel data covering the period from 1999 to 2005 in more than 100 countries to test this theoretical prediction. Our estimates confirm that the relationship between the shadow economy and the levels of pollution are dependent on the levels of corruption. Our results hold when we control for the effects of other determinants of pollution, time varying common shocks, country-fixed effects and various additional covariates.

1. Introduction

Water quality and air pollution have become serious problems in many developing countries. Human waste, fertilizers and industrial chemicals contaminate drinking water and cause significant health problems. According to the World Health Organization (WHO), water pollution is one of the main health risks and leads to approximately 2 million deaths annually. Air pollution causes about the same number of premature deaths worldwide per year. Pictures of megacities clouded by heavy fog, for instance, in China and Iran have appeared in newspapers around the world.[1] These problems are the negative effects of rapid growth driven by the extensive use of coal and fossil fuel.

Many of these environmental problems are fostered to a significant extent by the sizeable shadow economies in developing and emerging countries.[2] From 1999 to 2006, more than 50% of the overall GDP in Ukraine, Tanzania, Peru, Panama, Guatemala, Georgia and Bolivia originated in the shadow economy (Schneider et al., 2010). Between 1999 and 2006, the activity of shadow economies generated on average 34.5% of the official GDP in over 162 countries (Schneider et al., 2010).[3] Fig. 1 shows the average, minimum and maximum size of the shadow economy in the different regions.

The environmental hazards of the informal sector can be significant (Blackman, 2000). The shadow economy includes many pollution intensive activities, such as leather tanning, brick making, metal working, resource extraction, urban transportation with old and inefficient vehicles and production in small scale or family-based factories. In general, these firms do not follow environmental standards. The artisanal mining of gold, for example, uses mercury, which is discharged into rivers

☆ We are grateful to Peren Arin, Heike Auerswald, Caitlin Corrigan, Christian Lessmann and Gunther Markwardt for very helpful suggestions. We also wish to thank the participants of the European Public Choice Society conference (Izmir, 2010), 4th World Congress of Environmental and Resource Economists (Montreal, 2010), 11th IAEE European Conference (Vilnius, 2010), 67th Congress of the International Institute of Public Finance (Michigan, 2011) and brown bag seminars at the TU Dresden and ZEW Mannheim for their useful comments. The financial support of the Alexander von Humboldt foundation is highly appreciated.

* Corresponding author at: ZEW Mannheim, P.O. Box 103443, 68034 Mannheim, Germany. Tel.: +49 621 1235 227; fax: +49 621 1235 226.
E-mail addresses: amit.biswas@mailbox.tu-dresden.de (A.K. Biswas), farzanegan@zew.de (M.R. Farzanegan), marcel.thum@tu-dresden.de (M. Thum).

[1] Official Iranian sources report that approximately 10,000 people died due to the effects of pollution in 2005–06, calling living in Tehran a "collective suicide". Approximately 70% of Tehran air pollution comes from the transport sector where the informal transport plays a major role. (See http://news.bbc.co.uk/2/hi/middle_east/6245463.stm).

[2] A common definition of the shadow economy is "all economic activities that contribute to the officially calculated (or observed) gross national product but are currently unregistered" (e.g., Feige, 1994; Schneider, 1994). For a survey of the shadow economies around the world, see Schneider and Enste (2000).

[3] Employment in the informal economy is significant in many of these countries. More than 70% of all employment comes from the activity of the shadow economy in countries, such as Zambia (80.7%), Uganda (83.7%), Thailand (72.1%), Nepal (73.3%), Lithuania (72%), Ghana (78.5%) and Gambia (72.4%) (ILO, 2010).

0921-8009/$ – see front matter © 2012 Elsevier B.V. All rights reserved.
doi:10.1016/j.ecolecon.2012.01.007

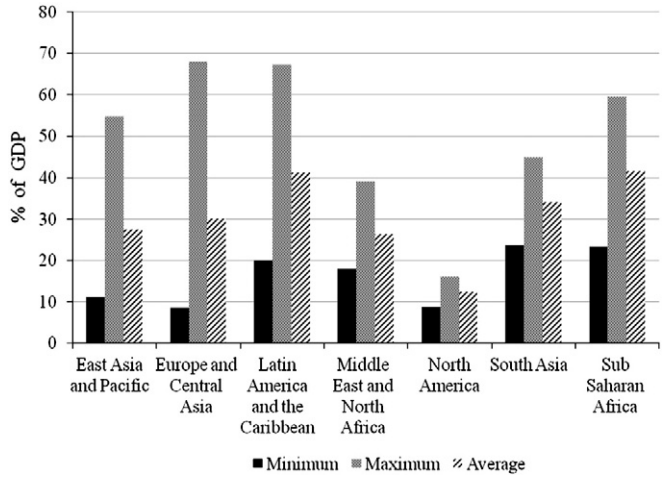

Fig. 1. Size of the *Shadow Economy* (% of GDP) around the World (1999–2005). Source: Schneider et al. (2010) and authors' calculations.

(Dondeyne et al., 2009). Bleaching, dyeing and tanning all produce dangerous chemicals, which can pollute rivers and groundwater (Baksi and Bose, 2010). Informal transportation in most developing countries is one of the main causes of local air pollution (SO_2 emission). Vehicles in the informal transportation sector are usually old, poorly maintained and do not meet environmental quality standards.[4]

Surprisingly, there is still a lack of theoretical and empirical research on the shadow economy–environment nexus. A few theoretical studies (Baksi and Bose, 2010; Chaudhuri and Mukhopadhyay, 2006) analyze the effectiveness of environmental regulation on informal sectors. One of the key insights is that higher regulatory pressures may induce firms to shift more activities to the shadow economy.[5] Unless governments fight the informal activities of shadow economies, they may not be able to implement effective environmental policies. Our model shows a similar effect of regulatory evasion. In addition, we account for the role of political and administrative corruption in the shadow economy–pollution nexus. Regulatory control is further weakened when economic agents in the informal economy can bribe corrupt regulatory officials, which enables firms to continue their polluting activities in the shadow economy even after detection.[6] We show that the destructive effects of the shadow economy are higher in countries with pervasive corruption. From a policy maker's perspective, fighting corruption may help to reduce the detrimental effects of the shadow economy on the environment.

In the literature, case and country studies provide evidence for the detrimental effects of the informal sector on pollution. For example, Blackman and Bannister (1998) and Blackman (2000) investigate the adaptation of propane by traditional brick makers in Mexico. Lahiri-Dutt (2004) examines informal mining in Asia and Biller (1994) describes the environmental hazards of informal gold mining in Brazil.[7] What is missing in the literature is a comprehensive, cross-country analysis of informal sector activities and environmental pollution. In our empirical model, we test the extent to which the informal sector contributes to pollution and corruption undermines environmental policy.[8] We use panel data covering the period from 1999 to 2005 in more than 100 countries. We find that the larger the shadow economy, the greater the pollution. However, this effect can be moderated by controlling corruption. Our results hold when we control for other major economic and demographic determinants of pollution, such as time varying common shocks, regional fixed effects and various additional covariates. We show the results for high-income and low-income countries separately to explore the possible differences between developed and developing countries.

The contributions of this paper are two-fold. First, we present a simple theoretical model that clearly demonstrates why we should expect the effect of the shadow economy on pollution to depend on the level of corruption. Second, we show that the theoretical effect of corruption on the shadow economy and pollution is empirically relevant. The remainder of the paper is structured as follows. Section 2 presents our theoretical model, which provides comparative statics that yield testable implications for subsequent analysis. Section 3 discusses our empirical strategy and the data. Section 4 presents the empirical evidence. Section 5 contains various tests of robustness and Section 6 concludes.

2. The Model

This section develops a simple model of production with pollution, which can take place in the formal and informal sectors. Administrative corruption may allow firms in the informal sector to circumvent environmental regulations without being punished.

The output x of a representative firm can be produced in both the formal and informal sectors: $x = x_F + x_I$, where x_F and x_I are the outputs in the formal and informal sectors, respectively. The basic difference between these sectors is that the formal sector complies with all governmental regulations, while the informal sector can illegally bypass them. As production generates negative environmental externalities, the government tries to restrict and monitor the production of x. Without abatement, each unit of output x produces one unit of environmental pollution. The government sets the level of abatement $e\varepsilon[0,1]Z$. The case of $e=0$ indicates no abatement. For $e=1$, there is complete control of pollution. When governmental regulation is in place, the degree of pollution for each unit of output is $1-e$. For the firm, the effort to reduce pollution comes at a cost of $a(e)$ per unit of x (with $a'>0$ and $a''\geq 0$) along with the marginal cost of production. The production cost is given by $c(x)$ with $c'(x)$ and $c''(x)>0$. The price of output is normalized to unity.

The cost of reducing pollution may tempt producers to move to informal production in the shadow economy. Shifting part of the production to the informal sector saves the producers the abatement costs on the amount of goods produced because the shadow economy does not require compliance with regulations. However, the government is aware of this possibility and monitors the production process. Thus, firms face the risk of detection. The probability of detection p depends on the size of informal production x_I. Therefore, $p = p(x_I)$ with $p'>0$, $p''\geq 0$, $p(0)=p'(0)=0$.

However, not all monitoring officials are honest. In our model, the share of corrupt officials is γ. Once a firm's illegal pollution is detected, the subsequent punishment depends on the type of monitoring official. If the monitor is honest, the firm loses all of its informal output (x_I) and the penalty is $L = x_I$.[9] However, if a dishonest producer meets a corrupt monitoring official, the firm can pay a bribe (b_I) to avoid legal consequences: $L = b_I$. The bribe will be determined by bilateral bargaining between the two parties.

[4] For more information on informal transport in developing countries, see a report by the UN-HABITAT at http://www.unhabitat.org/pmss/listItemDetails.aspx?publicationID=1534.

[5] Pollution leakage can also occur without the informal sector if environmental regulations differ between regions or sectors; see Copeland and Taylor (2003) and Fowlie (2009).

[6] The direct link between corruption and pollution is discussed elsewhere; see Lopez and Mitra (2000) for a theoretical analysis and Pellegrini and Gerlagh (2006) or Welsch (2004) for empirical studies.

[7] Veiga et al. (1994) point out that high mercury levels in the blood of fish-eating people in the Amazon are due to gold mining activities in the informal economy.

[8] We discuss the literature on the determinants of pollution in Section 3.

[9] We employ here a special punishment function because the firm loses all output in the informal sector. Note, however, that any function that links punishment to output and, in case of detection, reduces the net value below the outcome in the formal sector would lead to the same results.